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The Department of Defense

DEPARTMENT/AGENCIES PARTICIPATING:

Department of the Army

Department of the Navy

Department of the Air Force

Defense Advanced Research Projects Agency

Defense Nuclear Agency

Strategic Defense Initiative Organization

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Closing Date: 5 January 1990

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Number 90.1
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Innovation Research
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TABLE OF CONTENTS

		Page
1.0	PROGRAM DESCRIPTION	1-2
1.1	Introduction	1
1.2	Three Phase Program	1
1.3	Follow-On Funding	2
1.4	Eligibility and Limitations	2
1.5	Conflicts of Interest	2
1.6	Contact With DoD	2
2.0	DEFINITIONS	3
2.1	Research or Research and Development	3
2.2	Small Business	3
2.3	Minority and Disadvantaged Small Business	3
2.4	Women-Owned Business	3
2.5	Subcontract	3
3.0	PHASE I PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS	4-5
3.1	Proposal Requirements	4
3.2	Proprietary Information	4
3.3	Limitations on Length of Proposal	4
3.4	Phase I Proposal Format	4-5
3.5	Bindings	5
3.6	Phase II Proposal	5
4.0	METHOD OF SELECTION AND EVALUATION CRITERIA	6
4.1	Introduction	6
4.2	Evaluation Criteria - Phase I	6
4.3	Evaluation Criteria - Phase II	6
5.0	CONTRACTUAL CONSIDERATIONS	7-10
5.1	Awards (Phase I)	7
5.2	Awards (Phase II)	7
5.3	Reports	7
5.4	Payment Schedule	7-8
5.5	Markings of Proprietary or Classified Proposal Information	8
5.6	Copyrights	8
5.7	Patents	8
5.8	Technical Data Rights	9
5.9	Cost Sharing	9
5.10	Joint Ventures or Limited Partnerships	9
5.11	Research and Analytical Works	9
5.12	Contractor Commitments	9
5.13	Additional Information	10

6.0 SUBMISSION OF PROPOSALS.....10-11

6.1 Address..... 10
6.2 Deadline for Proposals..... 10
6.3 Notification of Proposal Receipt..... 11
6.4 Information on Proposal Status..... 11
6.5 Debriefing of Unsuccessful Offerors..... 11
6.6 Correspondence Relating to Proposals..... 11

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE.....11-12

7.1 DoD Technical Information Services Available.....11-12
7.2 Other Technical Information Assistance Sources..... 12
7.3 Counseling Assistance Available..... 12

8.0 TECHNICAL TOPICS..... 12

Appendix A --- Proposal Cover Sheet..... 13
Appendix B --- Project Summary..... 15
Appendix C --- Cost Proposal..... 17
Appendix D --- Technical Topics.....19-438

DEPARTMENT OF THE ARMY

Special Instructions..... 21
Addresses for Mailing Proposals.....22-27
Index of Army Topic.....28-36
Topic Descriptions.....37-157
Armament RDE Center (Topic 001-018).....37-48

Aviation Systems Command (Topics 140-158).....120-130
Belvoir RDE Center (Topics 109-021)..... 48-49
Chemical RDE Center (Topics 045-049.....66-69
Communications - Electronics Command RDE Center
(Topics 022-044).....49-66

Corps of Engineers (Topic 161-170).....131-138
Cold Regions Research and Engineering Lab (Topic 165).....134-135
Construction Engineering Lab Topics 161-164).....131-134
Engineer Waterways Experiment Station (Topic 170).....138
Engineering Topographic Lab (Topics 166-169)..... ..135-138

Institute for Research In Management Information Communicati.
and Computer Science (Topics 159-160).....130-131

Laboratory Command (Topics 089-139).....92-120
Atmospheric Science Lab (Topics 100-103).....98-99
Army Research Office (Topics 092-099).....93-98
Ballistic Research Lab (Topics 089-091).....92-93
Electronics Technology and Devices Lab (Topics 104-113).....99-105
Harry Diamond Lab (Topics 121-129).....108-114
Human Engineering Lab (Topics 114-120).....105-108
Materials Technology Lab (Topics 130-135).....114-118
Vulnerability Assessment Lab (Topics 136-139).....118-120

Medical Research and Development Command (Topics 177-192).....142-149
Missile Command (Topics 050-060)..... ..69-75
Natick RDE Center (Topics 061-068.....75-79
Research Institute for Behavioral and Social Sciences
(Topics 171-176).....138-141
Strategic Defense Command (Topics 193-206).....149-157
Tank Automotive Command (Topics 069-074).....79-82
Test and Evaluation Command (Topics 075-088).....82-92

DEPARTMENT OF THE NAVY
Special Instruction.....159
Addresses for Mailing Proposals.....160-166
Index of Navy Topics.....167-178
Topic Descriptions.....179-275
Air Development Center (Topics 231-241).....249-253
Air Engineering Center (Topics 252-254).....255-256
Air Propulsion Center (Topics 270-272).....261-262
Air Systems Command (Topic 060-118).....197-216
Air Test Center (Topics 303-305).....272-273
Avionics Center (Topics 306-310).....273-275
Civil Engineering Lab (Topic 267-269).....260-261
Coastal Systems Center (Topics 265-266).....260
David Taylor Research Center (Topics 298-302).....270-272
Marine Corps (Topics 021-044).....184-193
Medical Research and Development Command (Topics 058-059).....197
Ocean Systems Center (Topics 273-297).....262-270
Office of Naval Research (Topics 001-010).....179-181
Office of Naval Technology (Topics 011-020.....182-184
Pacific Missile Test Center (Topics 255-260).....256-258
Section Systems Command (Topics 119-170).....216-231
Space and Naval Warfare Systems Command (Topics 045-049) ..193-194
Supply Systems Command (Topics 050-057).....195-197
Surface Weapon Center (Topics 171-211).....231-243
Training Systems Command (Topics 261-264).....258-260
Underwater Systems Center (Topics 243-251).....253-255
Weapons Support Center/Crane (Topics 212-213).....243-244

DEPARTMENT OF THE AIR FORCE

Special Instructions.....277
Addresses for Mailing Proposals.....277-278
Organization Contacts.....279
Index of Air Force Topics.....280-288
Topics Descriptions.....289-363
Aeronautical Systems Division (Topics 069-133).....315-338
Arnold Engineering Development Center (Topics 021-025).....296-298
Ballistic Systems Division (Topics 167-183).....350-358
Electronic Systems Division (Topics 026-029).....298-299
Engineering and Service Center (Topics 052-056).....306-308
Human Systems Division (Topics 057-068).....308-315
Munitions Systems Division (Topics 001-020).....289-296
National Aero-Space Plane Joint Office (Topics 192-199)....361-363
Office of Scientific Research (Topics 184-191).....358-361
Rome Air Development Center (Topics 030-051).....299-306
Space Systems Division (Topics 134-166).....338-350

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Special Instructions and Address for Mailing Proposals.....365
Proposal Check List.....366
Index of DARPA Topics.....367-369
Topic Descriptions.....370-407

DEFENSE NUCLEAR AGENCY

Special Instructions and Address for Mailing Proposals.....409
Index of DNA Topics.....409
Topic Description.....410-419

STRATEGIC DEFENSE INITIATIVE ORGANIZATION

Special Instructions and Address for Mailing Proposals.....421
Index of SDIO Topics.....422
Topic Descriptions.....423-428

REFERENCES

A - Prior Years Results of DoD SBIR Program.....429
B - Notification of Proposal Receipt Request.....431
C - DTIC Information Request.....433-434
D - Directory of Small Business Specialists.....435-438

SBIR CONFERENCE NOTICE.....439

DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Nuclear Agency (DNA), and Strategic Defense Initiative Organization (SDIO), hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense related scientific or engineering problems.

Objectives of the DoD SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219 and PL 99-443. The basic design of the DoD SBIR program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, June 1988. The DoD program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD. Results from prior years are shown in Reference A at the back of this solicitation.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219 and PL 99-443. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measures of Phase I success include evaluations of the extent of which Phase II results have the potential to yield a product or process of continuing importance to DoD. Proposers are asked to consider whether the research and development they are proposing to DoD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the Government funded research and development phases.

Subsequent Phase II awards will be made to firms only on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the research or development. Also, under Phase III, federal agencies may award non SBIR-funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed in part, to provide incentives for the conversion of federally-sponsored research and development innovation in the private sector. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-on Funding

In addition to supporting scientific and engineering research development, another important goal of the program is conversion of DoD supported research or research and development into technological innovation by private firms. Therefore, on an optional basis, the DoD program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in this solicitation Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the cover sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in this solicitation.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD component for further guidance.

1.6 Contact with DoD

a. Oral Communications. Oral communications with DoD Components regarding this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness, with the exceptions as stated in Section 1.6, 7.0, and Appendix D of this program solicitation.

b. Contacts for General Information on This Solicitation. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(202) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Appendix D of this solicitaiton.

c. Requests for Additional Copies of This Solicitation. Additional copies of this solicitation may be ordered from the Defense Technical Information Center: Attn: DTIC/SBIR, Building 5, Cameron Station,m Alexandria, Virginia 22304-6415; telephone (800) 368-5211 (toll free)/(202) 274-6902 (commercial for Virginia, Alaska and Hawaii).

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research – A systematic, intensive study directed toward greater knowledge or understanding of the subject studied.

Exploratory Development – A systematic study directed specifically toward applying new knowledge to meet a recognized need.

Advanced Development or Engineering Development – A systematic application of knowledge towards the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (A) one concern controls or has the power to control the other; or (B) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contratual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Miniority and Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and

b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small businesses, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups; Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or Asian-Indian Americans.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51 percent owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

3.0 PROPOS _ PREPARATIONS INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR program is to provide sufficient information to persuade the DoD Component that the proposed work represents a sound approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the DoD program objectives, but can also serve as the base for technological innovation, new commercial products, process, or services which benefit the public.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation; including those contained in Appendix D.
- Use the free technical information services from DTIC (Section 7.5) and also the free assistance available at the DCAS near you (Section 7.3).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages.
- Don't include proprietary information in the project summary (Appendix B).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, (no type smaller than elite on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch) *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments*. Promotional and non-project-related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25-page limitation will be considered in proposal evaluation, and proposals in excess of the 25-page limitation *will not* be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss briefly as described in Section 3.4, items b and h.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered.

a. Cover Sheet. Photocopy and complete the form in Appendix A as page 1 of each copy of each proposal.

b. Project Summary. Photocopy and complete the form identified as Appendix B as page 2 of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, *will not* contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed descripton of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Briefly describe:

(1) Whether and by what means the proposed project appears to have potential use by the federal Government.
(2) Whether and by what means the proposed project appears to have potential commercial application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available insturmentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of two-thirds of each SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, or will be submitted, or from which an award is expected or has been recieved.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received
(6) If award was received, state contract number.
(7) Specify the applicable topics for each pending SBIR proposal submitted or award received.

Note: *If Section 3.4.1 does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."*

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds, will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is not initiated by a solicitation, but a proposal must contain a cover sheet (Appendix A) and a project summary sheet (Appendix B) of this solicitation. Instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government contracting officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, or research and development, program balance, budget limitations and the potential of a succerssful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the Government with approximately equal consideration given to each of the following criteria, except for item a., which will receive twice the weight of any other item.

a. Scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.

b. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.

c. Anticipated benefits of the research or research and development to the total DoD research and development effort.

d. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred-to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item a., which will recieve twice the value of any other item:

a. Anticipated benefits of the research or development to the total DoD research and development effort.

b. Scientific/technical quality of the proposal, with special emphasis on its innovation and originality.

c. Qualifications of the principal investigator and other key personnel to carry out the proposed work.

d. Degree to which the Phase I objectives were met at the time of Phase II proposal submission.

e. Adequacy of the Phase II objectives to meet the opportunity or solve the problem.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for a continued development from non-federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by Government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. **Number of Phase I Awards.** The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 5, 1990. The names of those firms selected for awards will be announced. *The DoD Components anticipate making 1200 Phase I awards during Fiscal Year 1990.*

b. **Type of Funding Agreement.** All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects. *Note: The firm fixed price contract is the preferred type for Phase I.*

c. **Average Dollar Value of Awards.** DoD Components will make Phase I awards to small businesses typically of one-half person-year effort over a period generally not to exceed six months, *subject to negotiation*. The legislative history of PL 97-219 and PL 99-443 clearly envisioned a large number of Phase I awards up to $50,000 each, *adjusted for inflation*.

5.2 Awards (Phase II)

a. **Number of Phase II Awards.** The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate making 450 Phase II awards during Fiscal Year 1990.*

b. **Type of Funding Agreement.** Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the Government to award a Phase II contract.

c. **Average Dollar Value of Awards.** Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific and technical merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, *subject to negotiation*. The legislative history of PL 97-219 and PL 99-443 clearly envisioned that the Phase II awards would be up to $500,000 each, *adjusted for inflation*.

5.3 Reports

Six copies of a final report on the Phase I project must be submitted to the DoD Component in accordance with the negotiated delivery schedule. This will normally be within thirty days after completion of the Phase I technical effort. The final report shall include a completed SF 298, "*Report Documentation Page*" as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. The summary may be published by DoD and therefore must not contain proprietary or classified information. The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon negotiations between the DoD and the successful Phase I offeror. Based on negotiations, successful offerors may be paid under applicable authorized progress payment procedures or in accordance with a negotiated price and payment schedule. Phase I contracts are primarily fixed price in nature under which monthly progress payments may be made up to 85 percent of the billing including an allowance for profit. Final payment will follow completion of contract

performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data, which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information of data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "*confidential proprietary information*" and provided that the following legend appears on the title page of the proposal:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the contract. This restriction does not limit the Government's right to use informaiton contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) ____ of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Informaiton Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the Government shall have the limited right to use such data for Government purposes and shall not release such data outside the Government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the Government shall retain a royalty-free license for Government use of any technical data delivered under an SBIR contract whether patented or not.

5.9 Cost Sharing

Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Paragraph 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

c. Examinaton of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The Government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Conveience. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. **Equal Opportunity.** The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The Government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

Five (5) copies of each proposal or modification will be submitted, in a single package, as described below.

6.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Appendix D to this solicitation.

One copy must be an original signed by the principal investigator and an official empowered to commit the proposer. Other copies may be photocopied.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate "information" copies or several packages containing parts of the single proposal.

6.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DoD Component is 2:00 p.m. local time, January 5, 1990. Any proposal received at the office designated in the solicitaiton after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than December 29, 1989 or (b) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late received proposal sent either by registered mail or certified mail is the U.S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term "postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U.S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye "postmark" on both the receipt and the envelope or wrapper; (b) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term "telegram" includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed and stamped envelope and a copy of the notification form (Reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced a debriefing may be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DoD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DoD-sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requestors who responded to previous DoD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DoD-funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DoD-sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DoD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 368-5211 (Toll Free)
(202) 274-6902 (Commercial for Virginia, Alaska and Hawaii)

DTIC Boston On-Line Service Facility
DTIC-BOS
Building 1103, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
AFWL/SUL Bldg. 419
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4320
(213) 335-4170

Use Reference C at the back of this solicitation to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible. Requests received after mid-December are frequently subject to mailing delays.

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

Aerospace Research Applications Center
P.O. Box 647
Indianapolis, IN 46223
(317) 264-4644

Central Industrial Applications Center
Southeastern Oklahoma State University
Durant, OK 74701
(405) 924-6822

Information Strategists
814 Elm Street
Manchester, NH 03101
(603) 624-8208

NASA/Florida State Technology Applications Center
State University System of Florida, Progress Center
1 Progress Blvd. Box 24
Alachua, FL 32615
(904) 462-3913

NASA Industrial Applications Center
823 William Pitt Union
University of Pittsburgh
Pittsburgh, PA 15260
(412) 648-7000

NASA/UK Technology
University of Kentucky
109 Kinkead Hall
Lexington, KY 40506
(606) 257-6322

NERAC, Inc.
1 Technology Drive
Tolland, CT 06084
(203) 872-7000

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

North Carolina Science and Technology Research Center
Post Office Box 12235
Research Triangle Park, North Carolina 27709
(919) 549-0671

Western Research Applications Center (WESRAC)
University of Southern California
3716 S. Hope Street #200
Los Angeles, California 90007
(213) 743-6132

7.3 Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout the continental United States. These specialists are available to discuss general administrative requirments to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference D at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCAS Activities.)

8.0 TECHNICAL TOPICS

Topics for each DoD Component are listed and numbered separately. Topics, topic descriptions, and addresses of organizations to which proposals are to be submitted are provided in Appendix D. Also included in Appendix D are instructions for contacting each DoD Component.

APPENDIX A
DoD No. 90.1

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to fill in all appropriate spaces may cause your proposal to be disqualified.
Avoid typing on lines - this form will be read by optical character reader.

TOPIC NUMBER:

PROPOSAL TITLE:

SUBMITTED BY:
FIRM:
ADDRESS:
CITY, STATE, ZIP

SUBMITTED TO:
NAME AND
ADDRESS

PHASE I OR II PROPOSAL (I OR II)
PROPOSED COST: $
PROPOSED DURATION (MONTHS)

Please provide answers to the questions below in the box to the right.

BUSINESS CERTIFICATION:

- Are you a small business as described in paragraph 2.2? (yes or no)
- Number of employees including all affiliates (average for preceding 12 months)
- Are you a minority or small disadvantaged business as defined in paragraph 2.3? (yes or no)
- Are you a woman-owned small business as described in paragraph 2.4? (yes or no)
- This proposal has been submitted to other US government agency/agencies; or DoD components, or the same DoD component. (yes or no) If SBIR proposal, list Topic Number and name of activity submitted to.
- Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? (yes or no)
- Disclosure permission statements:
  All data on Appendix A are releasable.
  All data on Appendix B, for an awarded contract, are also releasable.

- Project Manager/Principal Investigator

Name
Title
Signature
Date
Telephone

- Corporate Official (Business)

Name
Title
Signature
Date
Telephone

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed to the right of this paragraph.

Nothing on this page is classified or proprietary information/data.
Proposal page no. 1

APPENDIX B
DoD No. 90.1

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Topic No. ____ Military Department/Agency ____

Phase I ____
Phase II ____ (check one)

Name and Address of Proposing Small Business Firm

Name and Title of Principal Investigator

Proposal Title

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

Nothing on this page is classified or proprietary information/data
Proposal page No. 2

APPENDIX C
DoD No. 90.1

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PHASE I – FY1990
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total Dollar amount of the proposal (dollars)
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional trnasfers (at other than cost) (dollars)
   d. Total direct material (dollars)
8. Material overhead (rate ____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type.
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost.
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at Government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per Diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars)
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone/extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

APPENDIX D

Technical Topics

Topics for each DoD components are listed and numbered seperately along with instructions for submission of proposals:

COMPONENT	PAGE
Army	21 thru 157
Navy	159 thru 275
Air Force	277 thru 363
Defense Advanced Research Projects Agency	365 thru 407
Defense Nuclear Agency	409 thru 419
Strategic Defense Initiative Organization	421 thru 428

U.S. ARMY

INTRODUCTION

Companies submitting Army proposals to the Medical Research Acquisition Activity - Topics A90-177 Through A90-192 are subject to an Environmental Requirement. Under the provisions of the National Environmental Policy Act, USAMRDC requires a letter from the contractor, signed by a senior official, certifying the current status of compliance/noncompliance of their organization with applicable federal, state, and local environmental laws and regulations. The certification should also include a statement indicating whether the environmental impact of the proposed research has been considered and what, if any, significant impact the research will have on the environment. If, applicable, environmental concerns to be addressed will include, but not be limited to, handling and disposal of medical wastes; handling and disposal of hazardous toxic substances; handling, transportation, and disposal of biological material, and clean air and clean water concerns.

Inquiries of a general nature or where a problem may exist that requires the Army SBIR Program Manager's attention may be addressed to:

Commander
U.S. Laboratory Command
ATTN: AMSLC-TP-TI (J. Patrick Forry)
2800 Powder Mill Road
Adelphi, MD 20783-1145

In no case should proposals be sent to the above address.

ADDRESSES FOR

MAILING PROPOSALS

TOPICS A90-001 Through A90-018
Commander
U.S. Army Armament Research and Development
and Engineering Center
ATTN: SMCAR-AST
Bldg 1, SBIR Program
Picatinny Arsenal, NJ 07806-5000
Telephone: T. Ryan 201-724-7553

TOPICS A90-019 Through A90-021
Commander
U.S. Army Belvoir RD&E Center
ATTN: AMSTR-PBP, SBIR Program
Bldg 314, Procurement Receptionist
Ft. Belvoir, VA 22060-5606
Telephone: C. Harrison 703-664-1068

CECOM RDE CENTER

TOPICS A90-022 Through A90-044

TOPICS A90-022 Through A90-032
A90-040 Through A90-044
Commander
U.S. Communications-Electronics Command
ATTN: AMSEL-PC-BID, SBIR Program
Tinton Avenue
Fort Monmouth, NJ 07703-5000
Telephone: J. Crisci 201-544-2665

TOPICS A90-033 Through A90-036
Director
U.S. Army Center for Signal Warfare
ATTN: AMSEL-RD-SW-SA
SBIR Program (Dr. Royal Burkhardt)
Vint Hill Farms Station
Warrenton, VA 22186-5100
Telephone: J. Crisci 201-544-2665

TOPICS A90-037 Through A90-039
U.S. Army Center for Night Vision & Electro-Optics
ATTN: AMSEL-RD-NV-RM-PI
SBIR Program (Linda Kline)
Fort Belvoir, VA 22060-5677
Telephone: J. Crisci 201-544-2665

TOPICS A90-045 Through A90-049
Commander
U.S. Army Chemical Research, Development
and Engineering Center
ATTN: AMSMC-PC-B(A)
Procurement Directorate
Edgewood Site/Bldg F4455
Aberdeen Proving Ground, MD 21010-5423
Telephone: R. Hinkle 301-671-2031

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TEST AND EVALUATION COMMAND

TOPICS A90-075 Through A90-088

TOPICS A90-076, A90-078, A90-080, A90-084, A90-087
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ARMY LABORATORY COMMAND

TOPICS A90-089 Through A90-139

TOPICS A90-089-A90-091
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CORPS OF ENGINEERS

TOPICS A90-161 Through A90-170

TOPICS A90-161 Through A90-164
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INDEX
DEPARTMENT OF THE ARMY
FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

ARMAMENT RDE CENTER

A90-001 Fire Control Initiatives

A90-002 General Gun Bore Evacuator and Flareback Control Code

A90-003 Ignition of High Energy Density Charges

A90-004 Investigation of Combat Vehicle Fire Control Position, Navigation and Directional Reference Techniques Using Global Positional System (GPS)

A90-005 Ultrasonic Measurement of Through-Wall Stress State in Loaded Artillery Projectiles

A90-006 Fire Retardant and Wood Preservative Treatment for Wood

A90-007 High Speed Inspection of 5.56mm Cartridge Case Primer Pockets

A90-008 Radiographic Image Prediction and Computer Modeling

A90-009 Computer Virus Prevention for Embedded Computer Weapon System

A90-010 Integrated Target Recognition and Tracking

A90-011 Improved Fusible Link for FASCAM Mines

A90-012 Curved LCD for Multi-Option Fuzing Applications

A90-013 Low Cost COMVAT Cased Telescoped Ammunition

A90-014 Optical Designs for Enhancing Laser Eye Protection

A90-015 Radiographic Image Processing Using Neural Networks

A90-016 Electronics Encapsulation Materials/Methods Incorporating Electronic Shielding

A90-017 Remote Processing of Lead Styphnate

A90-018 Software Development with Enhanced RAM

BELVOIR RDE CENTER

A90-019 Low Emissivity and Low Reflectance Materials

A90-020 Lightweight Footbridge Concepts

A90-021 Long Pulse Solid State High Power Microwave Source

CECOM RDE CENTER

A90-022 Tactical Forces C3IEW Space Surveillance Countermeasures

A90-023 Spaced Based Battlefield Deception

A90-024 Voice Authentication/Recognition

A90-025 Innovation Techniques for Overcoming CoChannel Interference in HF Modems

A90-026 Artificial Intelligence for Command and Control

A90-027 Multiple Sensor Automatic Template Generator

A90-028 Modulation Based Pulse Association Techniques

A90-029 Fiber Optic Remote Antenna System

A90-030 Distribution Ada Real-Time Software: Development and Execution Support

A90-031 Requirements Engineering Methodology and Techniques

A90-032 Software Refuse Technologies & Tools

A90-033 Electronic Warfare HF Antenna Size Reduction

A90-034 High Power Density Transmitter Cooling Device

A90-035 Directive Radiating Expendable Jammer

A90-036 Analysis and Evaluation of Advanced Direction Finding (DF) Approaches

A90-037 Assumption Truth Maintenance System in ATR Algorithm Design

A90-038 Solid-State Laser Materials Development for Efficient Emission of Radiation in the Visible to Infrared Bands

A90-039 In Vacuum Processing of Infrared Detector Arrays

A90-040 Integrated Audio-Video Headset Display Terminal (IAVHDT) for Maintenance Personnel

A90-041 Process Improvement Tool for Software Development

A90-042 Testing of Military Production Hardware

A90-043 Improved Software Fault Tolerance Techniques

A90-044 Capturing Analog Design for Technology Update

CHEMICAL RDE CENTER

A90-045 Development of a Device for Sorting Micro Size Dielectric and Conducting Powders

A90-046 Single Particle Multianalysis Chamber

A90-047 Atmospheric Pressure Ion-Molecule Chemistry in Ion Mobility Spectrometers for Increased Sensitivity and Specificity

A90-048 Vehicle Interior Decontamination System

A90-049 Detection of Large Molecular Weight Toxins

MISSILE COMMAND

A90-050 Pulse Jet Engine Technology

A90-051 Slugless, Multiple High Velocity Pulse Shaped Charge Jets

A90-052 Low Cost Collapsible Mandrel Substitutes

A90-053 Drag Brake/Wing Deployment Mechanization

A90-054 Alignment Transfer for Helicopter Launched Inertially Guided Missiles

A90-055 Electro-Mechanical (EM) Actuator Driver

A90-056 Synthesis of Cadmium Sulfide

A90-057 Acquisition and Classification of Helicopters in Defilade

A90-058 Observer Degradation Model

A90-059 Infrared Targets for Testing System Resolution

A90-060 Power Transmission Utilizing Laser and Electro-Optic Technology

NATICK RDE CENTER

A90-061 Easy Open Metal or Polymeric Tray Pack

A90-062 Thermal Manikin Design and Fabrication Utilizing Heat Pipe Technology

A90-063 Eye Protection Against Tunable Laser Sources

A90-064 Integrated Ballistic Casualty Reduction and Ballistic Protection Model

A90-065 Novel EMI Gasket Concepts for Tactical Shelters

A90-066 Development of a Lightweight, Quiet, Power Source

A90-067 Processing and Spinning of Protection Fibers

A90-068 Coated Fabric for Five Soldiers Crew Tent (FSCT)

TANK AUTOMOTIVE COMMAND

A90-069 Robotic Convoy Capability

A90-070 Advanced Concept Evaluation (ACE)

A90-071 Cold Start Systems

A90-072 Robotic Vehicle Communication Controller

A90-073 Variable Valving Mechanisms

A90-074 Ruggedized, Low Cost, Engine Mounted Oil Analysis Sensor

TEST AND EVALUATION COMMAND

A90-075 Explosive Noise Abatement

A90-076 Improved Performance of High Energy Laser Exhaust System

A90-077 Rapid Active Small Arms Scoring System

A90-078 Scenario Generation for the White Sands Air Defense Test Bed

A90-079 Vehicle Mounted In-Situ Real-Time Dust Measurement System

A90-080 Radar Signal Processor

A90-081 Projectile Follower Tracking Control Subsystem

A90-082 Testing Embedded Neural Network-Based System

A90-083 Multistatic Projectile Tracking Radar

A90-084 Digital Filtering Using Simulation Models

A90-085 Measurement of Chrome Chipping in Gun Tubes

A90-086 Projectile Impact Point Scoring System

A90-087 Holographic Imaging of Plume Particulates in the Laser/Target Interaction Event

A90-088 Accelerated Corrosion Testing of Military Vehicles

BALLISTIC RESEARCH LABORATORY

A90-089 Compact and Field-Worthy Ultraviolet Laser

A90-090 A Device for Direct Measurement of Penetration in Steel Plates

A90-091 Firepower Allocation Methods

ARMY RESEARCH OFFICE

A90-092 Signal Design, Error-Control Coding, and Robust Stochastic Processing for Signals in Noise and Interference

A90-093 Optical Techniques for the Control and Data Processing of Microwave and Millimeter Arrays

A90-094 Methods for Reaction Front Measurements

A90-095 Concentration Fluctuation Measurement in the Atmospheric Boundary Layer

A90-096 Application of Ion-Induced Disordering to the Fabrication of Novel and Ultrasmall Electronic Structures

A90-097 Low-Cost High-Performance High-Electron-Mobility Transistors

A90-098 Computational Methodology for Finned Missiles and Guided Projectiles

A90-099 Adaptive Antennas and Processing

ATMOSPHERIC SCIENCE LABORATORY

A90-100 Nowcasting Temperature Inversions

A90-101 Optical Device to Measure Aerosol Densities

A90-102 Atmospheric Mesoscale Precipitation and Cloud Model

A90-103 Modeling Atmospheric Effects on Thermal Clutter

ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY

A90-104 High Energy Density Dielectric Materials

A90-105 10 Micron Infrared Phototransistor

A90-106 Integrated Circuit Device Packaging Protection Against High Power Microwave Directed Energy Weapons

A90-107 Multi-Beam Phased Array Sensor for Tank Defense

A90-108 High-Temperature Superconductor Devices

A90-109 Monolithic Microwave-Acoustic Devices

A90-110 RF Circuit Testability and Built-In-Test Approaches

A90-111 Nanoelectronics

A90-112 Microwave Plasma Deposition of Refractory Materials for High Performance Electronic Devices

A90-113 Microcircuit Reliability Temperature Dependency

HUMAN ENGINEERING LABORATORY

A90-114 Artificial Intelligence (AI) Applications to Tactical Logistics

A90-115 T-Handle Side-Arm Control for Combat Vehicles

A90-116 Combat Robotic Command Center Simulator

A90-117 Combat Vehicle Tactical Display System (TDS)

A90-118 Visual Transition Enhancement

A90-119 Combat Vehicle Crewman (CVC) Seat

A90-120 Soldier Compatible Air Defense Display

HARRY DIAMOND LABORATORIES

A90-121 Tactical Terrain Reasoning System

A90-122 Performance of Multi-Layer Wide Band Patch Antennas

A90-123 Optical Interferometers for Sensing Electromagnetic Fields

A90-124 Automated Electronics Assemble and Test

A90-125 Guided-Wave TeO2 Optical Devices

A90-126 Acceleration Sensing Module for Munition Safety Systems

A90-127 Electromagnetic Protectors for Microwave Circuitry

A90-128 Light Weight Electromagnetic Shielding Material

A90-129 Optical Control and Distribution of Microwaves

MATERIALS TECHNOLOGY LABOATORY

A90-130 Non-Destructive Evaluation of Bond Quality

A90-131 Novel Surface Treatments for Improved Adhesive Bonds

A90-132 Rugged Miniaturized Sensors for Real Time Process Control

A90-133 Metal Injection Molding of Tungsten Heavy Alloys

A90-134 SHS/Combustion Synthesis of Advanced Materials

A90-135 Directional Solidification of Liquid Phase Sintered Tungsten Heavy Alloys

VULNERABILITY ASSESSMENT LABORATORY

A90-136 Air Defense and Space Systems EW Vulnerability

A90-137 EW Vuln Assessment Methodology for Communications Systems

A90-138 Spectrally Tailored Electro-Optical Countermeasures (EOCM)

A90-139 Multispectral Scenes Simulations

AVIATION SYSTEMS COMMAND

A90-140 Flechette Expulsion Augmentation Mechanism (FEAM)

A90-141 Infrared (IR) Signature Reduction Flow Model Test Stand

A90-142 Incident Laser Directional and Power Level Sensor System

A90-143 Advanced Composite Structures Repair Technology - Heat/Pressure Fabrication Equipment/Materials

A90-144 Particulate Sensor for Turboshaft Gas Turbine Engines

A90-145 Improved Methods for High Heat Treated Vacuum Slag Remelt (VSR) and Electroslag Remel (ESR) Steels

A90-146 High Stability Cores

A90-147 Visualization Techniques for Displaying Cognitive Functions and Heuristic Reasoning

A90-148 Field Repair Techniques and Equipment for Fiber Optic Components

A90-149 Fiber Optic Components for Turboshaft Engine Control Systems

A90-150 Fatigue Effects of Thermoplastic Helicopter Components with Embedded Delaminations

A90-151 Nondestructive Inspection of Metal Matrix Composites for Gas Turbine Engines

A90-152 Semi-Automated Scriber for Measuring Bearing Defects

A90-153 Advanced Methods for Prognosis of Failure of Critical Rotorcraft Components

A90-154 A Technique to Assess the Cognitive Complexity of the Man-Machine Interface

A90-155 Knowledge Base Development for Rotorcraft Situation Assessment (SA)

A90-156 Piezoelectric Vibration Cancellation System

A90-157 Torque Sensors for Turboshaft Engines

A90-158 Dynamic Stall Control

AIRMICS

A90-159 Ada Programming Support Environment

A90-160 Application of Neural Networks to Executive Information of Support Systems

CERL

A90-161 Self-Contained Portable/Mobile Soil Testing Field Units

A90-162 Laser Paint Removal

A90-163 Ventilation Effectiveness Testing Method

A90-164 Design Features Based Project Data Organization

CRREL

A90-165 Ice Accretion and Persistence at Unmanned Sites

ETL

A90-166 Development of Automated Methods of Change Detection for Combat Support Using Digital Synthetic Aperture Radar (SAR) Imagery

A90-167 Detection of Long Term Changes for Updating Digital Terrain Data Bases from All Source Imagery

A90-168 Applications of Artificial Neural Networks to Object Detection from All Source Imagery

A90-169 Mission Planning Workstation

WES

A90-170 Camouflage Materials

ARI

A90-171 ircrew Member Task Allocation

A90-172 Cognitive and Temperament Predictors of Executive Ability

A90-173 Aids for Situation Development

A90-174 Personnel and Organizational Factors Affecting Organizational Performance

A90-175 Morals, Social Climate, and Job Satisfaction Indicator's for the U.S. Army

A90-176 Measurement of the Performance of Army Tactical Units

MEDICAL

A90-177 Medical Countermeasure Against Low Molecular Weight

A90-178 X Basic Research

A90-179 Medicinal Chemistry-Synthesis of Potential Drugs Effective Against Toxic Agents Agents of Biological Origin

A90-180 Detection, Diagnosis, and Therapy for Toxin Exposure

A90-181 Diagnosis of Natural and Induced Diseases of Military Importance

A90-182 Medicinal Chemistry-Synthesis of Potential Antimalaria Drugs

A90-183 Detection of Antibody to, Antigen of and/or Nucleic Acid of the Virus of Enterically transmitted non-A and non-B hepatitis (Hepatitis E Virus)

A90-184 Expression of Flavivirus Genes and Production of Proteins Suitable for Testing as Vaccine Candidates

A90-185 Medicinal Chemistry-Synthesis of Potential Antivesicand and Anti-Cyanide Drugs

A90-186 Ion Exchange Unit

A90-187 Instrument to Measure the Oxygen Equilibrium Curve

A90-188 Biologically Compatible Adhesive

A90-189 Micronencapsulation/Passive Dosimeter Development

A90-190 Development of a Bench-top Industrial Hygiene Test Chamber

A90-191 Development of a Rapid Field Water Microbiological Detection Capability

A90-192 Ocular Protection from Laser Hazards

SDC

A90-193 Electronics Materials

A90-194 Neural Network Software/Hardware for Directed and Kinetic Energy Antisatellite (ASAT) Weapons Systems

A90-195 Sensor Signal and Data Processing

A90-196 Optical Computing and Optical Signal Processing Technology

A90-197 Robotics and Artificial Intelligence

A90-198 Computer Architecture, Algorithms, and Languages

A90-199 Laser Communications

A90-200 Propulsion & Propellants for ASAT

A90-201 Nuclear and Non-Nuclear Power and Power Conditioning

A90-202 Sensors, Detection, Tracking and Kill Assessment

A90-203 Materials and Structures

A90-204 Directed Energy

A90-205 Surveillance and Early Detection

A90-206 Kinetic Energy Concepts and Technology

A90-001 Fire Control Initiative

OBJECTIVE: Develop gun fire control systems with significant improvements over current performance capabilities. Specific issues to be addressed are gunnery speed and accuracy and gunnery tactics and decision aids.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Continuing rapid advances in electronics, particularly computers and data storage have presented the opportunity to address fire control performance particularly in the critical areas of improved gunnery accuracy and speed and improved gunnery tactics and decision aids. Clearly, the availability of extremely fast signal processors and powerful computers small and rugged enough to be mounted on weapon platforms will revolutionize fire control; improving speed and accuracy while reducing the burden on the soldier. Technology issues of interest include novel target sensors, sensor fusion, target identification and hand-off, aided target cueing, path planner, weapon control (aiming and firing) inter-vehicle information, positioning/ navigation.

PHASE I: Develop methodology and approaches for addressing one or more fire control technology issues. Identify potential performance improvements in gunnery accuracy and speed and/or gunnery tactics and decision aids. Formulate system concept.

PHASE II: Develop a full-up laboratory prototype system with appropriate weapon interfaces and displays. Optimize hardware/software, algorithm and interface design based on laboratory test results. Provide fully integrated prototype system with documentation, source code (if appropriate) and test results.

A90-002 Generic Gun Bore Evacuator and Flareback Control Code

OBJECTIVE: Develop a finite element chemically coupled gas dynamic code to control flareback with generic gun bore evacuator pump devices.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Our understanding of the fluid mechanics of bore evacuator design has made significant progress by using ideal gas flow methods. These methods are being validated with air flow experiments at Rennsalaer Polytechnic Institute. Because this approach is in satisfactory agreement with experiment it appears logical to develop its use for preliminary design. However, flareback conditions can occur at every firing: At projectile exit, muzzle flash can initiate flame travel in the direction of fuel-rich gases within the barrel. The gases expand to ambient, but autoignition conditions continue at the muzzle. Flame velocity can then exceed the velocity of exiting combustibles, thus permitting the flare to advance into the barrel. This means that a well designed bore evacuator should pump air (and residual propellant gas) from the breech at speeds that exceed the flame speed plus muzzle head-wind. Otherwise, the nozzle exits can become flameholders. As the

discharge cycle subsides, such flameholders can permit flame travel through the nozzle array combustion of residual gas within the reservoir, possibly weakening and causing subsequent malfunction of the device. Thus, active flareback control is the desired goal: A 3D computer fluid dynamics code that accounts for dissipative gradients and real gas chemistry effects can yield toxic product compositions. Control will be accomplished with parallel coding of flow physics, and animated visualization of the flareback combustion processes. Planned developments include: (1) Construction of a real gas 1D bore evacuator design model to yield propellant gas simulations with compositions at valid equilibrium states. The BLAKE dense gas thermochemical code is used to obtain initial combustion product compositions. (2) NASA's dilute-gas code will determine premixed equilibrium combustion of real gas products with entrained air, thus establishing the dependency of toxic residuals on flareback.

PHASE I: Develop a multidimensional finite element Computational Fluid Dynamics program to defeat flareback by coding for parallel architecture machines: A modular approach can be used, beginning with the simplest model that can capture basic physics within the bore evacuator, viz., assymptotic steady-state, 2D inviscid, real gas flow. Exercise the code for comparison to the 1D results and experiment.

PHASE II: Develop the Phase I code by linking it to a specified reaction kinetics code. Exercise the code for comparison to the 1D results. Extend the Phase I algorithm to 3D Navier-Stokes flow.

A90-003 Ignition of High Energy Density Charges

OBJECTIVE: Development of Ignition Systems for High Energy Propellant Systems

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The trend in ballistic system design is toward use of those propellants which produce a high energy per unit volume. Consequently, there is considerable interest in use of consolidated, bonded and unified charges of various fluid propellants (liquid, gel, emulsion and slurry propellants) and new solid propellants. This increased energy density, however, can result in instabilities which run counter to the need for reproducibility of performance at accepted levels. Based on experimental evidence, much can be done to alleviate these problems. For example, careful tailoring of the ignition system (e.g., pyrotechnic, electric, laser, etc.) can do much toward achieving an effective ballistic system. Analytical and experimental efforts in the fundamental study of ignition and combustion characteristics of high energy density propellants are desired.

PHASE I: Feasibility Study of potential stimuli for use in improved ignition systems of high energy density charge and novel configurations.

PHASE II: Construct and demonstrate new igniter systems based upon results of Phase I study.

A90-004 Investigation of Combat Vehicle Fire Control Position, Navigation and Directional Reference Techniques Using Global Positioning System (GPS)

OBJECTIVE: The final objective is to develop one or more techniques for combat vehicle fire control system position, navigation and directional reference techniques using GPS combined with appropriate auxiliary or additional devices to insure operation in spite of GPS loss due to countermeasures. The Phase III objective is to demonstrate the technical performance of such a system in "brass board" form.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is a current need to investigate available position location and orientation technology for application to weapon fire control systems where intertial based technology (such as the Modular Azimuth Positioning System (MAPS)) are either too expensive of too large to be applied successfully. Systems based on the GPS are available which are low cost and small in size. However, such GPS based systems have some fundamental limitations. GPS systems, because they depend on satellite transmissions, can be susceptible to countermeasures and, at present, GPS systems provide only location data. They have no capability for orientation or azimuth reference determination. The purpose of this solicitation is to address those GPS limitations and to investigate techniques for overcoming them.

PHASE I: It is desired that Phase I produce three results. The first is an analysis of the susceptibility of a GPS position location receiver to countermeasures. This analysis should characterize the degree of loss of accuracy that would be expected in typical countermeasure situations. The second requirement is to investigate possible "backup" devices or technologies which would operate in conjunction with the GPS receiver to retain some level of position location capability if the GPS is degraded by countermeasures. The requirement of low cost and size/weight if compared to MAPS applies to the "back up" device. The third requirement is to investigate potential techniques for using GPS, or GPS integrated with another device, to obtain orientation of azimuth reference data. Accuracies down to 1 mil are desired, but lesser accuracy may be acceptable, depending on other features of the technique.

PHASE II: In Phase II it is desired that the feasibility of the most promising technique for GPS "back up" position location and for GPS azimuth reference determination be demonstrated in at least "brass board" form.

A90-005 Ultrasonic measurement of through-wall stress state in loaded artillery projectiles

OBJECTIVE: Develop an ultrasonic device which can reliably measure the through-wall stress state in loaded artillery projectiles.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Artillery projectiles are made by various metal forming techniques. The state of residual stress in these items are a reflection of these forming techniques and the annealing procedures used to reduce these stresses. A device is desired capable of monitoring the stress state of loaded projectiles to determine the integrity of the projectile under launch conditions. The particular device to be constructed must be capable of determining the residual stress gradient in the through-wall direction. The device should also be capable of determining the principal stresses and their directions.

PHASE I: Develop ultrasonic techniques for determining the through residual stress in thick wall cylindrical shell.

PHASE II: Construct and demonstrate an inspection device capable of scanning 8 inch artillery shell and determining the residual stress state at selected through-wall locations.

A90-006 Fire Retardant and Wood Preservative Treatment for Wood

OBJECTIVE: Develop a treatment for wood products that combines the aspects of fire and smoke retardants with those of wood preservatives.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: General Wood Products are used throughout the ammunition logistics system in packaging and dunnage. Wood products are easily adapted to these roles, but they have a tendency to burn. There is increasing emphasis to remove all of the burnable products from ship cargos to prevent the spread of fires and smoke on board ship. There is also a need for wood products to be treated with preservatives to prolong life. Treatments developed to date either satisfy one or the other requirement but not both. A method is needed to treat wood materials or develop a wood based material that has these properties in order to keep this adaptable substance in the ammunition logistics system.

PHASE I: Develop an overall plan to include a review of the requirements for materials that have fire retardance, smoke prevention, and preservatives; a plan for development of test samples; and test of these samples in the contractor's facility and government facilities. Produce a minimum of 12 test titles 6" x 6" for test.

PHASE II: Construct a set of 6 boxes per government provided drawing on the order of 19" x 12" x 36" for test. Develop a plan suitable for production of this material. Analyze the cost in production and the adaptability for large and small scale production.

A90-007 High Speed Inspection of 5.56mm Cartridge Case Primer Pockets

OBJECTIVE: Develop techniques for inspecting and sorting the dimensions of the primer pocket at high speed for adaptation into the current manufacturing process.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: On the current production process for the 5.56mm cartridge cases the primer pocket is checked for presence of the vent hole at the end of the process inspection system (CCMES). There is no capability to measure and inspect the dimensions such as concentricity, diameter and finish. These inspections are performed randomly on a sampling basis to satisfy the quality control level by an operator using manual plug gages and visual observation. The plant often becomes aware of primer pocket dimension problems when completed rounds fail tests at the guns.

PHASE I: Investigate the techniques to measure the dimensions of the primer pocket and develop the implementation process.

PHASE II: Construct a model or models for demonstrating feasibility of critical elements of a prototype to be installed on a SCAMP Cartridge Case Submodule at Lake City AAP for evaluation and demonstration as a follow on to this effort or, if possible, construct a complete prototype machine.

A90-008 Radiographic Image Prediction and Computer Modeling

OBJECTIVE: Develop and implement the software modeling of X-ray images of armament devices and material from CAD drawings.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: Solid modeling of armament systems, components, and subcomponents is commonly done today on CAD systems. Using similar techniques it would be possible to predict and display x-ray models from CAD drawings. Modeling would have to consider x-ray source parameters, object properties, and image formation parameters. The resulting model ought to be displayed with a resolution commensurate to that of radiographic imaging systems. Parameters such as the relative position of x-ray source, object, and viewing field should be easily selectable.

Such a modeling system could meet several objectives. For example, the modeling process would give the designer sufficient feedback to design armaments taking into account the need for inspectability. The designer would have feedback helping him to select component placement and material such that critical elements could be seen radiographically. Putting such capability into the designers hands should help eliminate problems later in the life cycle of the armament.

Another objective would be to feed the x-ray models directly into current Army radiographic inspection equipment in order to train the inspection equipment for inspection of items not currently handled by the equipment. Such inspection equipment requires a large number of images displaying the multifold combinations of possible configurations of components within the objects being modeled. Training of such inspection equipment is currently expensive and time consuming, requiring the manufacture of specially designed standards exemplifying the many possible configurations.

PHASE I: Preliminary work on this topic has already been done. Phase I should build on that preliminary work. Selection of a CAD system and determination of the interface to inspection equipment needs to be done during Phase I. The results of Phase I should prove the feasibility and utility of the project. The result of Phase I should be full detailed scope of work for Phase II.

PHASE II: Develop and implement the software modeling of x-ray images of armament devices and materiel such as fuzes, propellants, shells, etc., from CAD drawings. Build and deliver a complete system meeting the projects objectives with interfaces to Army owned radiographic inspection equipment and Army owned CAD systems.

A90-009 Computer Virus Prevention for Embedded Computer Weapon Systems

OBJECTIVE: To develop appropriate measures to safeguard against the presence of computer software viruses in embedded computer weapon systems. This includes developing anti-viral products, virus detection measures, and computer security policies.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: A computer virus (sometimes called a worm) is a piece of code inserted into other programs or operating systems. When activated, the virus will rewrite itself to other portions of your system or programs, and typically will perform destructive acts such as erasing your hard disk or destroying your data.

PHASE I: The contractor shall perform a comprehensive literature search on computer viruses (in general). The following topics, as a minimum, shall be addressed:

o What is virus and/or whom? What do they consist of and how do they work? What damage can they cause?

o How do you detect the presence/absence of a virus?

o What do you do if you know your system is infected? How do you quarantine one?

o Can you recover from contracting a virus, and if so, how?

o How do you prevent contracting a virus? How can you minimize the damaging effects?

o What anti-virus tools and/or vaccines exist on the market today? What are their characteristics/features? How do they work?

Utilizing these results, Phase I shall also consist of a study to determine the repercussions a computer virus could have in mission critical weapon systems. Areas to be addressed, as a minimum, include:

o What are the areas of vulnerability of the weapon system, i.e., how could the virus get in? Which types of weapon systems are more susceptible to a virus attack?

o How could the virus spread itself to other systems?

o What steps can be taken to prevent contracting a virus?

o What security measures and/or policies need to be established to prevent virus infections in weapon systems?

Phase I should provide demonstrations of anti-viral products and/or vaccines, if possible. Phase I should include two visits to Picatinny Arsenal, NJ, one for an initial kickoff meeting, and one for a final demonstration of the prototype. Bimonthly progress reports should be provided, as well as a final technical report. All documentation and software developed shall be delivered on both 1) paper listing and 2) magnetic media (format to be approved by the government).

PHASE II: Phase II should produce a prototype anti-viral product or vaccine for the problem areas identified in Phase I. The contractor shall also provide comprehensive software documentation, using DOD-STD-2167A as a guide for the software development process. Phase II should also establish computer security requirements, policies, and/or guidance on the prevention, detection, and treatment of computer viruses in mission - critical weapon systems.

A90-010 Integrated Target Recognition and Tracking

OBJECTIVE: Develop fire control systems for air and ground targets that use high resolution imagery for enhanced trajectory prediction.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The subject of this topic involves tracking the present position of a maneuvering aircraft or ground vehicle as well as predicting its future position. Tracking filters for both fixed and rotary wing aircraft have already been developed that use attitude angles (yaw, pitch, roll) in addition to the usual radar measurements. Computer simulation of tracker performance when tracking violently maneuvering aircraft indicates that a dramatic improvement is obtained by using optically-derived attitude information. It is desired to develop a similar filter for ground vehicles and to test it against real targets, as well as to improve the performance of the aircraft trackers and test them against real targets.

The development of an automatic target recognizer that will accurately determine target type and orientation is very important to this topic and may include techniques for global and partial shape recognition of three-dimensional objects by using two-dimensional exterior contour information, or recognition of three-dimensional objects by using three-dimensional surface information, or use of time-varying imagery to segment shape. Neural networks may prove useful here in hybrid combination with classical shape description methods. The development of very fast Kalman-filter calculation techniques is also important to this topic because of the requirement of work in real time and indicates the necessity of using parallel computations and making appropriate simplifying assumptions in the filter structures.

PHASE I: Develop methodology for integrated target recognition and tracking of violently maneuvering aircraft and ground vehicles, including target identification and orientation determination algorithms, tracking and prediction algorithms, and choice of a target locator and imaging sensor hardware suite.

PHASE II: Develop a demonstration of the integrated target recognition and tracking algorithms working in near real-time against real targets.

A90-011 Improved Fusible Link for FASCAM Mines

OBJECTIVE: Develop a one for one replacement for the current fusible link used in the self-destruct selection circuit of FASCAM mines. The current design results in an unreliable device with inconsistent electrical characteristics and is highly prone to open circuit.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: The current fusible link or microfuse per dwg. 9328688 is used exclusively in FASCAM mines to permit selection of different self-destruct times. The self-destruct setting circuit is a capacitive discharge type whereby the dispenser provides an electrical pulse into the mines through a magnetic coupling device. The energy received in the mine is used to fire a microdetonator (to initiate the battery) as well as to blow out microfuses. Different pulse polarities and amplitudes selectively blow out different fuse combinations, thus providing the logic to bias an integrated circuit which gives different self-destruct times.

The current device utilizes a simple tungsten bridgewire spot welded across two terminals in a non-hermetically sealed can. The bridgewire is so small (.00013 in dia.), that it is difficult to make a consistent, high quality product. The non-hermetic enclosure also allows contaminants to attack the bridgewire and terminals, which leads to changes in the fusing characteristics and often open circuits. As a result these deficiencies, many mines will lose their ability to be properly programmed and will self-destruct early, thus significantly reducing minefield effectiveness.

The mechanism by which the fuse responds to the capacitive discharge pulse and eventually opens has been studied extensively. Prediction of fuse response based on non-destructive testing has also been attempted. Both efforts have had limited success. It appears that the capacitive discharge pulse produces second and third order effects which are significant and highly dependent on device construction. Testing has shown that the device characteristics are affected significantly by weld integrity, bridgewire thickness, and bridgewire type. These efforts further confirm the need for a consistent high quality device.

PHASE I: Test the current fusible link and develop a new specification for the devices performance based on capacitive discharge excitation. Develop new test methods to assure device consistency.

PHASE II: Procure alternate fuses or develop new fusible link to duplicate characteristics of existing fuse. Test quantity of 200 fuses to insure device performance and design integrity.

A90-012 Curved LCD for Multi-Option Fuzing Applications.

OBJECTIVE: Develop a low cost Liquid Crystal Display which is either flexible or curved such that it is suitable for mounting in place of a typical fuze display window. The LCD must have response time times of less than 0.5 second over the temperature range of -40 to +160 degrees Fahrenheit.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Currently Artillery electronic fuzes depend on recessed Light Emitting Diode (LED) or LCD to convey mode and time of flight information to the operator. Some fuzes have an inductive autosetting capability, however, there is still a requirement that the fuzes be manually settable without any setting tools and this requires some kind of display. The visibility of current displays is not ideal, especially with a recessed LCD display. AN LCD display positioned on the fuse body in place of the current fuze display window would provide optimum visibility. Artillery fuzes must operate over a wide temperature range (-40 to +160 degrees Fahrenheit). Standard LCDs do not have a suitable response time at low temperatures. This display must be able to survive storage for up to 20 years and remain fully operational.

PHASE I: Display technology will be explored and prototype displays fabricated which demonstrate the feasibility of a curved or flexible LCD. Response times and digit clarity will be explored. Intuitive and easily readable fuze mode and digits will be investigated. As a minimum the LCD should be capable of indicating the following modes: Proximity, Time, Point Detonating (PD), and PD with delay. The Proximity mode should show turn-on time, height of burst (High, Medium, Low), and canopy option. The Time mode must show time of flight information up to 199.9 (seconds). Each of the four modes are mutually exclusive (i.e., Proximity and PD would not be displayed simultaneously). The Proximity mode would be displayed along with the proximity turn-on time which should utilize the same digits as the Time mode display.

Possible non-icon based abbreviations could include: VT or PROX for Proximity mode, T or Time for the Time mode, PD for Point Detonating mode, PDD for Point Detonating mode with delay. Suitable abbreviations or icons should be selected and evaluated based on good human engineering principles.

PHASE II: The display technology and configuration selected during phase I will be evaluated. Prototypes will be made and tested over the artillery fuze temperature range on simulated fuzes or fuze metal parts which conform to large caliber fuze contours per MIL-STD-333. Only a simple electronic circuit is necessary to exercise each display segment. The cost and longevity of the prototype displays will be examined. Prototypes will be made as appropriate to verify producibility and accelerated aging tests will be performed to indicate long term performance.

A90-013 Low Cost COMVAT Cased Telescoped Ammunition

OBJECTIVE: Development of a low cost high performance cartridge design for the 45-mm COMVAT gun system.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Combat Vehicle Armament Technology (COMVAT) program is an ARDEC tech base program developing an advanced high performance gun system for future combat vehicles such as the Future Infantry Fighting Vehicle (FIFV). COMVAT technologies include 45-mm cased telescoped ammunition and a rapid fire automatic cannon. The current ammunition design consists of a cylindrical cartridge utilizing consolidated conventional propellant, a steel case and spherical end caps. Both armor piercing fin stabilized discarding sabot (APFSDS) and training projectile (TP) types of ammunition are being developed. Current designs use many machined metal parts and an expensive propellant consolidation process.

It is highly desirable to develop a more cost effective cartridge design. Such as design shall minimize the number of machined metal parts, make maximum use of metal stampings, provide for cost effective propellant processing with low vulnerability (LOVA) formulations and provide for automated assembly techniques.

PHASE I: Develop the preliminary cartridge design, cost and performance estimates, and provide initial samples for testing.

PHASE II: Develop the cartridge design for a potential family of projectiles and continue cartridge refinement through a series of design, build and test iterations.

A90-014 Optical Designs for Enhancing Laser Eye Protection

OBJECTIVE: Designs for direct view optical sights which will enhance the operation of non-linear optical switches, sacrificial mirrors and other optical limiters placed in focal planes.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: To protect operators of a direct view optical sight from laser eye damage, optical limiters based on non-linear processes such as plasma formation and sacrificial mirrors must be placed in a focal plane of the system. Present systems are designed with the primary goal of presenting an adequate image to the eye. The purpose of this program is to add the requirement of improving the concentration of energy in the focal plan of the system in order to trigger limiters at a lower threshold of input energy.

PHASE I: An Army optical sight will be analyzed to determine its efficiency in concentrating coherent radiation at its focal planes. A 10x, +/- 4 deg field-of view system will be designed with the goal of matching its performance and increasing the concentration of flux in the focal plane. The final report will contain the optical design and analysis.

PHASE II: A device based on this Phase I design will be fabricated. Imaging performance will be measured and compared to that of a conventional system. The point spread function in the system's focal plan will be measured.

A90-015 Radiographic Image Processing Using Neural Networks

OBJECTIVE: Develop and implement innovative neural network image processing algorithms for analysis of radiographs of armament devices and materiel.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Inspection of armament devices and materiel after assembly is frequently done radiographically using image analysis algorithms. The type of features which need to be interpreted are such things as porosity, cracks and voids, and the existence, condition and placement of components such as gears and pins. Radiographic images are uniquely different from visual light images in that one is looking at shadows of objects superimposed on each other. Due to the complexity of the image, features are often difficult to pick out, even by the eye. Lack of contrast and high levels of image noise add to the problems of image analysis. The image processing algorithms in existence often are inadequate, especially in interpreting continuity in features. This request is for the development of a neural network algorithms for image processing appropriate for such an environment.

PHASE I: Select the most promising neural network algorithm from the many available which can meet the processing requirements for this problem. Selection must be made based on a thorough knowledge of the various neural network algorithms, knowledge of image analysis problems especially radiographs, and considering cost and timing constraints imposed by the manufacturing environment. Develop a prototype concentrating on one or more features in a typical armament device. Provide sufficient evidence that the prototype can be scaled up to production levels.

PHASE II: Develop and integrate a full scale neural network inspection system (hardware & software) with existing government owned automated x-ray inspection equipment for the inspection of armament devices and projectiles. The resulting system must keep up with armament production rates.

A90-016 Electronics Encapsulation Materials/Methods Incorporating Electronic Shielding

OBJECTIVE: Develop new methods (and materials if necessary) to encapsulate electronics assemblies which will provide immunity from radiated electro-magnetic energy without utilizing expensive nuclear hardened semi-conductor technology.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is great concern regarding the potential susceptibility of FASCAM mines to high powered microwave electro-magnetic energy. This type of energy has been known to cause disruption of electronic functions and even direct ignition of detonators at high enough energy levels. The various mine types have various degrees of inherent shielding to such energy (as a result of surroundings metal parts), however complete metal enclosure cannot be insured in most mine configurations without radical redesign.

It is desirable to investigate the possibility of modifying the electronics encapsulation (potting) materials/methods to provide shielding from radiated electromagnetic radiation. The improved encapsulation should not result in a significant increase in potting process time or cost compared with current designs.

PHASE I: Determine shielding properties of different encapsulation materials to microwave energy through test/analysis. Investigate/test modifications to current materials or the development of new materials. Investigate/test the possibility of combining or layering materials to achieve a certain effect.

PHASE II: Pot a minimum of 25 FASCAM anti-tank electronics assemblies with candidate improved potting material(s)/process(es). Test shielding afforded by various concepts by subjecting assembled mines to

microwave energy. Document selected process.

A90-017 Remote Processing of Lead Styphnate

OBJECTIVE: Develop a hands-off method for washing, and portioning batches of lead styphnate, a primary initiating explosive used in small arms primers. The equipment developed in Phase II will be installed at an Army Ammunition Plant for processing lead styphnate.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Lead styphnate is a very sensitive primary initiating explosive used in small arms primers and detonators. It is extremely sensitive to impact, friction and electrostatic discharge. The current manufacturing process requires extensive manual handling of the material be an operator during washing and portioning (weighing of a 20 lb. batch into containers containing 4 lbs. 10 oz. of lead styphnate). Due to the sensitivity of the material, both of these operations are very hazardous.

PHASE I: Develop a method of washing and portioning lead styphnate, to be obtained either from a batch process or from a continuous reactor, which eliminates direct handling be operator. Due to the sensitivity of the materials, the processing equipment is precluded from using traditional valves, pumps, centrifuges, or other equipment that could provide pinch points and other sources of initiation.

PHASE II: Design and model the equipment proposed in phase one to handle production rates of 20 lbs. per hour. A suitable stimulant must be selected for initial testing. Due to the hazard of these operations, remote operation of the equipment and elimination of direct handling are essential.

A90-018 Software Development with Enhanced Reliability, Availability and Maintainability

OBJECTIVE: Develop Software for Large Systems, possessing greater reliability, availability, and maintainability (RAM).

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: With the increased use of computers has come the important problem of developing and maintaining the software which controls the computers. Indeed, software costs have already passed hardware costs and will soon be the dominant expense. DOD is particularly concerned because of its extensive use of computers, with great emphasis on reliability, availability, and maintainability (RAM). Elaborate software systems are usually developed by contractors outside DOD, and these systems tech transferred to DOD which must maintain the software. DOD software maintainers are increasingly in touch with the outside software developers, from the beginning of the software life cycle. Software RAM is being addressed throughout the computer community, but more work needs to be done. This project will address the question: What can be done cost-effectively during software development to enhance RAM of the software?

PHASE I: Look at the software development process, including the currently popular approaches, from the standpoint of RAM and suggest possible improvement. What are the economic consequences of such changes?

PHASE II: Suggest new software development methodologies based on Phase I results, and demonstrate RAM improvements.

Belvoir RDE Center

A90-019 Low Emissivity and Low Reflectance Materials

OBJECTIVE: New materials for decoy military equipment.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: A fabric-like material is sought which posses both low emissivity in the thermal infrared and low reflectance in the visual spectrum. Its color should be dark (black, dark green, or dark brown), non-specular, and diffusely reflecting less than 5 percent of incident light. The range of emissivity should be as low as possible, preferably below 0.8. Materials capable of being manufactured in several different emissivities are desired. Physical performance characteristics should include a capacity for long-term folded storage and the ability to be draped in a wide range of outdoor environments without showing any creases. Some tension is allowable to accomplish this. Mildew-resistance and water repellency are desired.

PHASE I: The recipient will be funded to fabricate and test several material samples.

PHASE II: The recipient shall conduct a Manufacturing Methods and Technology program for possible production.

A90-020 Lightweight Footbridge Concepts

OBJECTIVE: The development of a man portable and deployable footbridge for the Light Infantry Divisions. The footbridge concept must provide the infantryman with bridging capability to cross wet and dry gaps quietly and quickly.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The current footbridge in the Army inventory only provided for wet gap crossings. The system requires motorized transport of the equipment and requires access to both sides of the gap in order to erect a cable prior to building the bridge. The system must be able to span a 20 meter dry gap and an unlimited wet gap. The system must be man portable and deployable quickly and quietly. The system should not require access to both sides of the gap in order to launch. The objective is for the soldier to cross the gap, perform the mission and get out without alerting the enemy.

PHASE I: This phase is devoted to developing a concept to meet the requirements. A comprehensive final report is required which will include a complete analysis of the structure, materials, and drawings. A demonstration model is required to illustrate the concept.

PHASE II: This phase will expand on the information obtained in Phase I. This phase will refine and optimize the concept developed in Phase I through use of the model and analysis. A full scale breadboard

prototype will be fabricated which can demonstrate the concept. The prototype will be evaluated for compliance with the requirements and the Trilateral Code. The deliverables will be a final report detailing fabrication, analysis, evaluation data, and the breadboard prototype.

A90-021 Long Pulse Solid State High Power Microwave Source

OBJECTIVE: Development of a solid state, compact source of high power microwave pulses.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The source required is to be evatuated for use as the heart of the high power transmitter. The scope of this effort is to investigate and prove a means for conversing continuous prime power into very high power microwave pulses for use in a radiating countermine weapon. Thus the real goal is production of as much microwave power as possible, subject to the constrains of: size and ruggedness (for weaponization considerations), efficiency (for prime power size considerations), and reliability. The current microwave requirements for the source are: greater than 100 megawatts of peak microwave power produced, pulse widths greater than 50 nanoseconds, and pulse repetition frequencies greater than 15 Hz. The source is to be stable in frequency (<1%BW) and power and energy levels from pulse to pulse. The sourceshall operate in or below the X band. the efficiency desired (average microwave power/average prime power required) is greater than 30%. Intended application willultimately require the source to be a highly reliable, ruggedized device with a size/weight envelop less than 2 cubic meters and 1000 lbs.

PHASE I: The contractor will be required to develop his proposed approach into an advanced conceptual design for meeting the above requirements. A feasibility analysis of the designshall be conducted to assess the costs and risks associated with development of the design and to identify design tradeoffs which are inherent in the approach. The contractor shall also plan the size and scope of the phase II demonstrator.

PHASE II: Physical proof of the validity of the conceptual design of phase I is to be the goal of this follow on effort. The contractor will design and build a scaled demonstrator device which proves the approach for efficiently producing microwave pulses. The limits of performance for the demonstrator should be clearly related to the scope of the effort. Any issues involving in up-scaling the design to the requirements described above shall be addressed in the phase I plan and shall be readdress during phase II. The contractor will be required to test and demonstrate the unit.

CECOM RDE Center

A90-022 Tactical Forces C3IEW Space Surveillance Countermeasures

OBJECTIVE: Research Technologies and Techniques that need to be developed to prevent Army commanders at all echelons from being observed by space based sensors.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Military organizations, (including the soviets), scientific organizations, news media, etc., are relying more and more on the use of the use of space based assets to sense and observe activity on the ground. As a result, we need to examine how we protect (MASK) Army commanders having forward and deep battle units from being sensed by space based platforms.

The thrust of this proposal is to conduct engineering level studies of the capability of the Army to defeat both intentional and unintentional space system surveillance. The studies should initially explore the vulnerability of one or more Tactical Corps or division level deployments to typical non-military earth surveillance systems such as spot or landsat, or others. This will require having access to the detailed parameters of the selected space platform in addition to having access to or generating electromagnetic signature and heat signature, etc, data for equipment on the ground. The next step would involve identifying equipment and technology available to mask combat operations, communications, radar, etc from such surveillance. The Final step should be a series of recommendations for providing masking capability.

PHASE I: Conduct a study as discussed above using a non military assets as a basis, and generate a comprehensive report of study results to include recommending follow up actions required for persuit those technologies/developments that show the most promise.

PHASE II: Pursue the recommendations of the phase one report, to include conducting demonstrations. Conduct additional studies based on a soviet military and other know unfriendly military satellite sensing platforms. This could become quite complicated as it will involve having access to

PHASE III: Approach prime C3/IEW contractors about investing in the above project to do some system development work and conduct field demonstrations. There is potential for high payoff from an operational standpoint. Operational payoff Equates to high probability for systems development.

A90-023 Space Based Battlefield Deception

OBJECTIVE: Research Technologies that exist or need to be developed to facilitate the generation of space based Battlefield Deception Techniques. Advise on the feasibility of the same.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Army is seriously pursuing the use of space based assets to enhance that tactical commander's war fighting and decision making capabilities. General Battlefield Deception is an area that is beginning to show payoffs. Space based Battlefield Deception is a new idea that requires much research and development.

The primary purpose of this proposal is to conduct engineering and technology level studies of potential Battlefield Deception capabilities generated from a space platform. One far term concept currently being considered addresses using space based platforms to generate three dimensional images, moving decoys, etc. on the air battlefield as a means of confusing the enemy into weapons commitments against a false target. Generation of false radar signatures and communications is another idea that is worthy of additional research/investigation.

In general the entire area of Battlefield Deception generated from space based platforms needs additional exploration from a technology and feasibility standpoint. An overall analysis of the space deception field is required. Technologies that need to be developed must be identified as well as the cost and operational aspects of this approach.

PHASE I: Conduct a study of the space deception field and payoffs as discussed above. Generate a comprehensive report of study results and recommend the follow up actions required to pursue those technologies that show the most promise.

PHASE II: Pursue the recommendations of the Phase I report. Conduct some laboratory experiments and demonstration to verify project results and payoffs.

A90-024 Voice Authentication/Recognition

OBJECTIVE: Develop a generic UNIX shell to enable multiple verbal communications with command and control system applications, and demonstrate the feasibility for replacing input/output (I/O) devices for current applications.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Current command and control applications use various input/output (I/O) devices such as a mouse, trackball or joystick to allow a user to interface with a computer system. It would be highly advantageous to develop UNIX shell which allows a user to verbally communicate with the applications on the system. The shell would be required to accept inputs from various users and would, therefore, have to be able to recognize inputs from a variety of tactical personnel under severely degraded conditions. Due to the variety of currently available command and control systems, this tool should be generic enough so that it could, with minimal effort, easily replace an I/O device for current applications.

PHASE I: Result in the initial development of the UNIX shell and a demonstration in which a user verbally communicates with specific command and control application on the system.

PHASE II: Extend the result of Phase I to accomplish the generic capability requirement to accept inputs from a variety of multiple users under severely degraded conditions, and demonstrate that it can reliably replace an I/O device for current command and control applications.

CATEGORY: Exploratory Development

A90-025 Innovative Techniques for Overcoming Cochannel Interference in HF Modems

OBJECTIVE: To develop a technique for single-antenna HF reception which can be incorporated as part of the demodulator to significantly improve signal reception in the presence of co- channel interference.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: HF radio waves often propagate long distances by ionospheric reflection, while channel allocations are severely limited by the available spectrum and MUF. As a result, HF radio reception is often disrupted by multiple transmissions which originate over a side geographic region but which occupy the same frequency channel. It would be desirable to be able to demodulate and recover the information contained in the desired signal in the presence of such cochannel interference. While adaptive antenna array techniques can be useful in solving this problem when the signal and interferences arrive from widely different directions, the receiver complexity and difficulty of deployment makes this solution impractical in many applications.

PHASE I: To evaluate and analyze innovative processing approaches to achieve the overall objectives stated above.

PHASE II: To provide implementation and laboratory and/or field demonstration of a full operating feasibility model.

PHASE III: As stated in overall objective above.

A90-026 Artificial Intelligence for Command and Control

OBJECTIVE: Develop an artificial intelligence based decision aid for evaluation by Regular Army personnel in a realistic command and control testbed.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: A successful proposal must contain both detailed descriptions of the technologies on which the potential decision aid is based; and the specific Army application it is intended to serve. Examples include, but are not limited to, the following:

a) A seamlessly integrated geographic information system and knowledge base. Such a system could be designed for one of these applications: determining and evaluation possible avenues of approach, defining optimal positions for artillery emplacements, assisting in the development of combat engineer barrier plans, properly situating signal centers, determining the best lines of communications for logistics support, structuring the best air defense network, or efficiently placing sensor systems.

b) An object oriented tactical simulator with automatic reasoning capabilities. The knowledge base for such a simulator should be populated with relevant information on Red and Blue tactics, equipment, order of battle, terrain constraints, etc. Such a simulator should be designed for realistic wargaming by G-3 staff officers.

c) A cooperative problem solving environment for command and contort in a dispersed command post. Such a system must facilitate the formulation of plans and the distribution of orders based on the combined requirements of maneuver, logistics, fire support, air defense, and intelligence units. Inputs and constraints from both higher and lower echelon units must be accounted for and properly prioritized. Methods for ensuring security, accountability, and retention of command authority must be considered.

d) Pattern recognition techniques applied to: terrain analysis (geometric computing); planning (plan monitoring and explanation); or image processing (intelligent image analysis). Applications include sensor interpretation for G-2 staff, tactical plan assessment, and rank ordering of messages entering signal centers.

PHASE I: Prepare a report describing the decision aid that can be built; the theories and technologies on which it is based; and the Army environment for which it is targeted. The report must reference a complex bibliography of relevant technical literature and contain a glossary. Objectives, plans, and required resources for the Phase II effort should be clearly specified in detail. Monthly progress reports are required. Delivery of software that illustrates a subset of the nominal system's functionality is desirable but not mandatory.

PHASE II: The specification, implementation, and evaluation of the decision aid defined in Phase I. Specification will be in accordance with a tailored version of DOD-STD-2167A. Implementation will be supported by commercial hardware and software platforms to the maximum extent feasible. Evaluation will be by Regular Army personnel in structured classroom or garrison environments. Evaluations may also be conducted in conjunction with Army command and control testbeds.

PHASE III: Extension, enhancement, and modification of the decision aid implemented in Phase II. The resulting system should be robust enough for inclusion in an Army command and control system. Documentation should be to a standard acceptable to an Army Program Manager.

A90-027 Multi Sensor Automatic Template Generator

OBJECTIVE: To develop the theory, algorithms and software to create templates for the identification of the source of data. The templates are to be used to perform template matching operations for the recognition of patterns in data of unknown sources.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Pattern recognition techniques have been used in the development of algorithms to identify the source of data available from different sensors. Among these, template matching has a strong appeal because it is easily understood and implemented. The performance of such a technique is heavily dependent upon the quality of the templates used. This effort ultimately will provide an algorithm and source code to create templates from extensive amounts of available sensor data.

Phase I of the effort should provide a survey of the available literature, an evaluation of the performance of the techniques already available, further theoretical development if required to maximize "performance" for the type of sensor used and a comparative evaluation of all the potential techniques being contemplated.

Phase II of the effort will provide preliminary coding of at least two of the potential template creation techniques. Data will be made available and the performance of each of the techniques will be evaluated using some previously defined Measures of Effectiveness (MOE's).

PHASE I: Will ultimately identify at least two possible techniques (including new ones developed under this portion of the effort) which are optimal in some predetermined set of parameters.

PHASE II: Will implement and code the selected techniques for performance evaluation.

PHASE III: The effort will concentrate in the coding of the selected technique to make it as efficient as possible and to reduce user interaction. The technique will be loaded in a Government computer facility and Government representatives will be trained on its usage and theory. The technique will be tested at the Government facility and by Government representatives and modifications will be performed by the contractor as required.

A90-028 Modulation Based Pulse Association Techniques

OBJECTIVE: Develop a means to accurately associate each pulse received by the front end of an Electronic Support Measures, ESM, receiver with the non-communications emitter that produced the pulse.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Modern ESM systems characterize each received pulse in terms of parameters such as frequency, angle-of-arrival, time- of-arrival, pulse width, etc. which are then expressed in digital form and input to a specialized computer for sorting. Modern emitters utilize several techniques to try to thwart current pulse association techniques and thus lower their probability of intercept. Some of these techniques are frequency agility, chirp, chip, jitter, etc. However virtually every emitter impresses some form unintentional modulation of pulse, UMOP, (e.g., leading edge overshoot, trailing edge rate of decay, etc.).

What is desired is a means to compare all pulses received (200,000 worst case) over some short (e.g., 100 msec) dwell with a "catalog" of the previously received pulses (100 different, independent emitters worst case)

to output a "best match" digital output (e.g., the current pulse is most like the 8th different type of pulse received) concurrently with the parametric of the current pulse. It should be assumed that a wideband (500 MHz wide) IF is provided as input along with strobe(s) signaling the start of pulse. Notes: pulses may overlap in time (i.e., a different frequency pulse is received before the first pulse has ended), all emitters will not necessarily transmit each dwell, the UMOP parameterics need not be explicitly measured and reported.

PHASE I: Develop the specification for and analytically predict the performance of the proposed approach as it could be implemented in an ESM receiver.

PHASE II: Demonstrate the performance of the proposed approach by building a prototype and interfacing it to the ELINT/ESM Testbed (i.e., MEDFLI).

PHASE III: Build a unit to interface with the growth slot in SILENT FOX (a joint US-Canadian ESM payload for the Unmanned Aerial Vehicle (UAV)) which will become a preplanned product improvement. Apply the technology developed to the next generation ELINT/ESM receiver.

A90-029 Fiber Optic Remote Antenna System

OBJECTIVE: Develop an antenna system that can be deployed remotely from the ground-based radar and/or jammer site.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Currently, all antennas are collocated with radar and jammer systems which operate at the microwave frequencies. This keeps the coaxial line transmission attenuation and electromagnetic radiation to a minimum. However, this limits the effective secure operational range and control of the radar and jammer systems. As a result, the antennas can not be placed at a remote site due to high electromagnetic radiation and high coaxial transmission attenuation at the microwave frequencies.

What is desired is an antenna which can be remoted using fiber optic links to transmit the RF energy between the radar/jammer and the antenna. The goal here is to minimize the weight/power consumption of the remote antenna, via the use of RF/optical conversion.

PHASE I: Show the feasibility of fiber optic remote antenna, develop the specifications, and propose an approach to develop the actual fiber optic remote antenna system.

PHASE II: Implement proposed approach, and demonstrate the potential of the fiber optic remote antenna system.

PHASE III: Implement approach in tri-service wide applications.

A90-030 Distributed Ada Real-Time Software: Development and Execution Support

OBJECTIVE: The objective of this project is to provide support for the development of distributed Ada real-time software for loosely coupled homogenous microprocessors. This will include addressing the issues of an Ada compilation system and a distributed runtime environment that will effect the distribution of a program through an integrated process without manual modification of code.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: In order to obtain the performance needed for Ada hard real-time embedded software systems it is often necessary to distribute a program so it runs on an network of loosely coupled microprocessors. The Ada language provides a tasking model that can be used as a single model of concurrency if distributed rendezvous can be supported across multiple processors. There is currently no simple method defined to accomplish the development, testing, and execution of distributed Ada programs. Software developed for distributed systems often involves manual preprocessing of source code or postprocessing of object code in order to effect the distribution. There are no provisions for, among other things, dynamic task migration between processors, transparent network debugging support with synchronous halting of all processors and system clocks, analysis of behavior that could predict overload conditions, analysis of tradeoffs involved when network interface standards are imposed that affect real-time response requirements, allowing for standard fault tolerance techniques, and testing that time requirements are being met by the software running on multiple processors. Distribution support is needed from an integrated compiler/linker/tester environment with a distributed runtime in order to realize the benefits of using the Ada tasking model of concurrency as a uniform model among multiple processors.

The results of phase I will include an analysis of the current state-of-the-art in the development of distributed real-time Ada systems, specifically in the tools to support distributed development and execution. It will propose a solution that will answer as a minimum the issues described in this solicitation. This solution will be embodied in proposed development, testing, and execution tools and a proposed distributed Ada runtime environment concept that will demonstrate the viability of the approach to accomplish the distribution of an Ada program.

Phase II will implement the proposed prototypes that will support the implementation, testing, and execution of distributed Ada software.

PHASE I: Research will be completed exploring issues and concepts and prototype solutions will be proposed.

PHASE II: Proposed prototypes will be developed.

PHASE III: Proposed product will be developed.

A90-031 Requirements Engineering Methodology and Techniques

OBJECTIVE: The object of this research is to develop or to integrate innovative methodologies, techniques, or tools for the development, validation, verification, and maintenance (tracking, linkage, change management, etc.) of requirements for Army systems as they relate to computer software.

CATEGORY: Engineering Development

DESCRIPTION:

GENERAL: Effective development and management of system and software requirements have a great impact on the life cycle cost. Technologies such as Computer Aided Software/System Engineering (CASE), Artificial Intelligence (AI), reverse engineering, interactive design techniques, and rapid prototyping need to be advanced to provide support for Army software under specification, development or maintenance.

The following is a partial list of relevant sub topics: The requirements development process: Definition of requirements, modeling the requirements process, supporting concept exploration, determining requirements functionality and feasibility, requirements analysis and validation, managing requirements changes throughout the

life cycle, requirements documentation, accommodating changing user needs and perceptions, and handling changing threats. Requirements engineering tools and techniques: How should/can requirements engineering be automated, languages and techniques, semantic analysis, information/decision capture and re-use, expressing concurrency and timing, and standards to provide compatibility between tools. Prototyping: Specification animation, executable specifications, and user interface. Battlefield and Army doctrine modeling with CASE technology.

Proposals should describe the applicability of the research to specific Army systems.

PHASE I: Phase I products would be reports establishing proof of concept and describing the approach and procedures to be used in Phase II.

PHASE II: Phase II products would involve demonstration of methodologies, techniques, or tools, together with documentary reports which fully describe recommendations for incorporating these advancements into the system life cycle.

PHASE III: Phase III efforts would be the incorporation of the advanced technology into actual Army systems, as well as the commercial production of software that supports requirements engineering.

A90-032 Software Reuse Technologies & Tools

OBJECTIVE: To develop Software Reuse Technology and Tools that will aid in the Reuse Process.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Software has become the major cost of Army C3I systems currently in teh field or in development. The mandate for the use of Ada offers the opportunity for reusing major pieces of previously developed software in the development of these systems. The lack of experience with Reuse and Ada, coupled with the increasing complexity of the systems being developed, has resulted in technical barriers to Reuse.

The objectives for this research topic are to develop the technology and tools to support the processes of generating and reusing Ada packages and components. Proposed tools for this topic should support reuse in one of two categories as follows:

a. DOMAIN SPECIFIC: The domain is partitioned by way of a thorough analysis which defines all of the reusable parts. Parts are categorized and stored in a domain specific library. A limited number of the parts may be applicable in other domains. This concept can be extended to what has been called a Generic Architecture (GA). In the GA, the design and components are reusable from one application to another. Artificial Intelligence techniques could be useful in the implementation of domain specific knowledge.

b. DOMAIN INDEPENDENT: Software modules/parts are designed for reuse in multiple domains. The modules/parts are analyzed with Reusability Metrics to determine their potential for inclusion in a general purpose software library. The library system requires a method for categorizing the parts and identifying the characteristics which will be keyed on the retrieval system. Storage and retrieval can be manual, semi-automated or fully automated.

Use of the DOD standard language, Ada, is a requirement for this research topic. Proposed tools should be described in terms of how they support the reuse process and whether they are limited to the domain specific case or not.

PHASE I: This phase should be a concept validation phase. The output is expected to be a report along with some demonstration software. The software does not have to deliverable. The report and demonstration should illustrate the viability of the approach.

PHASE II: This phase should develop a prototype version of the software tool. The software from phase II should be delivered for evaluation purposes. After a Government evaluation phase is completed, it is anticipated that some recommendations will be generated by the ARMY which will make the production version amour useful product.

PHASE III: This phase will take the prototype along with recommendations from CECOM and develop a production quality Software Reuse Tool.

A90-033 Electronic Warfare HF Antenna Size Reduction

OBJECTIVE: The objective shall be to determine whether new emerging technologies and materials in the areas of superconductivity research and/or dielectric material research can be applied to HF antenna designs. The goal shall be to determine if the physical size currently associated with available tactical HF antennas can be reduced without degrading currently accepted performance.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The purpose of this research shall be to investigate possible methods and/or technologies relating to superconductivity and/or dielectric materials for reducing the physical size of HF (1.5 to 30 MHz) jamming and intercept antennas. In a tactical environment where long setup times and camouflage of large antennas are impractical, the development of smaller HF antennas would have a significant tactical and operational impact. The intent of this program shall be to create smaller antennas without sacrificing gain, frequency or power handling capabilities. Designs should be flexible enough for use on a variety of carriers from tracked vehicles to drones.

PHASE I: This phase shall investigate superconductivity and/or dielectric material technologies/techniques and materials for reducing the physical size of HF antennas. A tradeoff analysis shall be performed based on frequency bandwidth, directivity, gain, weight, volume and cost. The critical design parameters are size and gain.

The tradeoff results shall be used to recommend the approach(s) that appear to offer the best realization of smaller but efficient HF antennas. A proposed design of the antenna along with calculated and or simulated performance data shall be submitted along with results of the tradeoffs in a Phase I report.

PHASE II: This phase shall consist of fabricating, testing, and evaluating the proposed design. Performance characteristics shall be measured, recorded, and analyzed. The contractor shall be expected to make design modifications during the testing phase to try to optimize the performance as much as possible. Phase II shall conclude with the delivery of a prototype antenna and a Phase II final report.

A90-034 High Power Density Transmitter Cooling Device

OBJECTIVE: Improvements of more than an order of magnitude are required in the methods and materials used for heat dissipation in high power density semiconductor transmitters so that the power devices can use their full rating can operate with ambient air cooling, and the junction temperature is kept at reasonable values for reliability.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Semiconductive devices are dominating high power density broadband applications such as ECM transmitters and communications transmitters. During the past few years the transistors have increased in capability where, in order to use their full CW rating, dissipation of 400–1400 watts per device is mandatory. Other circuit elements, such as ferrite loaded inductors used are HF/VHF impedance transformers, capacitors, and switches in harmonic filters are also required to be cooled to allow greater power densities. The transistors and other circuit elements have usually been cooled by water cooled heat sinks. This immediately limits the application of high transmitter powers to large vehicles which can carry the heat sink weight (which is eight or more times the circuit component weight) and the coolant, coolant pumps and radiator weight. The heat sinks are also very large compared to the devices and circuits that they are cooling.

The thermal packaging design is to maximize device power handling capability, be producible, reduce weight and volume of the supporting cooling system, preferably ambient air, and increase reliability by reducing junction temperatures of the transistor, particularly under typical CW and 2:1 VSWR operations. Previous efforts have used copper in place of aluminum as the heat sink, liquid cooling of the top of the die or other component, and very large heat pipes. Copper as the basic heat sink is too heavy. The liquid cooling of the die, while successful in some applications, adds the coolant weight, the weight of the second coolant container on the circuit card and potential orientation problems if the coolant is not deep enough to cover the die continuously. When ferrite components are to be cooled, then this second coolant container becomes very large. Large heat pipes in the heat sink have increased, not decreased the size of the heat sink.

The use of micro-heat pipes or a flat heat pipe with laminar flow imbedded into the heat sink has a potential of three to four orders of magnitude better heat conductivity than aluminum. There are other potential cooling approaches such as thermoelectric devices coupled to a heat sink or combinations of approaches. The heat pipe can be part of the transistor package.

PHASE I: Investigate, analyze, compare using thermal models of possible micro-heat pipe and other advanced cooling approaches for high power density transistors and circuit components. Conduct tests on cooling capability of best approaches.

PHASE II: Develop best cooling approaches into prototype models. Demonstrate on a typical 140 OW output CW operating push-pull amplifier of two transistors and ferrite loaded coupling transformer. The devices will be dissipating 100 OW each and the junction temperature should be held to 167–172 C using 62 C ambient air. Efficient circuit design is not part of this topic.

PHASE III: Convert the prototype design into a producible, modular component.

A90-035 Directive Radiating Expendable Jammer

OBJECTIVE: The objective of this research is to improve the jamming effectiveness of small expendable jammer systems by providing the capability to directively radiate their jamming signal. The technical challenge will be to engineer and design such as system that is of a physically small enough configuration to be part of an expendable jammer design.

CATEGORY: Exploratory Development

DISCRIPTION:

GENERAL: Current expendable or remotely emplaced jammer systems in development plan on using a single radiating element to transmit their jamming energy in an omnidirectional pattern. Assuming that these expendable systems are placed in targeted locations where some intelligence information about enemy tactical disposition, avenues of movement, etc. are know, this omnidirectional radiation does not effectively utilize the time limited jamming energy resources efficiently nor does it maximize its potential jamming effectiveness by concentrating this energy in a given direction. This project will investigate whether there is a viable technology available to increase expendable jammer effectiveness by incorporating directive transmission techniques into expendable jammer designs.

PHASE I: This phase will investigate the feasibility of introducing a directional radiating capability into a generic expendable jammer system design. Various techniques to beam steer or directively radiate shall be considered. Trade-off analyses and consideration shall be given to design factors for operation in the VHF and low UHF frequency range, achievements or not required power, and some methodology to set the direction of radiation either by programming prior to emplacement or by remote control such as a radio transmitted instruction message. Analysis will be conducted on whether jammer self-orientation knowledge would be required, i.e. whether the jammer will need to recognize North - South, East - West direction through its own capability in order to properly reference the correct direction commanded to radiate in.

The result of Phase I will be a conclusive feasibility analysis of providing a directive radiating capability into an expendable hammer configuration. The analysis will contain supported engineering estimates of critical design factors such as size, weight, power consumption, radiation effectiveness/efficiency, and directivity control/self-orientation schemes. The various directivity techniques considered will be analyzed and compared. A most feasible approach will be recommended.

PHASE II: This phase will require the contractor to design, fabricate, test, and evaluate a laboratory/prototype working model of the Phase I recommended approach. Standard laboratory test equipment shall be used to generate the expendable jammer exciter/transmitter signal to the input of the directive radiator subsystem. This subsystem shall be capable of accepting a maximum 10 watts continuous wave input from 30 to 500 MHz. This design should show achieving the frequency range, any tuning time, and efficiency comparable with current expendable jammer designs. The scheme recommended as most feasible to control directivity shall be demonstrated.

A90-036 Analysis and Evaluation of Advanced Direction Finding (DF) Approaches

OBJECTIVE: Provide inexpensive, user friendly, menu driven, evaluation and developmental DF engineering workstation and algorithms to verify that optimal direction finding solutions are provided to the US Army for tactical Direction Finding (DF) systems with the emphasis on SKYWAVE and single site location. The suite of tools will be used in field tests and for the laboratory modeling and simulation of ionospheric propagation phenomena and DF algorithms and to verify contractors' proposals of advanced DF technologies.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Army is unable to properly evaluate major DF system proposals because the simulation, modeling and verification equipment and algorithms needed would typically be as expensive as the systems proposed. The physical limitations and bounds of achievable accuracies possible in HF DF are unknown. This is particularly true of SKYWAVE and especially for the near vertical incidence skywave (NVIS) aspects of the problem. The Army needs an inexpensive laboratory testbed configuration to evaluate and verify emerging techniques using modeling and simulation to evaluate proposed system approaches from contractors. In

addition, this systematic capability would be used on a nearly constant basis for US Army researchers doing internal RDT&E in these fields. This broad requirement will require a very flexible system.

PHASE I: Incorporate reduced instruction set computers (RISC) and digital signal processing (DSP) ships into a modular, user friendly configuration with menu driven software to facilitate verification and testing of emerging DF concepts.

This suite of hardware must run propagation and ionospheric program models like METHODS AND MOMENTS, NEC, IONCAP and ADVANCED PROPHET in conjunction with the concepts under investigation, as appropriate. In addition to considerable scalar and vector processing requirement, the suite must include receivers, analog to digital converters, ionosondes, antennas and related hardware to provide actual test data in addition to the simulation and modeling approaches mentioned above.

Government furnished equipment will be incorporated, within reason, to keep costs down. The Phase I deliverable will be a "scientific engineering workstation" with appropriate software to support research and development, test and evaluation of new DF approaches and to aid in evaluating systems approaches proposed by contractors.

PHASE II: Test tactical DF systems to ascertain the degree to which they conform to stated contractual capabilities requirements. Model and simulate the existing and proposed Army DF systems and provide P3I recommendations to improve these existing and emerging Army DF systems. Establish a library of callable functions to include ionospheric calculations. Provide a means of processing near real-time data from multiple receivers with correlated ionosonde information.

PHASE III: The goal for Phase III is to amalgamate the best of the best ideas to serve as the foundation for a new generation of US Army tactical DF and location systems dapable of exploiting threats through the year 2020. Phase III will incorporate the best features of concepts developed by contractors, academia and US government researchers into a compact DF proof of principle 6.3A system. This system would be used to conduct field tests in a variety of conditions. This system would be the nucleus for the next generation of US Army Tactical DF Systems.

The library of callable functions developed in Phase II would continue to evolve to include capabilities to exploit emerging transmission schemes and use improved ionospheric calculations. The Phase III system would processes the data in real-time data from multiple antennas and receivers with correlated ionosonde information.

A90-037 Assumption Truth Maintenance System in Automatic Target Recognition ATR Algorithm Design

OBJECTIVE: The design of a truth maintenance system for dependency tracking and belief revision in automatic target recognition systems.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: In a given approach to ATR algorithm design, an underlying network of assumptions provides computational and conceptual efficiency. This network includes concrete assumptions about the physical characteristics of the real world scene and abstract assumptions about knowledge acquisition and representation. A facility for the identification and tracking of assumptions in dynamic systems is critical for performance

evaluation purposes. The intersection of the assumptions at a designated stage of the target recognition process defines the valid domain of application of the ATR system.

The investigation of truth maintenance for hierarchical reasoning with constraints is an active area of research in the artificial intelligence community. The intent of the proposed research is to develop an approach to assumption truth maintenance for application to complex, visual pattern recognition systems. The types of assumptions made in automatic target recognition systems will be systematically identified, from the low-level pixel domain to the high-level mission statement. This approach will permit the tracking of algorithm assumptions as they propagate through the pattern recognition process and provide for belief formulation and revision to maintain consistency. The automatic target recognition system will employ rule-based, hypothesis generation and test, or other reasoning paradigms conducive to model-based algorithm development. A prototype set of infrared test imagery at varying levels of resolution and signal-to-noise ratio, representative of the given problem domain, will be made available to the contractor.

PHASE I: Present one or more truth maintenance methodologies applicable to the target recognition task scenario.

PHASE II: Develop, implement, and demonstrate a selected truth maintenance system for a limited problem domain.

PHASE III: Expand the methodology for demonstrated applicability to a more generalized visual pattern recognition problem domain. Formulate specifications for a buildable truth maintenance module to integrate into a large-scale ATR system design.

A90-038 Solid-State Laser Materials Development for Efficient Emission of Radiation in the Visible to Infrared Bands

OBJECTIVE: New and efficient laser materials are sought for improved efficiency and lower cost of laser sources. This contractual effort is for the development of the materials only, and not of the actual laser device. This program will permit the growth of new, low cost and efficient solid-state laser materials on a quick turnaround basis.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Laser materials for efficient, tunable or discrete generation of laser wavelengths are sought that can be grown and evaluated on a fast turnaround basis between a proposed composition and growth on one hand, and materials evaluation and information feedback on the other, so that other compositions of host/dopant combinations can be synthesized and tried for successful growth. Non-linear materials in support of this program, as well as multidopant cascade or so-called two-of-one or multiphoton generation schemes could be acceptable as well. Organic crystal fabrication could be included if the crystal has a sufficiently wide transparency wavelength range.

PHASE I: Demonstrate feasibility of growing small crystals of selected compositions that will show promise of effectively increasing efficiency and lowering production costs.

PHASE II: Increase the scale of crystal fabrication for Industrial as well as for Government test and evaluation.

PHASE III: Produce commercially those crystals that show a drastic improvement in material efficiency.

A90-039 In Vacuum Processing of Infrared Detector Arrays

OBJECTIVE: To develop a high-yield low-cost processing technology for infrared detectors

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: When traditional semiconductor processing techniques are used to fabricate infrared detectors arrays, the yield is low and the array cost is high. To address this problem, novel processing schemes have recently been proposed by CCNVEO scientists. These schemes involve (1) growth of detector layers in a vacuum environment by the new technique of molecular beam epitaxy (MBE), and (2) formation of arrays on these layers without removing them from the ultra-clean MBE environment. In FY89, CCNVEO has made a major equipment investment to show feasibility of (1). To implement the entire processing scheme, techniques for accomplishing (2) must be developed.

In Phase I, feasibility studies will be conducted aimed at developing novel techniques for transforming epitaxial layers of mercury cadmium telluride into infrared detector arrays. These techniques must be fully compatible with the high vacuum environment of an MBE chamber.

In Phase II, the lowest risk processes will be optimize and tested. Testing will be accomplished by constructing vacuum processing modules, delivering them to CCNVEO, coupling them to the new CCNVEO MBE chamber and demonstrating feasibility of the substrate-in array-out concept.

PHASE I: Propose and show feasibility of new concepts for fabricating infrared detector arrays in a high vacuum environment.

PHASE II: Optimize in vacuum processing techniques and demonstrate feasibility of substrate-in array-out concept.

PHASE III: Commercialize the process and equipment for high- yield low-cost infrared focal plane arrays.

A90-040 Integrated Audio-Video Headset Display Terminal for Maintenance Personnel

OBJECTIVE: To develop an integrated lightweight audio-visual headset display terminal with a miniature swivel mounted color monitor, remote I/O receive/transmit capability, and a voice command access, response and control system. The IAVHDT will provide maintenance personnel with the ability to access, view and manipulate the information being displayed by benchtop PC- based ADP/TMDE equipment CRT terminals remotely at distances of up to 100 feet from the workbent, and to provide verbal input of information in lieu of keyboard entry.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Recent advances in the state-of-the-art of electronic speech synthesis, speech recognition and display technologies can now support development of a new generation of user wearable display terminals which can functionally replace the cumbersome keyboards and CRT display monitors of desktop and benchtop PC based ADP equipment. This will allow maintenance and repair personnel to effect troubleshooting diagnostic and repair activities more easily by remotely bringing the ADP based capabilities to the work/repair site rather than taking the failed equipment to the ADP site. This will also provide maintenance personnel with new

capabilities to work in awkward or contorted body positions, confined spaces and locations, or out of the visual/physical range of conventional CRT monitors/keyboards.

The IAVHDT should be designed as a two-piece system consisting of the user wearable headset and a base station. The headset should consist of microphone, and earphone, a color monitor capable of high resolution graphics and 25 line 80 column text display. The headset should be lightweight, ruggedized battery powered, and capable of remotely operating up to 100 feet from the base station. The base station unit should contain all necessary hardware and the system operating system. The base station should interface to existing or planned diagnostic systems, PC based equipments, computer based technical documentation systems, Knowledge Based Expert Systems and be connectable to telephone networks for accessing remote facilities. A calculator style keypad and/or test probe should also be capable of being connected to the headset when voice response would become impractical as the particular repair situation/user application dictates. The normal mode of user access/control shall be through voice commands and responses.

PHASE I: Conduct a feasibility study to examine the feasibility of alternative concepts, ideas, technologies and products which could be utilized to develop a system solution with the desired capabilities. The study should address currently available off- the-shelf products/components, system costs and cost- effectiveness, technical and technological risks, human factors and ergonomic considerations, and compatibility/interoperability with planned and existing Army logistic and maintenance systems. The study shall also recommend one or more system hardware/software solution approaches and describe several applications of how to proposed solutions could be used in the maintenance of Communications-Electronics systems and equipments to demonstrate feasibility.

PHASE II: Design, develop, fabricate and conduct test and evaluation activities on a prototype demonstration system to demonstrate system feasibility, cost effectiveness and utility/worthiness.

PHASE III: Produce commercially available off-the-shelf production hardware/software and applications packages.

A90-041 Process Improvement Tool for Software Development

OBJECTIVE: To improve the effectiveness of detecting and analyzing errors during software development so that the feedback can be used to improve the software development process. In other words the objective is to improve the detailed technical mechanism of Total Quality Management in the area of software.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: During the development of maintenance of large software intensive C3I Systems it is a well known fact that the earlier problems are detected the less expensive they are to fix. Important techniques for early detection of software errors/defects are Software Quality Assurance (SQA) Audits, structured design and code walkthroughs and unit tests. The importance of using these techniques in a systematic and effective way is emphasized by the following key questions in the DOD Software Engineering Institute's Method for Assessing the Software Engineering Capability of Contractors (Sept. 87).

Is a mechanism used for verifying that the samples examined by SQA are truly representative of the work performed?

Are the review data gathered during design reviews analyzed?

Is the error data from code reviews and tests analyzed to determine likely distribution and characteristics of the errors remaining in the product?

Is review efficiency analyzed for each product?

Are analyses of errors conducted to determine their related causes?

The focus of this SBIR topic is to explore the feasibility of an advanced computer-based tool that will significantly enhance government or contractor capability for control of the software development process including also control of the quality, validation and verification checks which are normally performed as part of software developments. The tool would be required to operate in a DOD software development environment in the detailed design phase, coding phase and unit test phase. The optimum types of inputs to the tool should be identified during Phase I. The inputs would include information such as defect/error data from manually provided discrepancy reports and from RDL and code analyzers, quantitative data from quality assurance reviews, and design/cod walkthroughs, and data from the review of unit testing. Other relevant information such as system characteristics and software development methodology might also be input. Phase II would involve development of the tool itself for a limited range of applications. The emphasis for the tool is in near real-time feedback into the software evaluation process which would improve the overall software development process.

PHASE I: The objective of Phase I is to explore the feasibility of tool, and determine a set of tool characteristics which should be achievable. Relevant software project information which would be needed for the software tool should also be identified during Phase I.

PHASE II: The objective of Phase II is to develop a tool which would be oriented to the DOD software development environment, would be usable by software engineers or product assurance personnel, and which would be tested and validated with respect to a particular software development example. An improvement in software development effectiveness should be achievable through the use of the tool.

PHASE III: The objective of Phase III is to commercialize, distribute and refine the tool for general application.

A90-042 Testing of Military Production Hardware

OBJECTIVE: To determine the optimal levels of hardware testing at each level of assembly to maximize end item reliability and minimize total cost.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Current military procurement contracts invoke military standards which require extensive testing of components, subassemblies, assemblies, and end items. The combined efforts of this testing may induce latent defects or reduce life expectancy of military equipment/systems. This study should determine the accumulated effects of imposed environmental and electrical stress occurring during the manufacturing test sequence from component to final end item acceptance for the purpose of determining the detrimental effects of such testing.

PHASE I: Determine the impact environment and electrical stressing has on a CECOM item which has just come off the production line but has not been fielded and report the finding of this investigation to the government. The method used to conduct your investigation should be documented to the extend the allows other who may conduct such an investigation to arrive at similar findings.

PHASE II: If the results of Phase I indicate that environmental and electrical test currently being employed by CECOM have a detrimental effect on the reliability of an equipment/system the contractor should provide an alternative and improved mythology for measuring reliability without adversely affecting the reliability newly produced items. This mythology should be implemented on a prototype and a detail report of finding provided to the government which underscore the results of the new stress (test) procedures.

PHASE III: Providing Phase III revised stress/test procedures are in accordance with best environmental and electrical testing practices, provide guidance documentation for use by the technical community which explain in detail how to implement the new stress/test guidelines for communication equipment.

A90-043 Improved Software Fault Tolerance Techniques

OBJECTIVE: To develop and facilitate implemenation of techniques to improve the software fault tolerance attributes of tactical real-time Ada computer programs.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The reliability and availability of tactical system software are critical to the soldier in the field. Significant progress has been made in reducing the number of software faults/failures through improved quality assurance, testing and software reliability measurement techniques. However progress in improving tolerance to and recovery from software faults (a factor affecting availability to the user) has not had as much impact. Exception handling is part of the Ada Language; however implementation of this feature in software has been less than systematic. The use of multiple program versions for redundancy is only practical in the most critical applications (i.e., space vehicles). Research effort is needed to identify practical techniques that can be applied to requirements, design and coding which will localize the effects of software faults and reduce the time neccessary to recover. The concept of software fault tolerance can be broadened to include all softwar features which can be used to reduce system downtime and maintain continuity of operations when software errors occur. Tactical system software requirements are normally stated in the positive sense, in terms of what the final product should do for the user. It is difficult to specify requirements for how the software should perform in the case where there may be undiscovered errors in the software. Software developers are reluctant to assume failure. What is needed is an approach to software development which will build in software fault tolerance.

PHASE I: The objective for phase I is to define a set of software fault tolerance enhancement techniques and determine the feasibility and extent of automated assistance for implementing these techniques on actual tactical Ada software.

PHASE II: The phase II objective will be to implement a prototype tool that will support the performance of the techniques defined in phase I and refined in phase II. The recommended software techniques and prototype tool would be demonstrated in a small "pilot" software development effort and analysis will be performed on the resulting software product test data.

PHASE III: The objective of phase III is to commercialize, distribute, and refine the tool and techniques for general application.

A90-044 Capturing Analog Design for Technology Update

OBJECTIVE: To investigate and implement techniques for minimizing the impact of obsolete analog parts on the readiness of military communication-electronic equipment.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Military systems become obsolete due to the inability of the government to procure critical components for the support of field equipment. For digital components VHSIC Hardware Description Language (VHDL) has helped to solve these problems by capturing the functional requirements. A similar approach may help solve this problem for analog parts which in turn will keep field equipment operating.

PHASE I: Conduct a feasibility study to determine whether or not the functional requirements for analog circuit can be captured on a description language such as VHSIC Hardware Description Language (VHDL).

PHASE II: Target a CECOM equipment/system using analog circuitry and capture the functional design in hardware description language and provide a prototype example using this new technology which does not change the fit form or function of the original equipment/system. Test and report findings regarding the function of the prototype to the government for evaluation.

PHASE III: With the successful completion of Phase II identify fielded CECOM items that have a field life expectancy of seven years or more and prepare a Request For Proposal that would allow for the redesign and manufacture of this equipment. All rights, documentation, products etc. created as a result of this research effort is deliverable to the government prior to beginning Phase III of this project.

Chemical RDE Center

A90-045 Development of a Device for Sorting Micron Size Dielectric and Conducting Powders

OBJECTIVE: Develop a device to sort quantities of micron size dielectric and conducting powders, such as pigments, based on particle size and shape.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Pigments and other powders each contain a distribution of particle sizes and shapes. Commercial methods of centrifugal air classifying particles are suitable for separating small aerodynamic size from large aerodynamic size. An additional separation mechanism besides centrifugation, such as electrostatic surface charging followed by separation in an external electric field is suggested to separate based on both size and shape. This is important to the U.S. Army smoke program because performance of powders as aerosols depends both on particle size and shape.

PHASE I: A small prototype device will be constructed, perhaps using commercially available components. The Army will supply twenty samples of powder to be separated and returned to the Army for testing along with a description of the device and an analysis describing the physical working principles.

PHASE II: A larger device will be constructed, tested and delivered to the Army. Twenty samples will be provided by the Army for testing. The device will be capable of sorting greater than ten pound quantities of

the powders within an hour and with no more than one operator in attendance. Preferably, the device will continue to operate unattended one started.

A90-046 Single Particle Multianalysis Chamber

OBJECTIVE: Construct a pilot device to sample micron-sized particles from the atmosphere and inject single particles into an electrodynamic suspension device for analyzing the same particle by several different methods including light scattering and various spectroscopies. The device must be capable of moving particles from one chamber to another for different types of experiments and adding chemical as needed for analyzing the particle.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: In recent years the use of various types of suspension chambers has led to the development of optical means of analyzing the content of particles including both solvents and solutes. The particles analyzed are in the one micron to thirty micron size range. The use of fluorescence, infrared, and Raman spectroscopy has been shown to allow analysis of the contents of liquid droplets in this size range. The use of optical resonances in the mie scattering can enhance the sensitivity of these spectroscopic techniques and provide high resolution volumetric analysis. Electrodynamic suspension in the chamber can provide gravimetric analysis. A device is needed where several of the above methodologies can be performed sequentially on the same single micron-sized particle. It is desirable to develop means of sequentially moving single particles non-destructively from one chamber to another so that after the first type of optical analysis, a second type of experiment may be performed on the same particle including adding various test chemicals also in micron-sized amounts to identify the contents of the original particle. These tests should be capable of being performed at temperature controllable to +/- 0.1 degrees Celsius at know pressure, in controlled humidity and with known atmospheres of surrounding gases. Further one should be able to automatically monitor changes in mass of the unknown particle as it absorbs gas, evaporates or has test chemicals added to it. The means for adding carefully monitored micron-sized amounts of test chemicals to a suspended particle must be provided and demonstrated. Finally, since it has been shown that mass spectrometry of the chemicals making up a single particle is of use in identifying the particles, the same particle should be able to be delivered for analysis in such a device after all the other tests have been carried out. One should alternatively have the option of saving the particle for microscopy.

PHASE I: Experiments to determine which of the above methodologies may be achieved in a single device as well as theoretical analyses to show which combination of methods yields the best information regarding the nature of an unknown particle studied.

PHASE II: Construction of a pilot model of a device utilizing several of the analysis methods. The methods to be included in the instrument will depend on the results of the Phase I experiments, but will include a minimum of the ability to move a single particle from one chamber to another, to add chemicals to a suspended single particle, and to utilize more than one type of spectroscopy on one single particle. All these features should be combined in a single instrument.

A90-047 Atmospheric Pressure Ion-Molecule Chemistry in Ion Mobility Spectrometers for Increased Sensitivity and Specificity

OBJECTIVE: To develop specific gas phase ion-molecule chemistry in Ion Mobility Spectrometry (IMS) systems and to develop new IMS signal processing techniques to allow significant improvements of military systems and, therefore, application of such systems to the detection and monitoring of illicit/illegal drugs, chemical taggants in explosives, and hazardous industrial chemicals.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Military, hand-held systems are used for detecting chemical warfare substances, IMS systems can be useful in industry to monitor chemical storage sites for hazardous vapors. IMS systems have also been shown to be responsive to both heroine and cocaine as well as to chemicals used in the manufacture of these drugs and, therefore, applicable to the "War on Drugs". IMS response to many compounds that have been proposed as taggants to allow detection of concealed explosives has been demonstrated too. Most detection and monitoring applications are encumbered by presence of other chemical substances that represent interferences to the determination of the materials of interest.

PHASE I: Perform a background study of the state-of-the-art in specific materials that can be added to IMS systems to improve specificity by virtue of ion-molecule chemistry and in signal processing algorithms to allow interference rejection. Phase I would delineate chemistries and signal processing that will improve IMS detection of:

a. Illegal drugs (cocaine, heroine, etc. and their precursors)
b. Chemical taggants for commercial or military explosives
c. Industrial hazardous chemicals (solvents, cleaners, etc)

PHASE II: Quantitative and semi-quantitative studies of the ion-molecule reactions must be carried out and documented in an easy to use form. The peak selection, or compound identification, algorithms must be refined and tested in a variety of scenarios with respect to Phase I applications above. "Add-on" hardware (e.g., heated inlets, aerosol samplers, etc) identified in Phase I must be constructed and tested. Phase II would result in the provision of information and systems that can be used in a variety of military, environmental, and law enforcement applications where previously developed IMS systems are ineffective.

A90-048 Vehicle Interior Decontamination System

OBJECTIVE: To demonstrate the technical feasibility of the development of a system to be used for the decontamination of combat vehicle interiors.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There are no systems currently in the field or in development which may be used to decontaminate the interiors of vehicles, vans, shelters, or other enclosed spaces. Traditional aqueous based systems are not applicable since the equipment usually cannot be sprayed with water solutions. Gas phase systems based upon the concept of fumigation, which are used for biological disinfection, have been investigated sporadically but have suffered either from a lack of reactivity or from the converse, an excessively reactive or corrosive nature. A concept for a system utilizing hot air to accelerate the evaporation of the agents was carried into development a few years ago but the effort was halted when it became apparent that the process would be too slow to be operationally feasible. To be acceptable the method must be rapid, efficient,

non-destructive to electronic equipment, and capable of being carried on board the vehicle on which it is to be used. New concepts, which address these requirements, or modifications of previously attempted concepts which eliminate earlier drawbacks cited above are sought.

PHASE I: The objective of Phase I will be the initial feasibility demonstration that the concept proposed will be suitable and effective. Some experimentation to validate that the method will work but will not destroy equipment typical of that found on the interiors of tactical vehicles will be required.

PHASE II: Reduce the concept to the breadboard or working model stage. This effort will show that not only will the concept work in a controlled laboratory setting, as demonstrated in Phase I, but it is likely that a larger scale could be developed which could be successfully fielded.

A90-049 Detection of Large Molecular Weight Toxins

OBJECTIVE: The objective of this project is to develop a test kit which would be capable of detecting large molecular weight toxins from environmental samples.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The M256 and M272 test kits are fielded items which have the capability to detect classical chemical agents from the air, surfaces, or water sources. A product improvement effort is presently underway to expand the capability of these kits to detect small molecular weight toxins; however, there is no present effort with respect to large molecular weight toxins. Recent advances in areas of immunoassays and miniature instrumentation have made available simple, rapid capabilities to detect a variety of different substances with little or no skill on the part of the operator. Utilizing government furnished reagents, the contractor will develop a test kit for the detection of large molecular weight toxins. The technology need not necessarily be capable of identifying the toxin, but should be able to demonstrate that a hazard exists. The technology should be capable of interfacing directly with either of the kits above, and not compromise the performance of these kits with respect to shelf-life or detection capabilities. The probability of success of this project is high. Commercially available technology already exists in the clinical and home health-care marketplace. These products have undergone rigorous testing by the Food and Drug Administration for safety and efficacy. The multitude of home pregnancy test kits attest to this fact. It is only necessary to evaluate this technology for agents which are of interest to the military.

PHASE I: Demonstrate the capability of the technology to detect up to three agents, using government-furnished reagents.

PHASE II: Demonstration of such characteristics as stability and interface capability with the presently available chemical agent test kits. Successful technologies could then be transitioned to advanced development or directly into production.

Missle Command

A90-050 Pulse Jet Engine Technology

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The pulse jet, due to the inherent mechanical simplicity of such engines, has the potential of being developed into an extremely low cost airbreathing propulsion system. Such a low cost propulsion system may be suitable for targets, decoys, training rounds, and low cost weapons. Innovative pulse jet concepts are required that lead to improved engine reliability and performance without adversely affecting cost. Critical technology areas that should be evaluated are: fuel injection/ control systems, valves, ignition/start systems, and materials. Airframe/engine integration should be considered in any concept evaluations. Emphasis should be placed on the theoretical and experimental evaluation of hardware designs. The static thrust range of interest is 50 to 200 lbF. Flight durations of 20 minutes at maximum thrust are desired. The desired vehicle flight speed is subsonic above Mach. 3.

PHASE I: Would involve the design, fabrication, and static testing of heavy wall engine.

PHASE II: Would involve design, fabrication, and flight testing of a flight weight engine. Engines developed under both phases would be delivered to the government for evaluation.

A90-051 Slugless, Multiple High Velocity Pulse Shaped Charge Jets

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Conceptually, there is an advantage in attacking tank armor repeatedly in the same spot with jets formed by shaped charge warheads. Currently, practical devices are limited to the formation of two jet "pulses" because of the formation of a slug (a concentration of slow moving shaped charge liner material) for each high velocity jet pulse. The development of slugless, high velocity jets, combined with shaped charge designs that produce three or more pulses should have a significant performance advantage in terminal homing missiles.

PHASE I: Should identify technical approaches, and determine which are feasible based on modeling and simulation. Phase I should end with the selection of the most promising design approach to be pursued in Phase II. The design approach selected should be capable of defeating multiple layers of reactive armor sandwiches which are located within a one meter path.

PHASE II: Will demonstrate, through fabrication and firing tests, that the design approach will perforate multiple layers of reactive armor, as well as passive armors. Phase II will be structured to permit the demonstration of the design to occur through successive iterations (approximately three) of fabrication and test.

A90-052 Low Cost Collapsible Mandrel Substitutes

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Filament winding and other composite material fabrication techniques often require mandrels which must be removed through small openings. A number of various procedures are in use such as collapsible metal tooling, inflatable tooling, sand wash out, wax melt out and eutectic alloy melt out materials. Each of these may serve in a particular area, but each has significant disadvantages so as to prevent its universal usage.

A material is needed which readily forms to the required mandrel dimensions, resist the temperature and handling stresses inherent in composite parts fabrication and, then, is just as readily removed without leaving residue inside the finished part.

PHASE I: This effort will consist of evaluation of various materials and/or techniques that will meet the requirements described. It is anticipated that several approaches will be tried before the right combination of strength, temperature and ease of removal is developed. This phase is exploratory development and should culminate with a demonstration of the technique to be used for mandrel fabrication and removal.

PHASE II: This phase will consist of fabricating several mandrels of different configurations. On these mandrels, composite structures will be fabricated. These structures will use different composite materials and will require different cure procedures. This is also exploratory development. The success of this phase will depend on the ease of making the mandrels, how well they hold up during fabrication, and the ease of removal from the finished part.

A90-053 Drag Brake/Wing Deployment Mechanization

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Missiles which must fly a considerable distance at a relatively high velocity and then slow to a very slow velocity for part of the mission could fly out on the body-tail lift and then deploy wings for the slow phase of the flight. One concept under consideration for FOG-X has four wings folded aft along a square fuselage. The wings would deploy to an intermediate position to serve as drag brakes and then fully deploy to act as wings. This task consists of designing, fabricating and testing a mechanism for deploying four panels which would serve as both drag brake and wing. The wings should deploy to an intermediate position as a drag brake during the slowdown such as a flat plate 30 degrees to the airflow. Then the wings must rotate 90 degrees during the deployment from drag brake to wing. The wings should deploy in such a manner that very small changes in aerodynamic moments are generated due to differences in deployment position. It is of utmost importance that the mechanisms involved in the deployment be simple and use as little internal volume in the missile as possible. The internal volume of the wing could be utilized.

PHASE I: Activities should provide a basic design and supporting analysis including stress analysis. Engineering drawings should be provided for review.

PHASE II: A full-scale model is required and it shall be required to demonstrate the deployment mechanisms against loaded wing panels.

A90-054 Alignment Transfer for Helicopter Launched Inertially Guided Missiles

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The accurate transfer of alignment from a helicopter stabilized tracker platform to an Inertial Measurement Unit (IMU) package on-board a missile being carried by that helicopter is the key capability needed to achieve a true long range fire and forget capability via an inertial strapdown navigation midcourse

and autonomous handover to a terminal seeker for final homing. Innovative non-interference hardware and processing concepts to continuously measure angular motions of the missile while it is mounted on the launcher, relate these motions to the helicopter's stabilized target track line-of- sight, and perform alignment transfer immediately prior to launch are required. Missile IMU to helicopter stabilized tracker alignments 5 to 10 times more accurate than current launcher motions are required. The new helicopter transfer alignment system shall require little or no crew interaction as an autonomous part of the launch process.

PHASE I: Activities should provide a basic design, supporting analysis, and a laboratory breadboard demo of the basic missile motion measuring mechanism.

PHASE II: Activities should provide a brassboard demonstration of the alignment transfer on a representative helicopter/missile system.

A90-055 Electro-Mechanical (EM) Actuator Driver

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: High efficiency, high packaging Density Pulse Width modulation (PWD) motor drive circuits are required for EM control actuators for lightweight missiles. There exists a need for low cost, fully integrated H-bridge circuits capable of switching up to 50 volts at 5 amps to provide bi-directional control of single/multi-phase DC motors. Circuit input is required to be TTL level pulses. Complete circuit drive one (1) motor shall package in 0.8 cubic inch or less and operate continuously at 20 percent duty cycle without external cooling. This effort is exploratory development.

PHASE I: The objective of the first phase of the proposed effort is to design, fabricate, and test a prototype circuit. The configuration of this prototype shall be sufficient to prove the basic functional performance of the design. Although this prototype shall not be required to meet the size constraints, it shall be demonstrated by analysis that the proposed design can meet the size and power dissipation requirements in the final (Phase II) form.

PHASE II: The objective of the second phase of this effort is to design, fabricate, and demonstrate a fully integrated package which meets the size and power dissipation requirements as described above.

A90-056 Synthesis of Cadmium Sulfide

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Cadmium sulfide, in single crystal form, is in the STINGER POST missile system. Present production processes suffer from many problems, some of which result from differences in the properties of the cadmium sulfide powder used to grow the single crystals. Research is required to complete the development of the spontaneous reaction between dimethylcadmium and hydrogen sulfide which yields highly pure cadmium sulfide.

PHASE I: Results from spectroscopic and stoichiometric analysis will be combined with results from x-ray diffraction and scanning electron microscopic analysis to show that each production batch is highly pure and the same. Analysis, results, and samples will be supplied to us in appropriate reports.

PHASE II: Enough powdered cadmium sulfide will be produced to grow several single crystals of cadmium sulfide. Several will be from unit production of cadmium sulfide and several will be from combinations of several productions of cadmium sulfide. Analysis, results, samples and single crystals will be supplied to us in appropriate reports. (Basic Research)

A90-057 Acquisition and Classification of Helicopters in Defilade

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Threat helicopters may utilize nap of the earth maneuvering to screen themselves from conventional ground based surveillance systems. Techniques are needed to detect, discriminate and classify these threats so that fire, counterfire or avoidance can be implemented by our weapon systems. Concepts may utilize active or passive sensors for this exploratory development program.

PHASE I: Concept description and feasibility studies that predict sensor performance to distances greater than 8 kilometers are required. Measured data when available should be utilized in the studies. Deliverables shall include reports and any computer codes utilized.

PHASE II: Sufficient hardware shall be assembled/developed and utilized to demonstrate the concept and predicted performance in field experiments.

A90-058 Observer Degradation Model

OBJECTIVE: Support the inclusion of observer degradation effects on targets for hardware-in-the-loop simulation.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Innovative methods are needed to include the degradation effects of an observer on a three-dimensional, infrared target model as it is viewed by the observer. These methods must account for the image degradation due to the effect of range variation on image resolution. The methods must also account for effects such as the observer spectral bandpass and spectral response curve. The methods must be shown to agree with data taken at various ranges. The techniques developed must be capable of running on UNIX-based engineering workstations such as the IRIS 4D/70 Graphics Turbo, and must require minimal human intervention in their operation. This work should be considered Exploratory Development.

PHASE I: Production of computer software capable of running on MICOM's IRIS 4D/70 GT workstations which fully satisfies the objectives described above.

PHASE II: Extend the software in PHASE I to encompass a closed loop, 6 Degree-of-Freedom flight simulation for a missile and plume as viewed by an imaging infrared sensor. The extended software must account for observer degradation effects such as the fields of view (both total and instantaneous), blur circle size, detector pixel array geometry and response, point spread function, and signal processing. All pertinent effects must be included so as to produce the time dependent signal(s) that would be injected into a seeker breadboard during a hardware-in-the-loop simulation. Also, the extended software must be capable of

modifying and/or degrading the three-dimensional, infrared target model file to appropriately account for the above mentioned effects such that a new three-dimensional, infrared target model file is produced. The identification of various distinct parts of the model (such as wings or tank turrets) must be maintained in separate sections of the new faceted, 3D, target model file. The format of both the original and new target model files will be specified by the Government. The software developed must be capable of running on the IRIS 4D/70.

A90-059 Infrared Targets for Testing System Resolution

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The rapid growth in the number of military systems that utilize sensors has placed increased demands on system testing. Some important elements include that of measuring the resolution of infrared sensors and determining the effect of line-of-sight stability on system resolution. Many military systems could benefit from such an exploratory development program and the end item will be marketable to the tri-services.

PHASE I: This will be an exploratory development stage that will include engineering analysis to demonstrate the feasibility of building a device with the characteristics outlined below.

PHASE II: Infrared targets are required in order to support field/captive flight testing of infrared sensors. Characteristics required for the infrared targets include: a target board with dimensions 3 meters X 3 meters (not including a 1 meter border), the capability of varying the number of bar targets (detention, recognition, identification) and the ability to change the relative orientation of the bar targets (vertical, horizontal) at least once every two minutes. Other requirements include the capability vary to the target to background temperature difference from 1.5 to 10° C with an accuracy 0.2° C and to maintain the background temperature within 0.2° C of ambient. The system should also be capable of changing the temperature difference from maximum (+10° C) to minimum (+1.5° C) within a 2 minute period. In addition, the system should be computer controlled with the capability to remotely command a vertical or horizontal bar orientation for detection, recognition, or identification of the target board. Phase II will be an engineering development stage that will include delivery of hardware meeting the requirements outlined above. If the end item meets the technical requirements, this device will fill a need for the tri-services.

A90-060 Power Transmission Utilizing Laser and Electro-optic Technology

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: A method is required to remotely power missiles and telemetry electronics during Electromagnetic Environmental Effects Tests. While testing these effects, power cannot be delivered using conductive wires which would change the test fields. Currently batteries are used to power the missiles and telemetry. The batteries have to be replaced often which means a time consuming disassembly of the missile under test. Currently being explored is the use of electro-optic power conversion technology to meet the power requirements. The idea is simply to convert laser power guided to the missile by a nonconductive fiber optic into electrical power capable of powering the telemetry. The small size of the conversion module, less than two inches in diameter and two inches in height, and the power regulation requirements further limit and challenge

the design. The needed hardware includes a laser, a fiber optic transmission cable, and a power module. Preliminary design and fabrication of proof of concept of the power modules is preceding in-house.

PHASE I: Would be the final design and fabrication of a test power module.

PHASE II: Would produce from one to three fully operable systems to be utilized for extended proof-of-principle tests.

NATICK RDE Center

A90-061 Easy Open Metal or Polymeric Tray Pack

OBJECTIVES: To design and develop an easy open feature for present metallic Tray Pack or polymeric Tray Pack under development.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The present metallic Tray Pack has to be opened using a can opener. It is desired to have an easy open feature that will eliminate the need for a can opener. It must be taken into consideration that the can must be able to withstand the rigors of military handling. A polymeric Tray Pack is under development at this time. The easy open method must be developed for the tray as well.

PHASE I: Conduct a study and report findings as to the feasibility of an easy open design feature for the present metallic tray pack can and its polymeric equivalent. Both trays are approximately 10 X 12 X 2 inches in size and hold approximately 100 ounces of thermally processed foods.

Produce a quantity of prototypes for evaluation.

PHASE II: Produce, test and deliver to Natick a quantity of easy open tray pack cans, both metallic and polymeric. Tray packs shall be filled, sealed, thermoprocessed and abuse tested prior to delivery to Natick for further evaluation.

A90-062 Thermal Manikin Design and Fabrication Utilizing Heat Pipe Technology

OBJECTIVE: To fabricate a thermal manikin test apparatus utilizing heat pipe technology to achieve ISO thermal surface temperature over the entire surface of the manikin's human form shape.

CATEGORY: Exlopatory Development/Advanced Development/Engineering Development

DESCRIPTION:

GENERAL: A thermal manikin apparatus is utilized to measure heat transfer properties of clothing and equip age in order to establish their environmental limits. A need exists to review a government generated base design plan for 17 zone thermal manikin, fabricated from heat pipes to achieve isothermal surface temperatures. In Phase I, design changes, modifications and improvements, as appropriate, will be prepared to achieve a functionally sound and complete manikin design package which meets specific performance requirements. Phase II requires manikin fabrication based upon the Phase I design.

A90-063 Eye Protection Against Tunable Laser Sources

OBJECTIVE: To demonstrate principles and construct systems for significantly attenuating all wavelengths of light from 400 - 1065 mm.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: While protection against a reasonable number of fixed laser wavelengths appears technologically feasible, simultaneous and instant protection against all laser wavelengths in the visible and very near infrared, by a method feasible for the low weight, bulk and power requirements has not yet been demonstrated. Methods and materials are sought which would provide instant (subnanosecond) attenuation of all wavelengths of light in the visible and very near infrared region of the spectrum. The normal state of such a system should provide a high level of transmittance, very low level of distortion, and a wide field of view.

PHASE I: The first phase will include all work necessary to establish the soundness of the proposed approach, including demonstrations of the scientific validity of the approach, where appropriate. The first Phase will also include experimental verification of the principles proposed, in the form of breadboard demonstration or hand-held demonstration devices. These devices should show or permit a demonstration of the effectiveness of the approach against any arbitrarily selected visible or near infrared wavelength (to 1064 mm), and indicate its potential for use in a lightweight headborne device.

PHASE II: The second Phase shall include refinement of the principles demonstrated in Phase I, to optimize desirable operating characteristics and reduce or eliminate shortcomings or inadequacies.

The second phase shall also include the construction of several complete demonstration goggle-type devices. Such devices shall retain or improve all of the required protective characteristics of the Phase I device, but shall also permit evaluation of their essential characteristics, including recovery times, field of view, optical distortion, durability, etc. Potential manufacturing problems should be discussed and addressed.

A90-064 Integrated Ballistic Casualty Reduction and Ballistic Protection Model

OBJECTIVE: At the completion of Phase II, an automated computer simulation model will exist that will allow designers and manufacturers of individual ballistic body armor to rapidly assess the effects of design/material changes on performance in order to optimize specific designs. This will be accomplished through an interactive process that assesses changes in the armor's casualty reduction potential resulting from any design/material changes. The model will simulate various ballistic impacts from a range of appropriate threat weapons.

CATEGORY: Exploratory Development

DESCRIPTION:

PHASE I: Optimize existing computer simulation programs that describe projectile penetration and ballistic protection effects for new computer hardware. Extend methodology to predict the effects that varying body armor materials, design, and construction have on casualties.

PHASE II: Integrate the optimize and extended methodologies of Phase I into an overall, user friendly, menu driver, stochastic program to specifically support the development of optimize body armor protective systems.

PHASE III: Develop both graphic and tabular output routines for the simulation model and provided for multiuser access on commonly available engineering workstation on parallel processor computers.

A90-065 Novel EM Gasket Concepts for Tactical Shelters

OBJECTIVE: Develop gaskets to replace existing inadequate gaskets.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The door seals on electromagnetically shielded tactical shelters are typically made of metal mesh gaskets. It is known that these gaskets deteriorate rapidly due to corrosion and compression set. Metal finger type gaskets require precise door assignment, frequent maintenance, and are susceptible to physical damage. Novel designs and methods are needed for making electrical contact around shielded doors. Novel designs should require only low closure/compression force, should provide high shielding effectiveness (greater than 60 dB at 100 kHz, magnetic), should be of rugged construction, and should provide a long service life with only minimal maintenance.

PHASE I: The effort would consist of generating gasket concepts fabricating prototypes, and performing bench top, proof of concept tests on the prototypes.

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

A90-066 Development of a lightweight, quiet, power source.

OBJECTIVE: To develop a lightweight, quiet power source to be used in the development of a man-portable microclimate cooling backpack.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The proposed program is for the design and construction of a lightweight, quiet power source that will be ultimately used to power a microclimate cooling backpack. Currently, there is no commercial source of power sources of the size, weight, power, and fuel utilization required for backpack application.

The power source can deliver either shaft or electrical work. If the output is shaft work, the power source will be used to drive a compressor as part of a vapor-compression refrigeration loop. If the output is electrical, the engine will be used to supply power to either an electrically driven compressor or a thermoelectric cooling device. Power output should be greater than 300 watts and the device should be quiet, vibration free, efficient, easily operated and maintained and weigh less than five pounds. Since this device will be used for backpack applications, keeping the weight to a minimum is essential.

PHASE I: The contract will be for the preliminary design concept. Enough data will be developed in this phase to permit assessment of probable success.

PHASE II: Will be for the development and construction of a working prototype.

A90-067 Processing and Spinning of Protein Fibers

OBJECTIVE: To identify optimal processing and spinning requirements for the formation of high strength fibers based on fibrous proteins.

CATEGORY: Basic Research and Exploratory Development

DESCRIPTION:

GENERAL: Current research efforts are focusing on genetic manipulation of natural systems for the production of new protein-based polymers. These bioengineered materials can be produced in relatively large quantities in fermentation systems from recombinant organisms.

PHASE I: To develop processing requirements for the isolated fibrous proteins to prepare these products for fiber spinning. To develop fiber spinning conditions to optimize desired performance such as high tensile strength. To produce sufficient quantities of fibers for evaluation of fiber performance.

PHASE II: To scale-up the processing and spinning conditions developed in Phase I to produce sufficient quantities of fibers for full scale evaluation of fiber performance as a woven material.

A90-068 Coated Fabric for Five Soldier Crew Tent (FSCT)

OBJECTIVE: Develop fabric to replace existing FSCT fabrics.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: Develop fire, water and weather resistant fabric that would also address NBC threats.

FSCT Fabric - SBIR

The army has a need for a new, lightweight, fire, water and weatherproof fabric for the newly developed Five Solider Crew Tent. The existing fabric cracks and delaminates following short term exposure. A new fabric is needed that will:

1) Be less than 70 oz/yd^2

2) Meet or exceed federal STD 5903 for fire resistance

3) Have minimum physical characteristics of:

   a. Breaking strength, warp and fill, 175 lbs.

   b. Tearing strength, warp 15 lbs, fill 8 lbs.

   c. Stiffness, warp and fill, maximum at
   $+70^0$ F -/- 2^0 F 0.005 X 0.005 inch pounds
   -20^0 F -/- 5^0 F 0.200 X 0.200 inch pounds

   d. Water repellency

   (1) Hydrostatic resistance, centimeters, minimum, held for 10 minutes: 50 cm initial and 50 cm after -40^0 F cold crack.

(2) There shall be no evidence of cracking after cold soaking and creasing of the specimens.

e. Adhesion of laminated film or coating, 10 lbs per two inch width, initial and after ultra violet light exposure.

f. Be capable of accepting a camouflage pattern coating.

This new fabric must conform to the requirements of NBC Survivability as defined in AR 70-71.

PHASE I: Determine if stated minimum requirements are feasible with current state of the art techniques and materials. Determine if any trade-offs may be required to achieve the desired physical performance characteristics and provide the ramifications of each. Investigate commercially available, nondevelopmental materials which may possess the desired minimum requirements and determine prototype costs estimate.

PHASE II: Initiate material development program to continue exploration of promising materials with the goal of obtaining a quantity of prototype yardage to be used in actual end item test applications.

Tank Automotive Command

A90-069 Robotic Convoy Capability

OBJECTIVE: This program will provide another tool for potential users of robotic system to enable them to achieve multiple vehicle control. The objective is to develop a system of sensors and controls which will allow unmanned vehicles to autonomously follow either a manned or another unmanned vehicle. Robotic convoying together with computer aided driving and autonomous road following will in the future enable one person to control several vehicles at the same time.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: In the deployment of numerous robotic vehicles from a single Robotic Command Center (RCC) it would be desirable to have the capability to teleoperate one robotic vehicle while having the other robotic vehicles autonomously follow the teleoperated vehicle in a convoy formation (i.e., robotic convoy). This capability does not currently exist. The overall requirement is for a contractor to develop a first generation robotic convoy system using currently available hardware.

PHASE I: In the phase I effort the contractor shall design and document a robotic convoy system. The design will need to specify the required sensors, processors, communications system, navigation system, etc., and specific details as to how the components will be integrated together. Any system configuration developed should employ currently available hardware only. Expected system performance capabilities e.g. speed, following distance, lateral position errors, etc., will need to be estimated. Supporting technical rationale for component selection, integration, etc. should also be provided. Documentation shall be sufficient to enable the fabrication of a breadboard prototype in a subsequent phase II effort. Minimum documentation requirements are as follows: Concept sketches, Subsystem and system functional specifications/block diagrams/performance capabilities, Detailed system description and a final report.

PHASE II: In the phase I effort, the contractor shall fabricate and test a breadboard prototype robotic convoy system in accordance with the design developed in Phase I. Vehicles will be provided by the government for implementing the robotic convoy system. Field tests will be conducted to explore the performance capabilities of

the system. The following items shall be deliverable under this effort: Design drawings, Test report, Final report and the Breadboard prototypes.

A90-070 Advanced Concept Evaluation (ACE)

OBJECTIVE: Design and demonstration of advanced desktop/laptop workstation computer software for complete design and evaluation of concept vehicle armor protection systems. Investigate the limits of using state-of-the-art armor design and evaluation software on advanced PC, PS or workstation units.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: These are various armor design and evaluation models for different threats and different armor system types. They come in many sizes and capabilities and are usually created by armor design and test experts, not computer software, graphics, or hardware experts. The computer models are executed on general purpose processors of one type or another, but seldom on a dedicated state-of-the-art hardware system. The armor concept design and evaluation would require excessive time and effort. This effort seeks innovative concepts and designs using state-of-the-art and available hardware at the U.S. Army Tank- Automotive Command, and specially packaged armor design/evaluation software for the creation of dedicated desktop/laptop workstations for concept vehicle armor design and evaluation against KE and CE threats of all sizes. This effort seeks new interactive computer aided software and techniques that will reduce combat vehicle armor concept design and evaluations to within days instead of taking weeks.

PHASE I: Literature, technology, and TACOM hardware survey, Concept development, System designs and analysis.

PHASE II: Component software development, tests, and assembly, System packaging, System testing, demonstration, and documentation.

A90-071 Cold Start Systems

OBJECTIVE: Cold Start techniques for military diesel engines shall be developed allowing for quicker more reliable starts down to -25 F without external aids and to -60 F with arctic auxiliary kits.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Current high output military low compression ratio diesel engines have difficulty in meeting cold start specifications. Simpler techniques are required to improve cold start capability. All starting hardware should be rugged and compact, capable of integral vehicle installation. The prime vehicle fuel, diesel, or its alternative, should be the only fuel required. High flash point fluids such as ethers and nitrates are discouraged.

PHASE I: The cold start design concept shall be completed with estimates of cold start capability and improvements provided. Drawings should be furnished demonstrating how the system could be integrated into a military propulsion system design.

PHASE II: The system described in Phase I shall be fabricated and demonstrated on an engine in cold room tests. Baseline to new configuration cold start test results shall be made and compared to demonstrate improvements.

A90-072 Robotic Vehicle Communication Controller

OBJECTIVE: The objective of this effort is to design, fabricate and test a communication controller which would manage the information that is passed over the communication link between robotic vehicles and robotic command centers. The information communicated between vehicles would be greatly reduced by allowing only that information which is of true value to other members of the network to be communicated. This would allow more robots to be operated in the same area.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Army anticipates that multiple robotic systems will be operating in close proximity to each other. Each robotic system would consist of a Robotic Command Center (RCC) controlling up to four robot vehicles (RV). The RV would perform a variety of missions including weapons firing, NBC detection, decoy, recon, mine detection and clearing and target acquisition and designation. The command, control, communications and intelligence requirements of such a robotic fleet require the improvement of present communication control technology. It is anticipated that there would be two way message traffic from RV to RV, RV to RCC, RCC to RCC and RCC to a Central control center. The Army envisions the development of a black box to be integrated into the RCC and RVs which would manage the communication network to determine 'who' needs 'what' information and 'when'.

PHASE I: The phase I objective is to determine the feasibility of developing a black box which would be placed between robot vehicle computers and the radios to manage the information flow into and out of the vehicle. The black box would determine what incoming information is needed by the vehicle and what information available from on board sensors is needed by other members of the network Block diagrams would be developed to show modules which would make up the black box. Functional descriptions would be provided for each module.

PHASE II: In phase II, the contractor will fabricate the black box based on the concept developed in phase I. Hardware will be built and software written to perform the functional modules described in phase one. The black boxes will be integrated on the Government supplied RCC and Robotic Wiesel vehicles for testing at Ft. Knox

A90-073 Variable Valving Mechanisms

OBJECTIVE: Mechanical, hydraulic variable valve timing/lift variation mechanisms are to be designed, built and demonstrated. These systems may be directly or micro-processor controlled.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The system to be designed should allow variability in valve events as well as opening and closing rates. Potential benefits include: improved engine transient response, provide for engine braking, more optimized cold starting and ability to optimize a chosen engine function throughout its operating range.

PHASE I: The variable valve timing system design concept shall be completed in this phase with engineering estimates on performance and potential applicability to modern diesel engines provided. Estimates such as valve lift/rate of lift versus time and system power requirements shall be provided as well as drawings as to how system could be incorporated into modern diesel engine designs.

PHASE II: Feasibility of the variable valve timing shall be demonstrated. The demonstration shall be accomplished on a single cylinder diesel engine, four valve head configuration.

A90-074 Ruggedized, Low Cost, Engine Mounted Oil Analysis Sensor

OBJECTIVE: Development of an Engine Mounted Oil Analysis Sensor which can be mounted on an vehicle/engine and perform detailed oil analysis in real time.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Army requires a low cost engine mounted oil analysis sensor. Significant manpower, materials, and facility resources are currently committed to the Army Oil Analysis Program. Increased program effectiveness and lower program costs could be achieved through the implementation of real time engine oil analysis with engine mounted oil analysis sensors.

PHASE I: During Phase I, the effort would demonstrate the capability of performing real time oil analysis and would be completed with a technical report documenting the preliminary design of the sensor.

PHASE II: The Phase II effort will consist of design, fabrication, and evaluation of the Oil Analysis Sensor. This sensor would demonstrate the capability of performing real time spectroscopy or other real time oil analysis suitable for the detection of oil contaminants' particulates sizes, densities and identities: first in a laboratory environment and then in a Government dynamometer facility with a contractor supplied breadboard sensor.

Test and Evaluation Command

A90-075 Explosive Noise Abatement

OBJECTIVE: To employ the required technique for noise attenuation of a small explosive (approximately 25 pounds) charge test.

CATEGORY: Exploratory Development

DESCRIPTION (Statement of Work):

GENERAL - The testing of Army material routinely involves detonations of 25 to 100 pounds of high explosives. These detonations are performed outdoors. Some meteorological conditions cause the noise produced by the testing to be focused to areas outside the military reservation. This noise is an annoyance to neighboring residences and in extreme cases has resulted in property damage.

PHASE I - The objective of this research is to pioneer a method or device for attenuating the noise level by 10 decibels in order to allow testing to be performed under most meteorological conditions. The method or technique employed shall have the capacity to handle a test item which occupies the equivalent volume of a 30 foot cube.

PHASE II - The objective is to employ the required technique for noise attenuation of a small explosive (approximately 25 pounds) charge test.

A90-076 Improved Performance of High Energy Laser Exhaust System

OBJECTIVE: Accomplish performance improvements of High Energy Laser Exhaust System.

CATEGORY: Advanced Development

DESCRIPTION (Statement of Work):

GENERAL - The exhaust of the high energy chemical laser contains components that are hazardous in nature; Specifically, Hydrogen Fluoride (HF) and Nitrogen Tri-Fluoride (FM3). Present meteorological models often predict that a hazardous toxic corridor of excessive length will occur. Based on this prediction, laser testing is held in abeyance until the models predict improved conditions. The predictions of these models significantly impact the test schedule of the nation's only Tri- Service Laser Test Facility and delays incur significant cost to the government. The inputs to these models are presently based on a rough and unvalidated empirical analysis. The characteristics of the exhaust system are not well understood and what is assumed is not validated. The existing methods for estimating scrubbing efficiency and effluent composition is highly susceptible to error and accounts for only 80 of the effluents of concern and should be improved to address all exhaust components.

PHASE I - The research activity would investigate methods of accurately determining exhaust system efficiency, then evaluate modifications to be made to the laser exhaust scrubbing system to improve the efficiency of scrubber performance and effluent/air mixing.

PHASE II - Design and incorporate necessary changes to the laser exhaust scrubbing system to obtain optimum efficiency of scrubber performance and effluent/air mixing.

A90-077 Rapid Active Small Arms Scoring System

OBJECTIVE: The prototype system will be developed into a production unit. The system will be refined and redesigned to maximize performance and minimize physical size and cost.

CATEGORY: Engineering Development

DESCRIPTION (Statement of Work):

GENERAL - There currently exists a need to accurately score subsonic and supersonic small arms projectiles fired in single and burst modes. To date, a satisfactory, commercially available system has not been identified which can accommodate the requirements identified.

PHASE I - A "burst mode" small arms scoring system is required for use at various firing ranges. This system must be capable of handling burst rates of up to three thousand rounds per minute including duplex rounds (fired in burst mode) and flechettes (fired in burst mode). Accuracy of the calculated impact point must be less than one centimeter from the true impact point on rounds as small as 5.56mm diameter. The system must be an active system, i.e., the system will provide its own light source (such as laser diodes used in conjunction with photodetectors) and not rely on passive lights.

PHASE II - The phase II effort will involve the prototyping of a scoring system for evaluation of system accuracy, reliability and operational ease.

A90-078 Scenario Generation for the White Sands Air Defense Test Bed

OBJECTIVE: Design and develop a prototype Scenario Generator Workstation using existing equipment. Demonstrate feasibility to integrate the workstation into the existing SUITE of WSMR test and evaluation computer instrumentation via a Local Area Network (LAN).

CATEGORY: Exploratory Development

DESCRIPTION (Statement of Work):

GENERAL - The Scenario Generator (SG) Workstation will make maximum use of existing White Sands Missile Range (WSMR) equipment. The WSMR SG equipment consists of color graphic display, keyboard, digitizing tablet, printer, VAX II-750 computer and local area network. The SG will accept user entered data and through a series of prompts and menus will guide the scenario developer to build the scenario. The SG will provide a detailed air and ground picture overlayed on a digitally stored 3-D terrain map and will provide a sequence of events to comprise a scenario. The air and ground picture will include aircraft and ground maneuver units with masking and corridors overlayed.

PHASE I - Develop the specifications for the design and development of the Scenario Facility. The specifications shall include the system specification (A-level), the development specification (B-level), and the product specification (C-level). The A, B, and C-level specifications shall be developed in accordance with the intent of MIL-STD-490 and DOD-STD-2167. The cost, risk, and utility tradeoff analyses studies used to develop the design shall be included in the contractor's product.

PHASE II - Develop the prototype scenario generator workstation software according to the specifications developed during Phase I. The software shall be tested and demonstrated on the existing VAX 11-750 equipment at WSMR. An interface shall be developed to port the data via local area network to other existing computer systems at WSMR.

A90-079 Vehicle Mounted In-Situ Real-Time Dust Measurement System

OBJECTIVE: The manufacture of a dust measurement device with the following characteristics: measures dust concentration in place (without sampling), dust levels to 20 gm/m3, small sensing unit (cigarette-pack size), particle-size compensation, and real-time read-out (seconds).

CATEGORY: Engineering Development

DESCRIPTION (Statement of Work):

GENERAL - Development of a real-time in-situ dust measurement system with small se[illegible] suitable for mounting on military vehicles undergoing dust testing.

The airborne dust concentrations around military vehicles undergoing dust testing can vary from milligram levels to levels exceeding 20 gm/m3 with some particle sizes exceeding 100 microns. The average particle size can vary by nearly a factor of 10 between areas of high dust concentration and low concentration. This requires that the system has the capability of compensating for average particle-size changes.

An in-situ measurement is required because the large variance in particle sizes and the indeterminate flow velocities can cause large sampling errors. A small sensing unit is required to reduce disturbance to the measured airstream and to allow more freedom in the placement of the sensor. A small sensing unit connected by a flexible umbilical to a larger control unit would be an acceptable concept.

It is anticipated that some form of nephelometry could take advantage of the particle-size vs. wavelength response characteristics by using two or more widely disparate wavelengths such as 10.6 micron and visible/near-infrared to give varied weights to large/small particles. The relative response from the two nephelometers would be used to compute the particle-size compensation factor.

PHASE I - Theoretical and Engineering Analyses of the problems and capabilities of the proposed concept. Laboratory demonstrations of key parts of the concept desired.

PHASE II - Development, testing, and calibration of field capable prototypes meeting the objectives stated for Phase III dust measurement systems.

A90-080 Radar Signal Processor

OBJECTIVE: Develop a prototype processor for an MPS-36 instrumentation radar that will perform such things as error signal normalization and adaptive tracking at the PRF.

CATEGORY: Exploratory Development

DESCRIPTION: (Statement of Work):

GENERAL: A number of monopulse instrumentation radars (e.g., FPS-16, MPS-36) are currently in use at the White Sands Missile Range (WSMR), NM and other military test ranges in support of the testing of missiles, projectiles and aircraft. These monopulse radars typically operate at C band with a Pulse Repetition Frequency (PRF) of 320 or 640.

Previous research has been conducted to investigate enhancements to these systems that could significantly improve their performance. It now appears feasible to incorporate these enhancements into the operation of the radars with a high speed programmable digital signal processor. A system that extracted, for example, the digitized delta azimuth signal, delta elevation signal, sum signal, AGC level, etc., could perform real-time error signal normalization, apply adaptive tracking techniques, implement multiple tracking gates, perform N-gate error signal extraction and perform coherent angle and fine line tracking research into additional enhancements that could be programmed into a processor of this type is desired. The processor would include the programmable interfaces for the radar, recording devices, displays, modems, and servo encoders.

PHASE I: Appropriate investigations under a Phase I effort include research of new techniques as well as the application (in concept) of previously developed ideas, that would provide improved radar performance. The research should determine the feasibility of realtime application of the radar improvements identified and include a conceptual design of the required digital signal processor. The final results should indicate recommended approaches, rationale, tradeoffs, and approximate cost.

PHASE II: Under a Phase II effort a system design should be well defined and a prototype system developed. The prototype should be tested in normal operational environments as well as under simulated conditions.

A90-081 Projectile Follower Tracking Control Subsystem

OBJECTIVE: Construction and testing of a tracking control subsystem.

CATEGORY: Engineering Development

GENERAL: The projectile follower is a device capable of providing continuous, high speed photographic data of ammunition along 200 meters of the flight path. The system is capable of providing photographic information only if a predetermined flight profile has been programmed into the system. A flight profile must be developed from base line data (acquired from previous tests) concerning dynamic flight characteristics of the projectile. A realtime tracking subsystem is required so that the system will be able to acquire the photographic information from a projectile with missing or unavailable flight data.

The projectile follower is described by Brown and Dickens in "Optoelectronic Instrumentation Projectile Follower System for Ballistic Applications," (Proceedings of the Society of Photo-optical Instrumentation Engineers, Volume 779, May 1987, pp 50- 59).

PHASE I: The phase I effort shall consist of a feasibility study and a detailed design of a real time controller for the Projectile Follower. This controller shall be capable of locating a projectile's instantaneous position along it's trajectory and command the follower mirror subsystem to the proper angle such that the camera line of sight will be aimed at the projectile. This control subsystem shall be capable of determining the projectile's position within the first 200 meters of its trajectory to within 0.25 meters. Control shall be accomplished at a minimum 60 Hertz rate with a maximum of 100 microseconds elapsed time between the instant that the projectile is at the determined location and required correction is initiated by the follower mirror subsystem electronics. The Phase I effort would consist of a feasibility study and detailed design of the tracking control subsystem.

PHASE II: The phase II effort will involve construction and testing of a tracking control subsystem.

A90-082 Testing Embedded Neural Network-Based System

OBJECTIVE: To fully develop the test tool developed in Phase II into a production system written in Ada. A portion of this effort would involve validating the test methodology and the software test tool on embedded neural networks.

CATEGORY: Exploratory Development

DESCRIPTION: (Statement of Work)

GENERAL: A variety of Government and industry funded research initiatives are underway to create, develop, and transfer to production, computational environments based on neural computing or neural networks. A number of these environments have alredy reached the stage of commercial products. Testing of embedded systems employing these enviroments will require new knowledge and techniques, and these may vary to some degree with the computational model implemented. The testing will need to extend into the characteristics of the environment itself to verify a correct implementation of the model employed as compiler, operating system, and architectural technology of current systems. This task will establish a working taxonomy of computational models and neural computing techniques and build a test tool to assist in testing model features implemented in the environment to be tested, and address quality factors such as reliability, performance, correctness, and maintainability.

PHASE I: A number of computational environments based on neural computing or neural networks have reached the stage of commercial products. This may soon lead to embedded battlefield systems employing such technology, yet the current test techniques and expertise will be totally inadequate to assess their the Phase I effort is to investigate a testing methodology and demonstrate feasibility of implementing this methodology into a software test tool to aid in the testing of neural networks embedded in battlefield systems. This task will

establish a working taxonomy of computational models and neural computing techniques and build a prototype test tool. This prototype may aid in identifying and characterizing systems under development in terms of the taxonomy, generate, from a library of proven algorithms, benchmarks for testing model features implemented in the environment to be tested, and/or address quality factors such as reliability performance, correctness, and maintainability. The initial prototype of the tool is acceptable in any suitable development environment. The ultimate target use of the tool dictates that the architecture selected will allow for a straightforward migration to the Ada language for production versions.

PHASE II: The objective of this effort is to fully develop the test methodology recommended in phase I into a more robust the test tool. This tool should assist in characterizing the system under development, generate or suggest benchmarks or methods to test a particular neural model. Assessment of quality factors such as reliability, maintainability, correctness and efficiency of neural networks would be addressed in detail at this time. At some point the tool should also make the network more visible to the tester; i.e., translate weights and biases into a higher level of abstraction closer to the actual decision process. This effort should consider the Ada language for the more robust version. A portion of this effort would involve validating the test methodology and the software test tool on embedded neural networks.

A90-083 Multistatic Projectile Tracking Radar

OBJECTIVE: Modifications to existing radars such as Sgt York and Hawk radar units to demonstrate multitarget tracking capability. Real-time operation desired.

CATEGORY: Engineering Development

DESCRIPTION: (Statement of Work)

GENERAL: There is a requirement to track multiple small radar targets that are dispersed over a small region of the sky. The targets consist of submunitions and the remnants of the artillery projectile from which the submunitions were expelled. A modified Hawk air defense system radar can satisfactorily track the projectile up to the point at which the submunitions separate from the shell. It is necessary, however, to track each submunition in order to provide real-time pointing data to optical instruments.

The Hawk radar is continuous wave (CW) type that provides a doppler frequency that is a function of the target velocity relative to the radar. Position can only be inferred by integrating the velocity over time from the known location of the gun muzzle. A pulse for pulse-doppler radar could be used to track the projectile, but it is likely that several submunitions would fall into the range gate and, thus, would not be distinguishable form one another.

It has been suggested that the CW Hawk radar be used to illuminate the region that contains the targets. Several passive receivers would pick up the returns from the targets. The emitted signal from the Hawk would also be used by the passive receivers a reference frequency to determine the doppler shift for each target. The velocities of the targets relative to the receivers might then be computed by performing a fourier transform of the complex return to extract the frequently associated with each target.

The relative velocities of the targets should then be used to resolve the target positions.

PHASE I: The proposals will be evaluated considering the depths of analyses for phase I in the areas of energy balance, physical layout, transmission, and mixing of the reference frequency, spectral analysis, velocity computations, correlation of velocities with targets, computation times, processing hardware required, and radar

design. Consideration will also be given to the knowledge and experience of the principal researchers in the areas of digital signal processing, radar design, and in particular the Hawk and Sgt York systems.

PHASE II: Modifications to existing radars such as Sgt York and Hawk radar units to demonstrate multitarget tracking capability. Real-time operation is desired. It would be preferable if available assets were used to assemble the multistatic radar. Radar components from the Sgt York program are available as well as the Hawk radar.

A90-084 Digital Filtering Using Simulation Models

OBJECTIVE: Develop digital filtering algorithms and hardware, for use in both offline and realtime processing of trajectory data, that utilize differential equation process models in the determination of the present state of a process. Trajectory data includes time, space position, derivative, and attitude.

CATEGORY: Basic Research

DESCRIPTION: (Statement of Work)

GENERAL: Digital filters are used in test range tracking instrumentation applications to reduce the noise level in the collected data and provide better estimates of the trajectory parameters of objects being tracked. The motion dynamics exhibited by the many different types of objects tracked at test ranges varies greatly. Such objects include slow moving ground vehicles, helicopters, supersonic aircraft, 20 mm cannon bullets, high speed missiles and orbital vehicles. The types of tracking instruments utilized varies greatly also and includes optical (both film and video) tracking systems, and millimeter wave and microwave radars. Data rates available from these tracking systems can vary from 60 to 15000 samples per second. Digital filters are used for processing data in both real time and post test applications.

Polynomial process models are typically used to solve this wide range of problems requiring digital filtering; primarily because these models can be used over a wide range of applications, are relatively easy to apply, and are reasonably robust. While these filters function reliably, their performance is inferior to the use of other more accurate process models. The polynomial filters frequently introduce significant lag when the bandwidth is narrowed sufficiently to achieve adequate noise rejection performance. This attribute is potentially hazardous when such filters are used for in-flight safety calculations on high performance missiles. The use of a set of differential equations of motion, for the object being tracked, as a process model has been shown to produce superior digital filtering results. This superior performance has been achieved at the expense of using a much more complex algorithm that is tailored to a specific target. The process of developing such models has proved to be lengthy and labor intensive. These problems limit the potential for applying them to data collected from a wide range of targets.

The need is to develop algorithms, techniques and hardware that take advantage of the performance available from the differential equation process modeled digital filters, while retaining the robustness and ease of operation that is characteristic of using the polynomial process models. A user friendly system which permits easy development of differential equation process modeled filters, that can be easily adapted to a wide variety of targets, is envisioned. The investigation should determine the filtering improvements that can be engendered by such an approach and the feasibility of developing this capability in both an offline and realtime environment.

PHASE I: A Phase I effort should identify a number of possible approaches or variations of a single approach. Through analysis and simulation (utilizing real data in an offline mode), the filtering improvements of a specific

approach over currently utilized methods, should be demonstrated. As part of this exercise should be a demonstration of its user friendly facility for tailoring its operating to the various operational environments.

PHASE II: Under a Phase II an identified approach should be implemented in a prototype system and again demonstrate its ability to improve filtering and provide user friendly interfaces. A series of tests should be run in which the system is interfaced with test range tracking systems. All documentation for analysis, software coding, test results, block and wiring diagrams, training, maintenance and repair should be included as part of the prototype system.

A90-085 Measurement of Chrome Chipping in Gun Tubes

OBJECTIVE: A complete inspection system will be constructed that can measure the amount of loss chrome in 105mm and 120mm cannon tubes.

CATEGORY: Engineering Development

DESCRIPTION: (Statement of Work)

GENERAL: This project will develop instrumentation that can be inserted inside a cannon tube to detect and measure the amount of chrome chipping that is present. This instrumentation will be an extension, second generation, or innovative replacement of existing instrumentation currently providing a qualitative evaluation of chrome chipping (available for observation at APG but will not be furnished to the contractor). The system must generate an image (video or other), determine good and bad areas, correct for geometric distortion, indicate the amount of chrome loss within the field of view, store this value and determine the location along the length of the cannon tube, record chrome loss as a function of position, and indicate total chrome loss in the gun tube.

PHASE I: This effort will:

a. Analyze the inspection system and items currently being inspected.
b. Select and obtain hardware best suited for this operation.
c. Calculate the appropriate algorithms needed to produce the correct values for the amount of chrome loss.
d. Determine and develop a method to keep track of the longitudinal position of the viewing area.
e. If a video method is pursued deliver a working prototype, train APG personnel in the operation, and provide manuals covering operation and maintenance.

PHASE II: After a complete user evaluation of the prototype delivered in Phase I, a production model will be constructed to measure the amount of chrome loss in 105mm and 120mm cannon tubes. This unit must be ruggedized to withstand the industrial shop environment and will incorporate design changes to eliminate any shortcomings detected during the evaluation.

A90-086 Projectile Impact Point Scoring System

OBJECTIVE: Develop the parameters to measure the impact point, to a centroid accuracy of 1 centimeter, of dynamic ballistics fired projectiles on a vertical target orthogonal to the line-of- fire.

CATEGORY: Advanced Development

DESCRIPTION: (Statement of Work)

GENERAL: Design the sensors, techniques and equipment necessary to detect, measure, transmit, display and record (in real time and without operator intervention) the impact points of direct fired projectiles on a vertical target matrix 12.5 meters by 12.5 meters, located along the line-of-fire up to 4000 meters from the weapon. The smallest projectiles have a target-to-diameter aspect ratio of 400:1 and velocities in the range from 333 M/sec to 2000 M/sec. The system shall be developed to measure the exact point the projectile passes through the target vertical plane, measured by quadratic coordinates from the virtual center of the target, with the measurement of the impact point to a centroid accuracy or 1 centimeter for all projectiles fired, and transmit the data to the firing point via encrypted secure format. Secondarily, measure the projectile impact angle of incidence to an accuracy of 1 mil. The system shall perform via microcomputer concepts and operating parameters.

PHASE I: Conduct basic research and development to design the equipment and algorithms to measure cited parameters for the projectile impact point, to a centroid accuracy of 1 centimeter, on large and small caliber ammunition on direct fire accuracy range, ballistically fired onto a vertical target orthogonal to the line-of-fire.

PHASE II: Design, fabricate, and install the prototype accuracy measurement system on a designated firing range. Conduct collateral data acquisition operations during actual direct fire test operations and verify the operational integrity and accuracy of the prototype system.

A90-087 Holographic Imaging of Plume Particulates in the Laser/Target Interaction Event

OBJECTIVE: Engineer the hardware and methodology developed in Phase II so that a "generic", standardized holography system can be manufactured, capable of being used at various locations, under varying laboratory conditions. Standardization will require construction of manufacturing jigs, fixtures, etc.

CATEGORY: Advanced Development

DESCRIPTION: (Statement of Work)

GENERAL: The placement of a high power laser beam, such as the MIRACL DF beam, on a material surface results in fast disintegration of the material surface, followed by recession of the target material under the laser footprint, and the expelling of the target material in the form of gases and solid particulates (the plume). While the evolved gases play a small role in the interaction of the HPL with the plume, the major interference derives from the HPL scattering by the solid particles. While it is true that optical density (OD) measurements may be made without imaging the particulates, such imaging will allow information to be extracted from the plume which will shed light on the following:

a. The physics occurring at the laser/target interaction monolayer.
b. The nature of the chemical pyrolysis of the target.
c. The "structuring" of the plume according to particulate size.
d. The cross section for HPL laser interaction with the particulates, when used with OD measurements.
e. A direct comparison with post-plume particle gathering to help determine post-plume oxidation conditions and the efficacy of the downstream particle gathering experiments themselves.

Deep field, holographic imaging will allow the experimenter to focus into the plume, layer by layer, and thus to view the plume in slices for detailed examination. Since most plume particles are small, the magnification

capability of the hologram must be great to allow imaging of micron sized particulates. Additionally, plume particulates traveling at high speeds places great constraints on the resolution of the hologram formation system.

PHASE I: It is the objective of phase one of this effort to define the instrumentation and conditions necessary to accomplish holographic imaging of particulates generated in a high powered laser (HPL)/target interaction event. The phase I study will result in an experimental plan to delineate a set of experiments designed to result in the demonstration of hologram formation and reconstruction to satisfy the above requirements. Included in the study will be a complete literature search (the bibliography of which will be reported), a survey of the concurrent similar efforts, and the composition of a formal plan presented to the appropriate government personnel for approval.

PHASE II: The objectives of phase II are two in number as follows:

a. To demonstrate the hardware and methodology necessary to perform the task of the holographic image recording of small, fast laser plume particulates (typified by the MIRACL target plumes) and the reconstruction of the hologram.

b. To manufacture one complete holography recording and reconstruction system for use with MIRACL in the HELSTF effects test area.

The deliverables will consist of the complete holography system and detailed documentation to the level necessary to completely disassemble, do component checkout, reassemble, calibrate, and perform systems checkout prior to use in MIRACL laser.

A90-088 Accelerated Corrosion Testing of Military Vehicles

OBJECTIVE: To verify the accelerated corrosion testing methodology developed. This includes subjecting a sample of new military vehicles to the accelerated corrosion test and comparing the results with vehicles which had been previously fielded and used in a corrosive environment.

CATEGORY: Exploratory Development

DESCRIPTION: (Statement of Work)

GENERAL: The Army procures military vehicles to be used both on and off road in a variety of environments. Manufacturers are required to apply corrosion preventive compounds to military trailers and vehicles to prevent rusting in conditions of heavy rainfall, high humidity, snow, salt spray, acid rain, tropical environments, and areas with industrial or atmospheric pollutants. During technical testing, the requirements of the purchase contract are verified, but the shortfall in the test process is the lack of a method to verify the effectiveness of the rustproofing application. A rustproofing application that is supposed to last 10 years cannot be verified without methods to simulate the environment and accelerate the corrosion. There is a requirement to develop a accelerated corrosion test (applicable to entire vehicles, not just selected components) that will simulate 10 years of corrosion growth within one year or less.

PHASE I: Perform a test methodology study (concerning accelerated corrosion testing) to determine the effectiveness of the rustproofing application for military vehicles.

PHASE II: Verification of the testing methodology developed during Phase I. This phase will include subjecting a sample of new military vehicles to the accelerated corrosion test and comparing the results with vehicles to the accelerated corrosion test and comparing the results with vehicles which had been previously

fielded and used in a corrosive environment.

Ballistic Research Laboratory

A90-089 Compact and Field-Worthy Ultraviolet Laser

OBJECTIVE: Demonstration and Delivery of an Operational UV Excimer Laser.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There exists a great need and substantial opportunity to develop a compact, light-weight, and field-worthy ultraviolet (uv) laser for the United States Army. This laser should be able to operate at all of the uv excimer wavelenghts: ArF (193 nm), KrCL (222nm), KrF (248 nm), XeCL (308 nm), and XeF (350 nm). This type of laser is not commercially available and would be used for numerous applications which include explosives and agent detection, explosives initiation, explosives initiation, and as an igniter for various propulsion systems. Design and performance goals include: weight < 100 lbs, volume = 2 cu. ft. 25 mJ output pulse energy at 193 nm, 10-20 nsec pulse duration, gas fill lifetime = 24 hours minimum (ArF operation), 100 Hz rep rate, and unstable optical resonator.

PHASE I: An engineering feasibility study will be performed to determine the optimum electronic and optical design parameters required to build a scaled-down laser. An early prototype delivered to BRL for evaluation would be desired.

PHASE II: The electro-optic engineering parameters determined in Phase I will be utilized to build a fully operable prototype system which satisfies the specifications outlined in the topic description.

A90-090 A Device for Direct Measurement of Penetration in Steel Plates

OBJECTIVE: Demonstration and delivery of a portable device capable of being used on an outdoors test range which could measure penetration depths in steel plates with an accuracy of + or - 1 millimeter. The ability to measure hole volume as well would be an attractive additional capability.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There exists a need for a device which will allow the measurement of penetration depths into steel plates. The device should be hand-portable and capable of being used on a test range. Accuracy required is generally + or - 1 millimeter.

There are complicating factors which must be considered. First, there is generally some penetrator left in the hole. Consequently, a direct measurement is not always possible. Some of the penetrator material is classified as hazardous; drilling through it may not be feasible. The plates are not always flat after testing. Use of ultrasonic devices, as has been suggested in the past, might be difficult.

Currently, the steel plates must be torched and cut with a band saw to provide an accurate measurement of hold depths. X-ray facilities are also used to provide quick answers, however, this method is not as accurate

as desired. There is a continual backlog of stored target plates awaiting measurement. Data must be obtained in a timely manner.

The requirement is to have these measurements done immediately after testing so that the plate may be disposed of, if necessary. Plates should not have to be cut in order to make the measurement.

PHASE I: The feasibility study should address all of the complicating factors in making the desired measurement at the accuracy level stated. A method or device should be proposed which is capable of filling all of the requirements.

PHASE II: There should be a fully operational prototype device delivered for taking the type of measurement described above.

A90-091 Firepower Allocation Methods

OBJECTIVE: Develop an Appropriate Algorithm to Analyze Complex Data Confronting Fire Direction Officers.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Investigate the potential uses of Case Based Reasoning (CBR) for determining the allocation method(s) used by Fire Direction Officers (FDO) for allocation of firepower on enemy units.

The data will be provided by BRL. One data set contains 3000 tactical fire control decisions, and another data set contains 500 decisions. Each data item is an 18 element vector which includes the following: FDO, target type, target size, target range, type of fire mission, ammunition available, allocation method chosen, total number of rounds fired, type and number of first munition fired, type and number of second munition fired.

Several parametric and nonparametric statistical procedures have been applied to the data, but these have not been successful. This is probably because of the following unusual properties of the data: nonstandard structure, mixture of data types, nonhomogeneous variable relationships, and different degrees of influence of the variables.

PHASE I: Initial efforts will require data formatting and establishment of various schemes to evaluate the data. Preliminary analysis of the proposed methodologies to establish feasibility is required.

PHASE II: Full analysis of all data and delivery of decision methods to be used by FDOs is expected.

Army Research Office

A90-092 Signal Design, Error-Control Coding, and Robust Stochastic Processing for Signals in Noise and Interference

OBJECTIVE: Develop new processing methods and architectures for Army tactical ground radio communications systems.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The Army ground radio network of the future is likely to be a spread spectrum, packet radio network. New robust processing methods and architectures are required for these Army tactical ground radio systems. Army signals are wideband (spectrum spectrum), utilize coding with random characteristics, are highly mobile creating complex channel propagation characteristics, and encounter strong interference (jamming). Research is sought to define performance metrics and stochastic signal processing to reduce error probability, increase throughput, and reduce delay. Some specific topics for research include extraction and use of side information, error control coding/decoding, rapid acquisition/synchronization (especially in the presence of interference), theory and methods for identification and extraction of signal features and modulation characterization, and interference suppression and excision.

PHASE I: The goal of Phase I is to identify techniques for the identification and extraction of desired signal feature from broad based signals under conditions of intense interference (jamming).

PHASE II: The goal of Phase II is to demonstrate robust, processing methods and system architectures for extraction of data and error control of broad band signals.

A90-093 Optical Techniques for the Control and Data Processing of Microwave and Millimeter Arrays

OBJECTIVE: Elucidate, define and apply principles and techniques for improved performance of microwave and millimeter wave arrays with reduced cost through the use of optical signal distribution and data processing.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Active microwave and millimeter wave arrays require distribution of signals over long distances in terms of the system wavelength with very precise control of amplitude and phase. This requirement leads to systems requiring tight dimensional tolerances and resulting high cost. Optical signals from one or more LASERS can be modulated and/or combined in a non-linear device to generate the microwave/millimeter-wave signal with the proper phase relationship required for each element of the array. These optical signals may be distributed to the array elements via single mode optical fibers. Processing of the received signal may also be processed in the optical domain through the application of wavefront processing techniques. Innovative techniques and approaches are needed to realize the potential of such architectures at low cost. Of special interest are innovations associated with optical micro-wave/millimeter-wave interfaces and in wavefront processing techniques This research addresses specific aspects of goals described in the DoD Critical Technologies Plan topic "Phased Arrays".

PHASE I: The goal of Phase I will be to establish the feasibility of signal distribution, control, and beam forming for phased arrays using optical techniques for both transmission and reception.

PHASE II: The goal of Phase II will be to demonstrate, in hardware, optical techniques for phased array systems and to demonstrate the viability of optical wavefront processing for reception.

A90-094 Methods for Reaction Front Measurements

OBJECTIVE: To develop new, innovative methods for measurement of temperature, pressure and chemical species concentrations in the reaction front of solid propellants subjected to impact loading.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Solid energetic materials (gun and rocket propellants) are believed to form localized shear bands under high rate impact. Hot spots, formed within the shear bands, are considered to be the sites responsible for ignition of the matrial under impact loading. The modeling of this ignition process and thus, the prediction of material response to impact, is quite uncertain due to lack of knowledge about the formation the hot spots and the dynamics of ignition and subsequent combustion due to them. At present, the overall mechanism is inferred based on observed material response to impact and hydrocode calculations of internal material deformation. What is needed are direct measurements of local temperature, pressure and chemical species concentrations within the deforming, reacting shear band, with the spatial and temporal resolution necessary to resolve the hot spot dynamics. The extremely small size (submicron), short time scale (submicrosecond), and random location within the deforming shear band are factors which must be considered in attempting the measurements.

PHASE I: Formulation of experimental method to be used to measure shear band properties. Theoretical analysis of the proposed method, demonstrating the limits of spatial and temporal resolution, species to be determined, accuracy of the species concentration measurement, and accuracy of the temperature and pressure measurements. Analysis of the applicability of the proposed experimental method to measurements of shear band properties and hot spots in a composite, energetic material subjected to high rate impact. The analysis should clearly demonstrate the strengths and weaknesses of the method and identify technical risks.

PHASE II: Demonstration of the ability of the experimental technique to obtain precise data on the dynamics and reactions in an impacted energetic material. This will necessitate the construction of appropriate facilities and instrumentation to perform measurements on energetic materials, the conduct of appropriate experiments to demonstrate the range of applicability of the technique, and the analysis and interpretation of the results.

A90-095 Concentration Fluctuation Measurements in the Atmospheric Boundary Layer

OBJECTIVE: Develop the instrumentation to measure, in a wide range of local meteorological environments, the mean and fluctuating concentration of tracer material in a small (point) volume to distances of 5 km from a source and demonstrate its capabilities in a trial field program.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Measurement of inert tracer concentrations from controlled releases is a fundamental way to study the dispersive effects of atmospheric turbulence. A fundamental barrier to a proper field experiment is the lack of a small, inexpensive, stable, fast response (5 to 10 Hz) device for point measurements of a specific tracer at low concentrations.

Innovative ideas for making highly sensitive, portable, rugged, and fast response devices for measuring tracer gases suitable for atmospheric testing are needed. Such devices would be used in field trials to determine the instantaneous (0.1 to 0.5 second average) of the tracer material at a large number (approximately 100) of fixed locations near the ground and mounted on masts to heights of 30 meters. The devices must be amenable to

field calibration hold their calibration during field trials lasting at least 90 minutes. The devices should minimally disturb the air flow containing the tracer material.

PHASE I: A prototype sensing device meeting the above criteria should be assembled, calibrated, and tested in laboratory conditions.

PHASE II: Using several prototype instruments, a successful field demonstration of the devices should be accomplished.

A90-096 Application of Ion-Induced Disordering to the Fabrication of Novel and Ultrasmall Electronic Structures

OBJECTIVE: Provide a theoretical description of ion-induced disordering and apply new methods for controlling ion-induced disordering to realize greatly improved performance characteristics for electronic structures.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Ion-induced disordering of superlattices of GaAs and other compound-semiconductors may be used to mix adjacent super-lattice materials back into a single bulk compound-semiconductor. Innovative techniques and approaches as well as a more complete theoretical understanding of the disordering process are required to realize the design and fabrication of novel ultrafast electronic devices. Of special interest are disordering techniques suited for the fabrication of quantum-based electronic devices capable of operating at room temperature. Research conducted during the execution of this task addresses specific aspects of goals described in the DoD Critical Technologies Plan, "Preparation of GaAs and other Compound Semi-Conductors".

PHASE I: Define compositions and structures of superlattices to be disordered and identify ions to be used in ion-induced disordering; test the feasibility of such compositions.

PHASE II: Demonstrate ion-induced disordering in unique superlattice structures designed for use in high-performance electronic or optoelectronic structures.

A90-097 Low-Cost High-Performance High-Electron-Mobility Transistors

OBJECTIVE: Elucidate, define and apply principles and techniques underlying the improved performance and reduced cost of high-electron-mobility transistors.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Two-dimensional electron gases formed at the interfaces between two different compound-semiconductor structures exhibit very high mobilities and are suited for applications in high-speed electronics. Innovative techniques and approaches are needed to realize high-electron - mobility transistors with low cost, high switching speed, and low noise. Of special interest are innovations associated with greatly improved processing and fabrication techniques as well as novel designs and concepts for high-electron-mobility

structures. Research conducted in this task addresses specific aspects of goals described in the DoD Critical Technologies Plan, "Microelectroncis Circuits and Their Fabrication".

PHASE I: Define and test the feasibility of techniques for achieving high-electron-mobility structures with higher mobility and reduced noise levels.

PHASE II: Fabricated and characterize novel heterojunction-based high-electron-mobility structures and demonstrate higher mobility and reduced noise.

A90-098 Computational Methodology for Finned Missiles and Guided Projectiles

OBJECTIVE: To develop a computer code capable of accurate prediction of the flowfield around modern finned missiles and guided projectiles.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The prediction of the transonic or supersonic flow-field in the vicinity of the fins on modern fin-stabilized missiles and guided projectiles is currently relatively inaccurate, and may be improved by the application of advanced grid generation schemes and zonal solution methodologies. This problem is complicated by the possibility of multiple fin sets, irregular fin geometries with crude aerodynamic shapes, and large attack angles. Additionally, fin deflection can cause a significant gap between the inner fin edge and the body surface; at supersonic speeds this gap can cause substantial interference effects and reduce the fin effectiveness, possibly due to shock wave formation within the gap and the interaction of these shock waves to induce separation on the fin or the body. Analysis tools are required to accurately predict this three-dimensional flowfield, as well as the resultant force on the fins. Augmentation of these tasks by various experimental studies for verification of these concepts and the generation and/or use of benchmark experimental results for calibration of generated software might also be considered.

PHASE I: The basic research activity of Phase I should include a feasibility demonstration and assessment of the potential of the technique for future exploratory development.

PHASE II: The Phase II developmental goal is the validation of the technique against available experimental data. By the end of Phase II the technique should be developed to the extent that transition to advanced programs can be considered.

A90-099 Adaptive Antennas and Processing

OBJECTIVE: Perform research to provide technology for adaptive antenna arrays and processing for Army tactical ground radio communications.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Army tactical ground radio systems operate in an environment of strong and complex interference. Adaptive antennas have the potential to provide 20-30 db gain. However the systems must have the ability to converge rapidly in the presence of worst case countermeasures and must be small since Army communications terminals need to be mobile. Research is also needed on the operation of such antennas in

wideband systems such as spread spectrum, frequency hopping and direct sequence. Techniques must also be found for the utilization and integration of adaptive antennas in Army networks.

PHASE I: The goal of Phase I is to demonstrate the feasibility of small adoptive antennas under conditions of high interference (jamming).

PHASE II: The goal of Phase II is to demonstrate hardware implementation of small adaptive antennas.

Atmospheric Science Laboratory

A90-100 Nowcasting Temperature Inversions

OBJECTIVE: Develop a technique for estimating the occurrence of temperature inversions, especially elevated inversions, without resort to radiosonde observation.

CATEGORY: Exploratory Development

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Ground-based microwave temperature profiling is a promising technique for obtaining covert, automated, real-time profiles of atmospheric temperature. There is a need for improving the prediction and characterization of elevated temperature inversions.

PHASE I: Develop a technique which yields the strength, thickness, and base height of elevated inversions.

PHASE II: Refine the nowcasting technique and provide real-time demonstrations for evaluation.

A90-101 Optical Device to measure Aerosol Densities

OBJECTIVE: Development of a compact and inexpensive device to characterize battlefield aerosol distribution for possible use in predicting weapon system performance.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is a need for an inexpensive sensor which can be deployed in arrays for the purpose of producing distribution profiles of natural and countermeasure aerosol clouds on the battlefield.

PHASE I: Develop a device to measure aerosol densities through the illumination of an external volume of air and measurement of scattered light.

PHASE II: Evaluation and testing of a prototype device with a variety of aerosols in a controlled environment.

A90-102 Atmospheric Mesoscale Precipitation and Cloud Model

OBJECTIVE: Development of a mesoscale hydrometeor model which includes fog and haze with prognostic capabilities for tactical battlefield applications.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is a need for a simple multi-level prognostic cloud and precipitation model which can be utilized on the battlefield as a Tactical Decision Aid. The model should be capable of producing meaningful results from a minimum of observed parameters.

PHASE I: Develop an algorithm with the capability to analyze and predict cloud cover, ceiling heights, and the products of condensation or sublimation that are classified as hydrometeors.

PHASE II: Evaluation and testing of a prototype code using a variety of input observations to determine the optimum type of parameters to produce meaningful forecasts.

A90-103 Modeling Atmospheric Effects on Thermal Clutter

OBJECTIVE: Development of a computer model which may be used to characterize the amount of thermal clutter in a scene viewed by a thermal imager and how the clutter level changes with changing atmospheric conditions.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is a need for an engineering grade computer model for atmospheric effects on thermal clutter for use in target acquisition models which are being developed as tactical decision aids.

PHASE I: Develop a computer model which may be used to characterize the amount of thermal clutter in a scene as viewed by a thermal imager. The model should be conservative in usage of computer time and space and should use standard meteorological parameters as input.

PHASE II: Evaluate the validity of the clutter model developed in Phase I by comparisons with field data.

Electronics Technology and Devices Laboratory

A90-104 High Energy Density Dielectric Materials

OBJECTIVE: Develop materials with high dielectric constant; low dielectric loss; and high dielectric strength for pulse power applications.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Some future Army missions will require high pulse power with pulse width from several microseconds to hundreds of nanosecsonds and pulse voltage exceeding 5 kV/mil. The desirable energy density will be from 5 to 11 kJ/kg.

This requires materials with properties aforementioned in the objective. Polymers are preferred for their mechanical strength and ease of fabrication. In this category, poly (vinylidene flouride) (PVDF) is best known

for its high dielectric constant decreases. However, at higher frequencies, PVDF's dielectric constant decreases rapidly. This makes PVDF less desirable for fast pulse applications. We need to develop new materials. There are many ways to control the dielectric behavior of polymers. The most important one is manipulating the chemical structure.

This program calls for the fabrication of new polymer materials. These materials should consist of novel structure and new composition to achieve high dielectric constant, low dielectric loss and high dielectric strength over a wide range of frequencies.

PHASE I: Preparation of candidate polymer materials based on theoretical considerations. Preliminary evaluation of dielectric properties using laboratory samples.

PHASE II: In-depth examination of dielectric properties of several of the more promising materials resulting from Phase I. Construction and characterization of laboratory capacitors or pulse forming lines to demonstrate at least one new material.

A90-105 10 Micron Infrared Phototransistor

OBJECTIVE: Design and develop a sensitive, low noise and high speed 10 micron infrared dedtector based on GaAs/A1Ga AS marerial

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Recently, 10 micron infrared photoconductors have been successfully fabricated using GaAs/A1GaAs material system instead of the more conventional HgCdTe material. The advantage of this technological innovation is substantial. The new devices are cheaper, faster, more reliable and flexible, and easier to integrate to the supporting electronic circuits. However, the present sensitivity of these devices tends to be lower due to the larger associated noise. This project is to develop a new transistor-type of structure based on the same material to lower the noise level and hence increase the sensitivity of the device.

PHASE I: Phase I is to design the basic transistor structures and study the transport properties of the photoexcited hot electrons in these structures.

PHASE II: After a better understanding of the dynamics of the hot electrons is established, optimize, fabricate, and test the device structure to achieve the minimum noise level and maximum sensitivity of the devices.

A90-106 Integrated Circuit Device Packaging Protection Against High Power Microwave Directed Energy Weapons

OBJECTIVE: Study and investigate packaging and interconnection techniques to protect digital integrated circuits against high power microwave directed energy weapons.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Advanced VLSI/VHSIC digital devices using bipolar and CMOS technology are highly susceptible to upset and damage due to high power microwave (HPM) energy incident upon the chip or multichip package. The digital devices utilize sub-micron feature size technology, operate at clock rates of 100 mhz and logic levels of 3.3 volts. These devices are intended for use in advanced DoD electronic systems and must be protected against HPM energy, whether from friendly or enemy sources. New and innovative techniques for signal and power/ground interconnections, coupled with reliable packaging, are needed to solve the HPM energy problem.

PHASE I: Phase I should result in a technical report covering a study and investigation of alternative packaging and interconnection methods and techniques to protect digital integrated circuits from upset and damage due to high power microwave energy. Emphasis should be placed on packaging/interconnection technology and materials resistant to radiated and conducted microwave energy.

PHASE II: Phase II should result in experimental packaging and interconnection techniques and demonstration circuitry to show proof of principle for the chip and multichip protection against HPM. Testing and evaluation in a HPM environment should be included.

A90-107 Multi-Beam Phased Array Sensor for Tank Defense

OBJECTIVE: An investigatory and developmental effort directed towards the development of multi-beam high resolution phased array sensor for the detection and tracking of low flying and fast moving small multiple targets at moderate ranges.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Development of new sensor techniques for tank defense, target acquisition, and precision guided munitions are urgently needed to overcome the inherent limitations of existing technology and to improve systems performance and reliability. Phased array techniques incorporating the latest advances in solid-state devices should be utilized in this development. Proposed sensor applications should be incorporate spread spectrum techniques, have capability of fast acquisition and tracking of multiple targets and high angular resolution.

PHASE I: Analyze circuit techniques needed to identify low flying and fast moving multiple target as well as provide spatial resolution of individual reflectors on armored vehicles. Demonstrate functional feasibility of the circuit techniques studied.

PHASE II: Refine the techniques studies under Phase I and develop a functional multi-beam phased array sensor.

A90-108 High-Temperature Superconductor Devices

OBJECTIVE: To identify and develop active and passive high-temperature superconducting devices having a potential impact in future high-technology Army areas.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: This effort will assess the feasibility of utilizing recently developed high-temperature superconductors in a variety of devices suitable for use in present and proposed Army systems. This will be done by targeting one or more devices for design, fabrication and evaluation. The proposed effort must address one or more of the following classes of devices:

a) High-Q radio frequency structures (in the 1-40 GHz range)

b) Hybrid semiconductor (e.g. GaAs HEMTs) - superconductor devices for ultra-high speed, high-frequency information processing

c) Sensors and detectors for:
   (i) Infrared
   (ii) micro/millimeter waves
   (iii) magnetic fields

PHASE I: It is expected that by the start of the Phase I effort, much of the material properties of the high-temperature superconductors will be relatively well understood. As such, this phase will be concerned with device design, prototype fabrication (possibly by several of the established techniques), and prototype device evaluation. A simple proof-of-concept demonstration is required.

PHASE II: For the Phase effort, fabrication techniques and processing should be optimized for best yield, overall properties and device-to-device uniformity. An operable prototype system incorporating the superconducting device(s) is to be fabricated, tested and evaluated as to the advantages and feasibility of using it in a fielded system.

A90-109 Monolithic Microwave-Acoustic Devices

OBJECTIVE: Investigations leading to the development of high performance, monolithic, thin film acoustic resonator filters and oscillators operating at microwave frequencies.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: This study will guide technology and device developments providing a broad class of microwave frequency sources and/or frequency selective devices, synergistic with MIMIC modules, directed toward applications previously precluded by size, weight and cost considerations. Developments will ultimately lead to a family of building blocks providing monolithically packaged functions, e.g. receiver front ends, frequency sources and/or frequency selective devices, synergistic with MIMIC modules, directed toward applications previously precluded by size, weight and cost considerations. Developments will ultimately lead to a family of building blocks providing monolithically packaged functions, e.g. receiver front ends, frequency source/transmitter, etc.

PHASE I: Should result in a technical report providing major architectural innovations; high level of active and passive circuit integration with monolithic thin film resonators. Simple proof-of-concept demonstration models of select functions is desirable.

PHASE II: Detailed technology development of piezoelectric thin-film resonators integrated with active and passive circuit components. Implementation of necessary processing operations to obtain brassboard models of advanced concept chips and modules exhibiting specific functions. Performance demonstration of packaged devices, including test data and delivery of representative samples will be required at the conclusion of the

program.

A90-110 RF Circuit Testability and Built-In Test Approaches

OBJECTIVE: To examine and develop new techniques for Testable Design. Testability Analysis and Built-In Test for RF circuits.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: While testability analysis, design for testability and testing methodologies have been explored substantially for digital circuits, considerably less effort has been put forth in those areas for analog circuits, particularly those operating in the RF range. The non-deterministic nature of testability analysis and testing methods for RF circuitry, as well as the peculiar failure modes and operational sensitivities have precluded much progress in this area. This project should explore new methodologies and techniques for testability analyst and Boilt -In -Test (BIT) approaches for RF applications. This project should not require an initial linear model assumption. The testability approaches examined should include built-in-self test (BIST) techniques.

PHASE I: Phase I should result in a technical report that explores different BIT, BIST techniques that can be used in RF circuit applications. Simple demonstrations of the effectiveness of these techniques should also be presented.

PHASE II: Phase II should result in the application of a subset the techniques investigated in Phase I. In this phase, an example RF subsystem should be designed so that it is self-testing.

A90-111 Nanoelectronics

OBJECTIVE: Develop futuristic device concepts and consider conceptual issues in the ultimate formulation of device properties (modeling and device simulation, concepts, etc.) relevant to molecular-size electronics.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: As semiconductor technology continues to pursue the scaling down of IC device dimensions into the submicron (less than ten thousand angstroms) region, many new and interesting questions will emerge concerning the physics of microelectronics. Some of the more important topics to be considered include nonequilibrium transport (ballistic transport, overshoot phenomena, quantum transport, etc.), quantization effects arising from geometrical size constraints, proximity effects resulting from closely packed arrays of devices, and general solid-state considerations not heretofore considered questionable (effective mass approximation, the role of contacts, material and processing issues, and the like). Moreover, from the point of view of device physics, it is more desirable to have a microscopic description of physics in small dimensions, which is at least amenable to phenomenological treatment so that its properties can be meaningful incorporated into futuristic device concepts and simulations.

PHASE I: Identify novel concepts, issues, and technology barriers to be overcome in the formulation of molecular-sized functional structures designed to sense electromagnetic signals, pre-process and process

information with relatively high throughput, and lend itself to integration with high-powered computational tools.

PHASE II: Overcome the technology barriers identified in Phase I; assemble and implement an achievable, functional prototype to demonstrate proof-of-principle and/or feasibility.

A90-112 Microwave Plasma Deposition of Refractory Materials for Performance Electronic Devices

OBJECTIVE: Investigate microwave assisted plasma deposition processes and develop the associated materials technology to grow semiconductor grade refractories suitable for high performance electronic devices.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: An area of intense interest which has not been fully exploited is microwave assisted plasma deposition of high purity, high quality refractory compounds. This investigation will assess the feasibility of using microwave assisted plasma deposition (MAPD) techniques to produce refractory semiconductors and dielectrics (e.g. diamond; silicon oxide) for use in high performance electronic devices.

PHASE I: All of the parameters requisite to the microwave assisted deposition of high quality refractory semiconductors and dielectrics at low temperatures are not fully understood nor well defined. Phase I will study and derive optimized MAPD techniques and will result in the preliminary design of a basic deposition system for the growth of these materials.

PHASE II: After a more complete understanding of the MAPD parameters for refractory semiconductors and dielectrics is derived, a finalized deposition system design will be executed. An operable prototype system, incorporating an optimized chamber for microwave plasma assisted growth, is to be fabricated, tested and evaluated.

A90-113 Microcircuit Reliability Temperature Dependency

OBJECTIVE: To reduce size weight and cost of Army equipment through reduced cooling requirements.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Historically, silicon microelectronic device reliability as a function of temperature has been assumed to follow an exponential failure rate. The model most used is the Arrhenius equation of $R=R_0 \exp(-EA/kT)$. Device degradation occurs as a function of temperature through a chemical reaction within the devices package, on the device surface and within its bulk. Accelerated stress tests are usually performed to determine EA, which is then used to extrapolate to equipment use conditions. With today's ultra clean process, assembly and packaging environments, doubt is raised regarding the validity of a chemical reaction at the temperatures anticipated for system operation. If temperature dependence is not a reliability factor, then the tremendous burden imposed by additional cooling for electronic systems within helicopters, tanks, and wheeled vehicles could be reduced from active to only passive cooling.

PHASE I: A technical report will include the development of a model to explain present microcircuit reliability in the temperature range of -55°C to 125°C. All failure mechanisms will be addressed.

PHASE II: Validation of the model will be presented in a final report. Test structures could be used as vehicles to study and verify temperature independence.

Human Engineering Laboratory

A90-114 Artificial Intelligence (AI) Applications to Tactical Logistics

OBJECTIVE: Exploratory and advanced development efforts in the application of artificial intelligence (AI) technologies to tactical logistics planning, scheduling, and maintenance. The objective is to explore innovative, knowledge-based approaches to well constrained and focused military logistics applications, including a serious effort at knowledge acquisition and prototype development.

CATEGORY: Exploratory/Advanced Development

DESCRIPTION:

GENERAL: Tactical logistics planning is complex and dynamic, often exceeding the cognitive limits of experts and the computational limits of algorithmic solutions. Presently, Army tactical logistics planners manually generate logistics plans in response to tactical scenarios, taking significant man-hours and making it impossible to react to real-time planning contingencies. AI based decision support systems will enable field logisticians to make maximum effective use of available supplies, storage and transportation assets. AI based decision support systems will enhance the prediction of resupply requirements, allocation of transportation assets, the rapid evaluation of alternative logistics support plans, the distribution and maintenance activities, and the determination of stockage, repair and distribution policies. Specific areas of interest are:

a. Intelligent, adaptive, multimedia interfaces to knowledge- based systems which justify results, explain effects of "what if" changes, infer appropriate actions/answers, correct imperfect queries & resolve misunderstandings.

b. Knowledge-based decision support environment for log planning such as resource allocation, planning & replanning a course of action, & configuration of facilities. Develop techniques to resolve goal conflicts, exploit constraints, & reactively replan with minimal plan disruption.

c. General software architecture for diagnosing mechanical & electrical failures, which can be customized with domain-specific knowledge bases. Reasoning for multiple flaws, direct sensor feeds, repair-plan formulation, prognostics, on-line documentation, & knowledge-base integrity control.

d. Robust learning techniques (gentic algorithms, neural nets) capable of adjusting uncertainty parameters as performance data is received, updating knowledge bases, & detecting new patterns from accumulated experiences.

e. Knowledge-based aid for simulation modelling which manages simulation inputs, analyzes results & detects anomalies in simulation runs. Resulting sytem shall have the ability to generate scenarios, help build the simulation model, interactively suggest particular strategies & answer "what if" questions.

PHASE I - Emphasis should be on innovative knowledge-based approaches (including a rich knowledge representation scheme and advanced control structures) to well constrained and focused military logistics applications. The work should include a serious effort at knowledge acquisition (bidders must possess or obtain tactical logistics expertise) and prototype development (bidders must have their own computing facility).

PHASE II - Emphasis should be on development and field evaluation of full operational prototype demonstrating the increased effectiveness and added capabilities made possible by the technology.

A90-115 T-handle Side-arm Control for Combat Vehicles

OBJECTIVE: Design and develop a single control to be operated by one hand which will control the direction, maneuverability of an armored vehicle.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: A system must be developed to allow control of combat vehicles with one hand leaving the other hand free to perform required tasks (or permitting a wounded tanker to maintain control with one hand). The T-handle is a natural approach. Advancing the T-handle forward from a neutral point would engage the vehicle in a forward gear and add power, retarding the lever would slow it down. Bringing the lever back through the neutral point would engage reverse gear and add power as the lever is retarded further. Turns would be made by twisting the T-bar in the desired direction; applying left twist would result in a "locked-track" pivot. Some buttons and auxiliary controls could be added to the T-handle, but it should not be cluttered.

PHASE 1: Design and develop the T-handle controller and conduct static testing on vehicles on blocks. Locate the T-handle on the driver's station armrest and provide height adjustment and friction control to accommodate personal preferences. Consider provisions to permit either left handed or right handed operation.

PHASE 2: Install T-handle controller in a test bed vehicle (GFE) and conduct driving tests over a variety of conditions and using a range of dirver experience. Incorporate thumb-operated ICS/RTO switch on the T-handle and evaluate locations appropriate for the other handle-mounted controls.

A90-116 Compact Robotic Command Center Simulator

OBJECTIVE: Using off-the-shelf, commercially available computer equipment, construct a portable test and evaluation capability for robotics command and control interfaces. Phase III system would be capable of emulating existing or proposed robotics operator interfaces and conducting human engineering tests under field conditions at remote sites, permitting the Army to take proposed interface designs out to the troops for testing prior to final design freeze for the systems.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Development of this system would permit the designers of soldier-robotic system interfaces to mock up, test, evaluate and modify proposed interface designs using real-time input from the soldier community. This capability would cut months from the design and testing schedule for robotic systems, permit the early evaluation of systems prior to actual hardware procurement, and reduce initial interface evaluation costs and could significantly impact final overall system training costs.

PHASE I - Procure basic equipment and write initial test and evaluation programs. Run limited static and (if possible) dynamic demonstrations to determine optimal configuration for final test system design. Evaluate possible use of interface prototyping programs such as LABVIEW for incorporation into the final design Provide final system requirements and desired performance parameters. Generate draft requirements, circulate for comment and incorporate comments into final Phase II design.

PHASE II – Procure final equipment and, using designs from the TACOM Robotic Command Center program and the HEL TEAM program, construct detailed interface layouts and test scenarios. Conduct pilot studies and refine software/hardware interaction. Develop final full specifications for Phase III test and evaluation capability.

A90-117 Combat Vehicle Tactical Display System (TDS)

OBJECTIVE: Design and develop a tactical display system for use in armored vehicles which would show terrain features as well as detected threats and force disposition. Display would be set-up during pre-mission planning, and would be automatically updated via data link as new threats are discovered and battlelines shift.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: A multifunction display (MFD) will be used by the vehicle commander to keep track of his position and the location of other friendly and hostile forces. For instance, an enemy gun emplacement and its effective field of fire could be displayed and the commander could modify his route to minimize exposure. Likewise, the warning of a chemical attack showing the origin and the downwind "footprint" could be transmitted to the vehicles in the field and used to avoid or minimize contact. Downlink could be from satelite or unmanned flying vehicle using secure burst communication.

PHASE I: Design and develop a MFD for use in an armored vehicle. Develop software interface to permit insertion and overlay of symbols on a contour map presentation. Initial map area may be large-scale and stationary, with growth potential to moving-map display capability. Include a menu of standard military symbols and develop symbology for depicting nuclear/biological/chemical "footprint".

PHASE II: Demonstrate the capability to update remote tactical displays from a command center. For instance, information on a hostile troop concentration could be broadcast and appear immediately on the MFD's of all vehicles in the vicinity. The same system could be used to indicate the desired location of maneuver elements.

A90-118 Visual Transition Enhancement

OBJECTIVE: Investigate the perceptual problems with making frequent and rapid transitions between external and internal environments, and develop cueing systems to reduce those problems and enhance performance.

CATEGORY: Basic Research/Exploratory Development

DESCRIPTION:

GENERAL: Currently, combat vehicle crewmen must transition from the external visual world to the limited views presented through periscopic vision blocks when he seals himself inside the vehicle. Infuture combat vehicle systems, the internal view will consist of virtual images presented on cathode ray tubes (CRTs) or similar visual displays. The crewman must be able to transition frequently and rapidly between these "real" and virtual" presentations while remaining oriented to external threats and landmarks.

PHASE I: Qualify the nature and extent of crewman disorientation, and the resulting reduction reductions in combat effectiveness associated with internal/external visual transitions. In particular, consider the effects of low-light and obscurants. Investigate visual cueing systems and other means to smooth the transitions and improve performance/survivability.

PHASE II: Design and develop prototype hardware based upon the previous work, and demonstrate the system effectiveness compared with present sytems under identical tactical circumstances. Evaluate under simulated threat conditions such as found at the National Training Center.

A90-119 Combat Vehicle Crewman (CVC) seat

OBJECTIVE: Using fire-resistant materials, design and develop crew seats which will stabilize and protect the user while traveling at high speeds over rough terrain. Sitting posture should be adjustable from upright through fully reclined.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: When traversing rough terrain at high speeds, crewmen have difficulty controlling weapons and sensor systems because of the shock loads transmitted to them through the existing seats. Furthermore, during extended periods of operation, the ability to rest in place at the combat crew station is reduced because of seat discomfort and limited adjustability.

PHASE I: Design several seat configurations which could be installed in present or future vehicles, and which would reduce chassis-generated shock loads to the soldier and provide a greater degree of adjustability and comfort.

PHASE II: From the various design approaches, select one for fabrication. The delivered product would be tested by the government, refined if necessary, and eventually installed in a combat vehicle for user evaluation in field settings.

A90-120 Soldier Compatible Air Defense Display

OBJECTIVE: Identify, prioritize and produce prototype displays and software. These displays must be compatible with forward area air defense command and control applications.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The utility of displays as a means of conveying air defense information needs to be otpimized. This research will examine display hardware/software techniques to ensure good information transfer in the time constrained air defense environment.

PHASE I: Identify and prioritize the types of displays and the software (human/computer) interfaces that are most effective in forward area air defense intelligence preplanned produce improvement applications. The display characteristics and tradeoffs at each node (forward area air defense command, control and intelligence subsystem) must be categorized.

PHASE II: Fabricate candidate display systems at fire unit, platoon, battery and battalion for forward area air defense applications. Demonstrate the effectiveness of these displays in a laboratory experiment. Validate results with field test using Army air defense personnel.

Harry Diamond Laboratories

A90-121 Tactical Terrain Reasoning System

OBJECTIVE: It is anticipated that a successful project would be incorporated into combat information processing and robotic equipment. The objective of this SBIR effort is to develop, integrate, and demonstrate a real time Tactical Terrain Reasoning System (TTRS).

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There is a large amount of applicable research ongoing in the areas of tracking algorithms, spatial reasoning and expert system tools, object-oriented data bases, and military doctrinal knowledge that exist within government, industry, and academia. There is a need to optimize and integrate appropriate technologies into an effective system oriented toward specific military problems. An example of such an application would be the requirement to predict the optimal place and time to interdict an advancing second echelon (sensed by a UAV based MTI RADAR) with artillery.

The ability for a system to continuously integrate the current battlefield situation with changing terrain and environmental conditions is a key factor for all five Army functional areas to assist the commander in effectively planning and executing current and future tactical missions. Terrain reasoning is a major factor in determining mobility, route locations, choke points; target areas of interest, sensor locations, fire power resource allocation, event detection, fuel consumption, logistical coordination, robotic equipment and many other time critical activities on the battlefield.

PHASE I: Conceptual/Preliminary Design Phase. Phase I will include a review of presently used technology that exists in the areas of terrain reasoning and tracking algorithms, spatial data bases, expert systems, and object-oriented data bases that exists in industry and academia, as well as the results of previous and ongoing government programs. The results of this study will be used to formulate a conceptual design document which addresses the high level hardware and software design of a TTRS in the form of block and dataflow diagrams describing algorithms as well as identification and discussion of the technology shortfalls.

PHASE II: Develop and demonstrate TTRS software in accordance with the detailed design performed during phase I. The software includes all man-machine interfaces, algorithms, and knowledge bases required to maintain operational capability of the TRS along with the software required to measure its performance. All software will be developed under the UNIX System V Release 3 on a 680xx based multi-processor system. Software will be written in one or more of the following languages C, C++, LISP, Prolog, ADA, a government approved expert system shell programming language. The ADA system will be demonstrated at Harry Diamond Labs on existing field demonstration hardware.

A90-122 Performance of Multi-Layer Wide Band Patch Antennas

OBJECTIVE: Results of successful projects may be incorporated into fuze production programs. The object of this project is to demonstrate the feasibility of producing small multi-layer wide band microstrip patch antennas for an artillery proximity fuze application; emphasis on low cost fabrication techniques is required.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: A need exists for wide band (at least 10%) microstrip patch antennas for next generation artillery proximity fuzes. Innovative techniques have been explored to enhance the bandwidth of single microstrip radiators with encouraging success. However, due to the techniques used to increase bandwidth, potential difficulties in the fabrication and production of such antennas are anticipated. Currently bandwidth

enhancement techniques use multi- layer substrates and proximity coupling to the primary radiating element for the increased bandwidth. Microstrip matching elements are also used at the feed point of the antenna. At higher microwave frequencies where process tolerances become important, registration of antenna features between the different layers of substrate are critical. Studies are needed to predict how well antenna performance will be maintained during fabrication and production of multi-layer wide band microstrip patch antennas, and whether, if required, economical means of tuning or triming antennas could be employed.

PHASE I: Determination of suitable fabrication techniques and substrate materials for the development of wide band multi-layer microstrip patch antennas. Develop and validate methods to predict performance variations using the selected techniques and materials.

PHASE II: Developmental fabrication and testing of wide band multi-layer microstrip patch antennas using materials identified in Phase I. Demonstration of feasibility of achieving low cost production and a study to show expected cost vs. production rate.

A90-123 Optical Interferometers for Sensing Electromagnetic Fields

OBJECTIVE: It is anticipated that a successful project would be incorporated into maintenance equipment for ensuring the survivability of critical Army mission equipment. The object of this project is to improve the accuracy of measuring wide band transient electromagnetic responses by using optical interferometer sensors which do not disturb the fields being measured.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The accuracy of measuring wide band transient electromagnetic responses can be enhanced by using nonmetallic sensors which do not disturb the fields being measured. Sensors utilizing a waveguide Mach-Zehnder interferometer approach this desired dielectric sensor; however, they still require metallic contacts and antennas. The operation of these devices is based on the electro-optic characteristics of the crystal material used in the interfereometer. A laser beam is divided into two channels within the interferometer. Metallic electrodes are then positioned at the appropriate locations on the waveguide channels so that when a voltage is applied to the contacts, the voltage across the two channels have opposite polarities. The resulting change in the index of refraction of the crystal delays the light in one channel with respect to the light in the adjacent channel, resulting in a net phase shift. When the light is recombined, a change in light intensity results due to the interference of the two light waves. The interferometer can be operated such that the light intensity is proportional to the voltage across the crystal. The required electrodes and antennas, although very small, perturb the fields being measured and create frequency limitations due to their interactions with the electromagnetic fields.

PHASE I: Consists of investigating the possibility of creating an interferometer with the crystal material of the two waveguide channels oppositely poled. This would effectively eliminate the need for the metallic electrodes and their associated limitations. The interferometer should have a flat frequency response from DC to 1GHz with at least 40 dB dynamic range. Analyses and/or experimentation will be required to determine the feasibility of manufacturing such a device and its capability to perform to the required specifications. Emphasis may also be placed on miniaturization. The feasibility of calibrators should be addressed.

PHASE II: Consists of the actual manufacturing of a prototype interferometer electromagnetic field sensor system.

A90-124 Automated Electronics Assembly and Test

OBJECTIVE: It is anticipated that successful projects would be used in the manufacturing process of military electronics. The objective is the development of new processes and innovative automated assembly equipment for electronics which will lead to reduced cost and or higher quality and reliability of electronic systems, both military and commercial.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: The scope of this project is to attack electronic assembly issues of national importance, the solution of which will have national economic consequences. This project includes all facets of the automated assembly of electronic sub-systems and the assembly of sub-systems into electronic systems. Examples of subject matter of interest are: solder joint theory, component- substratre joining, inspection of joints, new joint materials; innovative use of machine vision for assembly and test; robotics; new technology for inspection and test; extension of surface mount concepts; new concepts for printed wiring boards; wiring means for photonic circuits; advanced concepts for flexible manufacturing; advanced concepts; advancement of statistical process control, and the advancement of quality control theory.

PHASE I: Advanced development of the automated electronics assembly concept or process. Complete study short of building factory evaluation prototype.

PHASE II: Fabrication of working prototype capable of factory floor evaluation. Full technical data package containing all drawings and process information, complete operating manuals.

A90-125 Guided-Wave TeO2 Optical Devices

OBJECTIVE: This exploratory development would provide a means of obtaining a more efficient optical modulation element to be used in acousto-optic (AO) signal processing devices both for laboratory application and for EW system applications such as radar threat warning receivers, SAR return processors, and geolocation devices.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Tellurium dioxide is an AO material having a high figure of merit which has been extensively used as a bulk acoustic wave (BAW) AO modulator; however, relatively little work has been done to make use of the high figure of merit in a surface acoustic wave (SAW) AO configuration. In addition, transducer power limitations impose restrictions on the usable dynamic range of BAW AO devices. Developments in either or both SAW and BAW AO devices will increase the speed and processing gain of optical processing system.

Acoustic-Optic SAW devices use a surface acoustic wave (SAW) to interact signals with an optical beam passing through the crystal. Generally, these devices are constructed using photolithographically produced interdigital finger transducers to excite an acoustic mode which is closely confined to the crystal surface; however, there have been other mechanisms used to create the SAW. An advantage afforded by the SAW AO device design is that multiple transducers may be laid on the surface of the crystal, the number of which is limited only by crystal "real estate," and crosstalk amojng the SAW's.

BAW devices have been used extensively in the development of AO signal processors where high speed and high processing gain are required. The requirements on these devices are that they must have a large spurious

free dynamic range and large signal bandwidths. In order to operate in a spurious free region, the input power to the device must be at lower power levels. This puts a limitation on the dynamic range of the AO system unless methods are developed which will increase the efficiency of the BAW devices. Phases array transducer designs incorporated into the AO modulators can be used to increase operational bandwidth and efficiency of these devices.

PHASE I: Phase one would consist of the design of several breadboard TeO2 AO devices each having TBWP of preferably 1000 or better. They would be designed at several different center frequencies, affording bandwidths of roughly one-third their center frequency values. These would form the basis of designs for optical processing modules such as spectrum analyzers and correlators. The SAW devices would have at least two active, counterpropagating SAW's supported in the active optical aperture. The BAW devices would have a device each having an optical aperture of 70 microseconds and bandwidths of at least 30 MHz and up to 60 MHz.

PHASE II: Phase two would consist of the development of prototype TeO2. SAW and/or BAW devices which could be incorporated into optical processing systems designed for such applications as radar threat warning receivers and optical signal and image correlators suitable for field testing in flying systems. Existing designs would be modified for insertion of these new devices which should increase the calculational capabilities of the optical signal processing system.

A90-126 Acceleration Sensing Module for Munition Safety Systems

OBJECTIVE: The objective is to develop and test a minature, low- cost acceleration sensing and integrating module for use in missile electronic safety and arming systems. Size is to be less than 0.03 cu-in and cost is to be about $15 ea in small quantities of about 100 units.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Most current munition fuzes use an acceleration-time sensor as a primary safety element. Present devices for missile and rocket fuzes are generally composed of bulky spring mass systems interfaced to mechanical escapement mechanisms used to "integrate" acceleration and give an output when a safe separation condition is reached. What is needed is a simple acceleration sensor and electronic processing module to substitute for these bulky mechanical devices in electronic safety systems. The problem with currently available accelerometer devices that might fit this need is that they are too expensive, and too large in size.

PHASE I: Detailed design, functional prototype, and a formal descriptive report are the desired output from Phase I. A generic requirement is for an acceleration-time sensing device functioning in the range of 2 to 40 g with a single integral or double integral or time output in the range of o., 05 to 6 seconds. Output need be accurate only to about + 10% and is to occur only if a factory present condition is exceeded. Electrical power (logic level on the order of 5 volts) would be supplied to the sensor and circuit from the fuze. Target size is less than 0.03 cu in, and target cost is less than $15 each in quantities of about 100 units. Proposals will be evaluated on various factors to include: potential of design concept to meet size and cost targets, potential reliability, and flexibility of adapting a single design to a broad range of munition requirements.

PHASE II: Assuming that Phase I is successful, the most promising design will be developed by design refinement to enhance performance and producibility, building of one or more qualification lots, extensive testing for ruggedness and performance, and demonstration field testing. A data package and technical report will be prepared as required for proceeding to Phase III and as needed for integrating the device into various DoD munitions.

A90-127 Electromagnetic Protectors for Microwave Circuitry

OBJECTIVE: The objective is to develop the technology needed to manufacture a family of protective devices based on the saturation characteristics of ferrite or other materials capable of protecting microwave circuitry form damage from high levels of microwave energy. Phase III applications would involve incorporation into radar communications, and electronic warfare equipment.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: A protective device is needed to prevent damage to microwave circuitry when the risk of exposure to impinging high levels of microwave energy is present. At these frequencies, metal oxide varistors (MOV's) are not suitable because of their inherent capacitance. Seminconductor protectors present a design conflict because as the frequency is increased, the size becomes smaller with a corresponding reduction in power handling capabilities. Ferrite materials in an appropriate configuration present an alternative to these traditional approaches. Other potentially successful approaches are also sought. Ferrite materials exist and others can be developed that have high losses to microwave fields as the material saturation point is exceeded. Microwave ferrite devices currently in use include phase shifters, isolators, circulators and other devices, but no saturation-based protection devices. This program is an investigation of methods of utilizing the characteristics of materials to create a family of protective devices for preventing damage to micorwave systems exposed to high levels of electromagnetic energy. Types of protective device designs to be produced include but are not limited to microstrip, stripline, rectangular waveguide, and circular waveguide. Integrability with gallium arsenide is desirable.

PHASE I: Technology survey, analysis, and demonstration. *Phase I shall include* a survey of existing technology pertaining to ferrite or other material loss characteristics at microwave frequencies, investigation of saturation properties, formulation of specific configurations for various transmission line types, analysis of the potential of each specific configuration, determination of design parameters, and a preliminary experimental demonstration of a microwave protective device. Types of device configuration to be pursued include but are not limited to microstrip, stripline, rectangular waveguide, and circular waveguide.

PHASE II: Development and testing. Phase II is the development of the specific configuration identified as having potential in phase I. Although the specific requirements as to which and how many designs to be pursued in phase II depend on the results of Phase I, in general, phase II shall include the further development of specific designs at various frequencies, optimization of the material properties for use in protective devices, fabrication of small quantities each design, and testing of these devices.

A90-128 Light Weight Electromagnetic Shielding Material

OBJECTIVE: Investigate and design a material electromagnetically shielding an enclosure. Successful materials would be fielded in lightweight Army tactical shelters.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Presently tactical shelters use 30 to 50 mil aluminum sheets to harden and to maintain structural rigidity. MIL-STD-907B stipulates 60dB shielding effectiveness when tested in accordance with MIL-STD-285 procedure for DoD standard family of shelters if the shelter requires protection against EMI/EMP stress. It is

highly desirable to build a shelter made with composite material to reduce tare weight, but a lightweight material is required to harden the shelter.

PHASE I: Investigate and design a low cost material to harden a shelter made with composite material. Provide the Government the detailed documentation including the material performance against the EMI/EMP threat, electrical property, composition of material and test data. Design Goals: a) At least -60 dB of shielding effectiveness when tested in accordance with MIL-STD-285. b) Reduction of material weight by 80% or more over 30 mil aluminum sheet. c) Low cost with respect to 50 mil aluminum sheets.

PHASE II: Design and fabricate an S280 (C) - type shelter utilizing the composite material developed in Phase I. The designs for this shelter are to meet the critical mechanical and structural specifications for a standard S280 (C) shelter as given in the S280 (C) Shelter Specification Document.

A90-129 Ultra Wide Bandwidth Radar Components Development

OBJECTIVE: Is to develop devices that would allow construction of a coherent-on-receive UWB (ultra wide bandwidth) radar receiver.

CATEGORY: Basic Development

DESCRIPTION:

GENERAL: Functionally, what is needed could be supplied by an A/D (analog-to-digital) converter driven by a clock signal that is triggerable. Triggering that causes the clock zero crossings to become aligned to an asynchronous trigger pulse to within +\- 1/2 ps is desired. Clock stability of 10^{-9} over a 700 us. period after triggering is desired. Also desired is a long term clock stability of 10^{-9}. A full scale bandwidth of 2 GHz and 6-bits or more of accuracy is desired in the A/D converter.

A normal A/D converter accepts an input signal $f(t)$ and provides a series of values at discrete times i.e $f(t_0)$, $f(t_1)$, $f(t_2)$, $f(t_3)$. It would be advantageous for the A/D converter to function as an intergrating converter. That is, it accepts an input signal $f(t)$ and provides a series of values $\int f(t)dt$ between limits t_0 to t_1, t_1 to t_2, t_2 to t_3, and so forth. Proposals that identify technology applicable to implement these functions are solicited.

PHASE I: Develop Devices. Phase I will focus on demonstrating the feasibility of devices that would perform the described functions.

PHASE II: Develop a system. Phase II will focus on assembling a functional prototype.

Materials Technology Laboratory

A90-130 Nondestructive Evaluation of Bond Quality

OBJECTIVE: Development of a new, efficient, nondestructive evaluation (NDE) system capable of determining the quality (strength) of bonds in adhesively joined structures both on the manufacturing floor and in the field. Potential Phase III applications for this new NDE system include Army helicopter blades and panels, missile radomes and motor cases, projectiles, mines, fuel tanks, tank pads, and future combat vehicles; as well as commercial areas such as aircraft, helicopters, automotive, electronic, and construction.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Bond failure usually occurs interfacially and is usually due to poor adherend surface preparation and/or exposure to adverse environments. Conventional NDE techniques only permit a spot check of the bonding process. A lack of adequate NDE procedures and technology to determine bond quality has impeded the widespread use of adhesively bonded structures. Bond quality is defined as actual bond strength relative to the normal required bond strength of a given component as determined using NDT testing methods. Innovative approaches are needed for development of improved NDE methods to evaluate the quality of bonds. Since it is difficult to directly measure the bond strength nondestructively, it is necessary to infer bond strength from other properties such as bond areas, stiffness, bond thickness, and damping. Hence, in order to predict bond quality using NDE methods it is necessary to correlate bond strength with various other NDE technique properties as cited above.

PHASE I: Develop one or more novel NDE techniques and demonstrate that the concept involved can be effectively used to measure bond quality. Correlation of results with conventional destructive tests such as pull tests and tear tests will be required.

PHASE II: Optimize the most promising NDE technique(s) demonstrated in Phase I. Develop a Prototype NDE system along with any necessary auxiliary equipment and software to determine the quality of bonds in adhesively joined structures. The effectiveness of this system must be demonstrated on samples or specimen models typical of the potential Phase III Army applications cited in the "objective" above.

A90-131 Novel Surface Treatments for Improved Adhesive Bonds

OBJECTIVE: To develop surface treatments for metals which modify their surface chemistry so as to permit the formation of stronger, more durable adhesive bonds to them.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Conventional coupling agent chemistry has been applied extensively to the problem of adhesive bond strength and durability with modest success. Novel approaches resulting in very substantial enhancements are required for demanding military applications of this joining technology. By analogy with carbon chemistry where highly reactive species are generated on its surface by high temperature vacuum pyrolysis and subsequent reaction with monomers and other small molecules, it is of interest to functionalize metal surfaces through the interaction of similar small molecules with appropriately activated metals. Of particular importance are the advanced structural metals such as aluminum and titanium, where a native oxide is always present on the surface.

PHASE I: During Phase I, the feasibility of functionalizing surfaces would be determined. In addition, the effect of such surfaces on bond quality would be ascertained.

PHASE II: During Phase II, promising approaches identified in Phase I would be brought to the point where they could be implemented in production environment. This would include the scale-up of any necessary equipment and the generation of data as to the effect of variation of important processing parameters on the quality of resultant adhesive bonds. The specific product of this phase would be a Technical Data Package sufficient for the implementation of such a process on a production line.

A90-132 Rugged Miniaturized Sensors for Real Time Process Control

OBJECTIVE: Development of a pressure/temperature sensor small enough to allow its insertion into the part itself or arrayed to equipment for organic matrix composite processing to enhance process control.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: During the manufacture of organic matrix composite components, the quality of the resultant parts is significantly influenced by variations in the primary processing parameters. Thus improvements in processing through the use of automation is one possible path to making composite processes more efficient, and hence cost effective. Effective automation in complicated processes requires instantaneous interpretation of feedback from a multitude of sensors. However, currently available pressure and temperature sensors are often too bulky to use in certain composites processes such as pultrusion and resin transfer molding. A miniaturized sensor developed for measuring these critical process parameters could be integrated with an expert system to monitor and control a variety of composite manufacturing processes. The sensor would provide, in real time, critical temperature and pressure information, and an efficient control algorithm would anticipate and respond to future processing events. Such a sensor should produce a signal that is interpretable and reliable at all times during the processing phase, including severe pressure/temperature environments. The thickness of such a sensor should be less than 0.1 mm to allow for easy insertion into areas that would otherwise be inaccessible. In situ sensors could also be used for monitoring of wear, corrosion or other degrading mechanisms during service life.

PHASE I: Investigate and demonstrate the feasibility of developing a rugged miniaturized sensor to measure critical process parameters in real time for efficient process control during manufacturing of organic matrix composites.

PHASE II: Optimize and develop a prototype of the sensor demonstrated in Phase I along with any necessary auxiliary equipment and software. Demonstrate that this prototype has the capability to produce real time, efficient organic matrix composite process control as described in the general description above.

A90-133 Metal Injection Molding of Tungsten Heavy Alloys

OBJECTIVE: Develop and define the processing variables required to produce net or near-net shape tungsten heavy alloy products of high structural integrity.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Currently the manufacture of tungsten heavy alloy components is labor and materials intensive. The raw, sintered material is ingot-like and requires extensive working and machining to obtain final, useful shapes. As a result tungsten heavy alloy parts can be quite expensive. Metal injection molding (a powder metallurgy process) offers the opportunity to reduce this expense by producing net or near-net shape products by eliminating the working, machining and scrap. To this point in time, there has been little or no effort to develop the processing required to produce tungsten heavy alloy components by this process. In particular, the processing variables need to be defined, i.e. percent binder, binder composition, debindering temperature and time, and sintering temperature and time. Of additional importance is the effect of metal powder particle size and distribution. Lastly, but not less important, is the shrinkage of the part from the "green" stage to the final sintered product.

PHASE I: Work in phase I should demonstrate, on a laboratory scale, the use and limitations of currently available raw materials, e.g. binders, tungsten powders and matrix powders. Further, the work should identify the important process variables; particularly the time and temperature requirements of debindering and sintering. Also, the work undertaken should identify the maximum thickness that can be successfully sintered, and the shrinkage of the part that takes place upon debindering and sintering.

PHASE II: Phase II work will build upon the results of phase I by developing binders and metal powders that optimize the processing. The phase II work should construct an injection molding die to provide an Army relevant, tungsten heavy alloy component, and demonstrate the feasibility of producing that component by metal injection molding. The laboratory effort should continue, developing the processing necessary to scale-up the maximum size that can be successfully produced by metal injection molding.

A90-134 SHS/Combustion Synthesis of Advanced Materials

OBJECTIVE: The objective of this program is to stimulate the United States industrial use of SHS/Combustion Synthesis/Thermite Reactions for the production of powders, coating and bulk materials.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Self-propagating High-Temperature synthesis (SHS), Combustion Synthesis of Thermite Synthesis have been demonstrated to be able to produce high performance materials - including powders, coatings and bulk materials. R&D is needed to apply this processing technology in a wider variety of applications. Traditional material processing routes involve long times and are energy intensive, whereas, use of SHS-type routes require very small amounts of energy and short periods of time.

Very large efforts in Japan and Russia have successfully demonstrated the broad application of this technology to a variety of materials: Tic abrasive pastes, bulk ceramic materials, shape memory alloys, composites, ceramic-lined metal pipes, field coating of plowshares, $MoSi_2$ heating elements, etc. However, costs in Japan and, especially, Russia are artificially generated so it is important to explore the true free-market costs of these production technologies on selected materials and applications.

PHASE I: As described above, the potential use of SHS-related technologies in the production of advanced particulate, coating and bulk materials is very large. Phase I proposals in this area should demonstrate the feasibility of concepts to produce the following: Ceramic fibers and whiskers, ceramic composite powders, functionally gradient materials, ceramic-coated pipes, bulk ceramic materials, etc.

PHASE II: After feasibility has been demonstrated in Phase I, carry out production of scaled-up version for more complete characterization and property evaluation with a goal of a prototype-type version at the conclusion of this phase.

A90-135 Directional Solidification of Liquid Phase Sintered Tungsten Heavy Alloys

OBJECTIVE: Develop the solidification processing techniques necessary to fabricate tungsten heavy alloys with elongated tungsten grains in the direction of solidification.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The tungsten grains in a liquid phase sintered tungsten-nickel-iron alloy grow during sintering from an initial particle size of 2 microns to more than 40 microns. The growth, in general, is by a mechanism of solution and reprecipitation and it may be possible to exploit this mechanism to grow elongated grains. Tungsten heavy alloys that have been hydrostatically extruded have elongated tungsten grains and these grains have been shown to increase the tensile strength of the heavy alloy with the elongated grains providing a fiber-like strengthening. The disadvantage to hydrostatic extrusion is to get reduction ratios that are advantageous it is necessary to start with large billets that require extremely high extrusion pressures. The desired goal would be to create a directionally solidified heavy alloy that had diameters that exceeded two and one hal inches.

PHASE I: Demonstrate the fabrication of directionally solidified tungsten heavy alloy. Develop the processing necessary to successfully scale-up the process in phase II. Also, show how these directionally solidified alloys can strengthen the overall alloy. Also demonstrate whether or not scale-up would be possible.

PHASE II: Scale-up the dimensions of the directionally solidified tungsten heavy alloy billet to the desired dimensions. Fabricate several billets that can then be cold worked to a higher strength level and be demonstrated in Army relevant systems.

Vulnerability Assessment Laboratory

A90-136 Air Defense and Space Systems Electronic Warfare (EW) Vulnerability

OBJECTIVE: To exploit technological advances which apply to and support the U.S. Army EW Vulnerability assessment (EWVA) program for air defense and space systems.

CATEGORY: Exploratory and Advanced Development

DESCRIPTION:

GENERAL: The U.S. Army EWVA program for air defense and space systems has been established to determine performance of systems or system concepts in hostile EW environments and to develop and recommend electronic countermeasures (ECCM) to preserve system performance in these environments. Technological advances are needed in active and passive electronic countermeasures (ECM), ECCM, ground-based, and laboratory instrumentation and techniques, and analytical methods and techniques. These areas involve all regions of the electromagnetic (EM) spectrum. To advance ECM technology, as applied to air defense and space systems, there are requirements to address methods of active signal generation, cooperative CMs, and passive support measures (SM) such as chaff and obscurants. In the areas of ECCM, there are requirements to perform ground- base measurements of parameters of airborne CMs such as responsive ECM, cooperative CM, and cross section or density of passive SM techniques. There are significant shortfalls in the technology supporting analysis of air defense and space systems. Work needs to be done in the development of hardware and software models of terrain clutter, chaff or obscurants, and atmospheric clutter. Another area of importance and interest is the use of fractal geometry for simulation, graphics application, and imaging decoding and reconstruction.

PHASE I: Feasibility study to determine the technical viability and merit of the concept.

PHASE II: Tangible results such as software, prototypes, etc., shall be developed to prove the feasibility of the proposed concept. In some efforts, proof-of-principle demonstrations shall be made.

A90-137 Electronic Warfare (EW) Vuln Assessment Methodology for Communications Systems

OBJECTIVE: To develop the methodology for the computation and processing of radio performance data and network topology to assess the EW vulnerability of complex networked communications systems.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The vulnerability analysis of a communication network involves the assessment of performance of, perhaps, hundreds of radio sets. Each radio set has a different topological aspect with respect to the remainder of the network and to the ECM threat. This project involves the development of methodology for the computation and processing of radio performance data in order to meet the requirement for assessing the vulnerability of the network and to quantify the degree of performance improvement needed to assure satisfactory network inter connectivity.

PHASE I: In Phase I the parameters used in the computation of performance will be identified and the interrelationships between parameters and measures of performance will be derived. The assessment techniques for pertinent interference waveforms will be established. The criteria for acceptable performance thresholds will be identified and the measures of performance shortfall defined. A procedure for the presentation of performance data for all radio paths in a network will be described and shown by example.

PHASE II: In Phase II the distribution of bit errors in the multiplexer signal format will be explored for various interference waveshapes. Relationships between the interference waveform parameters and the resultant disturbances on framing, signaling and voice channels will be determined. The specific waveform parameters needed to achieve particular bit error rate objectives will be optimized. A procedure for assessing the degree of jamming effectiveness enchancement achievable by tailoring the interference waveshape parameters for specific error pattern objectives will be determined.

A90-138 Spectrally Tailored Electro-Optical Countermeasures (EOCM)

OBJECTIVE: Develop spectrally "tailored" EOCMs for active and passive CM applications.

CATEGORY: Exploratory and Advanced Development

DESCRIPTION:

GENERAL: EOCM advances are required in both decoy and jammer categories. In the decoy category, both pyrotechnic and pyrophoric materials are required that can provide spectrally tailored output to match target signatures. The burn characteristics are required to be temporally adjustable by chemical mix or physical design to allow rise time/burn time selection for maximum effectiveness against specified systems. In the jammer category, advances are required in spectrally tailored infrared and ultraviolet sources that can provide higher output radiation power levels with reduced weight, physical size, and input power requirements. Jammer modulation technique advancement is required to provide programmable waveform shapes as well as CW waveforms from unmodulated constant level output to frequencies as high as 5 kHz.

PHASE I: Theoretical studies shall be made to determine the feasibility of designing/developing advanced EO decoys and jammers.

PHASE II: Prototypes of new advanced EO decoys and jammers shall be developed. Proof-of-principle demonstrations shall be made.

A90-139 Multispectral Scenes Simulations

OBJECTIVE: Develop a simulation that can simultaneously simulate multispectral scenes.

CATEGORY: Exploratory and Advanced Development

DESCRIPTION:

GENERAL: The technology to simultaneously simulate multispectral scenes is unavailable. A multipsectral simulator is required to assess multisensor systems utilizing automatic target recognition technology. The simulator would generate scenes of backgrounds, targets, and countermeasures in multispectal domains to include millimeter wave, far-infrared, and television wavelengths. This would benefit the Army by reducing costly EW field investigations.

PHASE I: Theoretical study to determine the feasibility of designing/developing a simulator that can simultaneously simulate multispectral scenes.

PHASE II: Prototype of a simulator will be developed that can meet the objective of the effort.

Aviation Systems Command

A90-140 Flechette Expulsion Augmentation Mechanism (FEAM)

OBJECTIVE: Design of a mechanism or insert which during expulsion increases the maximum pattern size realized with the current 2.75 inch Air-to-Air Flechette Warhead.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The current 2.75 inch Air-to-Air Flechette (ATAF) warhead contains either 585 120 grain or 1170 60 grain kinetic energy penetrators or flechettes. There is currently no mechanism to maximize the size of the pattern formed by the flechettes after expulsion from the front of the warhead. Increasing the flechette pattern size will result in an increase of the air-to-air effectiveness of the ATAF warhead.

PHASE I: This effort will result in the design of a Flechette Expulsion Augmentation Mechanism (FEAM) or FEAM's which maximizes the size of the 60 and 120 grain flechette patterns while minimizing the reduction in the number of flechettes in the 2.5 inch X 17.75 inch warhead cargo compartment. Additionally, this effort shall include sufficient analysis to support all design decisions and shall address the aerodynamics of pattern formation.

PHASE II: This effort will result in the fabrication and firing test of a sufficient number of FEMA modified ATAF warheads to quantify the resulting increases in flechette pattern size.

A90-141 Infrared (IR) Signature Reduction Flow Model Test Stand

OBJECTIVE: Develop and build a cool flow test stand for aerodynamic testing of a small scale IR suppressor and suppressor component.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The design and development of the suppressors involves mainly understanding the aerodynamic interactions of the engine exhaust gas with suppressor. Detail aerodynamic studies and development of small scale suppressors are more cost-effective on a cool flow test stand, because the cool flow test stand saves engine fuel and wear. It is also possible to make certain measurements which otherwise can not be obtained from a full scale suppressor on an engine test stand (i.e., total mass flow rate of air and flow field visualization).

PHASE I: Develop a method to accurately simulate engine exhaust gas flow in which the cool flow model test stand will provide the aerodynamic characteristics and behaviors as the exhaust gas.

PHASE II: Design and fabricate the cool flow model test stand. Demonstrate the accuracy of the model test stand in simulating engine exhaust gas aerodynamic characteristics and behavior.

A90-142 Incident Laser Directional and Power Level Sensor System

OBJECTIVE: To develop a sensing system for Army helicopters which monitors for coherent laser energy and can determine angle of incidence and power level on the surface of the aircraft.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Emerging dynamic laser protection systems require a sensing device for triggering activation. The sensing device must be capable of determining power level of a broad wavelength band consistent with eye protection. This information coupled with a directional indicator would be used to activate a protective device in the affected area of a helicopter cockpit.

PHASE I: The desired result is a preliminary design for the sensor system. Work would include analytical and experimental efforts as an input to the preliminary design.

PHASE II: Development and testing of a prototype system.

A90-143 Advanced Composite Structures Repair Technology-heat/pressure fabrication equipment/materials

OBJECTIVE: Investigate/propose innovative usage of existing/new technology, or combinations there of, in the area of heat and pressure application tools/equipment/materials to improve Army aviation field level repair capability of advanced composite structures.

CATEGORY: Exploratory/Advanced Development

DESCRIPTION:

GENERAL: Currently the Aviation Applied Technology Directorate (AATD) is developing an advanced composite structures field level repair kit using existing currently available technology [tools/equipment/materials]. This existing technology is not always completely satisfactory for Army aviation field level use, considering the Army operational service environment and the following factors: cost, weight, size, versatility, power requirements, storage/shelf life, etc. Therefore, it is desired to investigate/evaluate new or improved technology.

PHASE I: Identify/discuss/evaluate the feasibility of proposed new technology and provide substantiating data, as required, to support any concept/hardware to be developed, including any prototypes.

PHASE II: Prototype hardware development/demonstration and Army field use demonstration/evaluation.

A90-144 Particulate Sensor for Turboshaft Gas Turbine Engines

OBJECTIVE: Develop a flightworthy sensor to measure and classify sand and particulate matter entering a turboshaft gas turbine engine.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The ingestion of sand and dust into a gas turbine engine degrades performance and shortens engine life. Current Inlet Particle Separators (IPS) remove sand and dust from engines with very high efficiency but at the cost of power and specific fuel consumption (SFC). If a means of measuring the need for an IPS could be developed, the IPS could be designed to recover power or SFC when the environment is clean and possibly increase efficiently in severe sand environment. Also, a sensor that could measure the concentration of sand entering the IPS, could be used to estimate engine life in severe environments during a mission.

PHASE I: The objective of the Phase I SBIR effort shall be to develop a design for a sensor to determine (in real time) the concentration and nature of particulate matter as it enters the inlet of a turboshaft gas turbine engine. The contractor shall screen possible concepts for accuracy and ability of measurements and durability in severe sand environments to determine the most promising candidate. The size and power consumption of the sensor should be appropriate for application in DOD helicopters. The contractor shall evaluate the possibility of using the sensor to differentiate between water, ice, sand, and other environmental conditions. Other factors that should be considered in screening possible candidates are Electromagnetic Interference (EMI) protection (use of fiber optic output), mounting location, and system complexity.

PHASE II: The Phase II effort in this program shall include the fabrication and testing of a prototype sensor.

A90-145 Improved Methods for High Heat Treated Vacuum Slag Remelt (VSR) and Electroslag Remelt (ESR) Steels

OBJECTIVE: The overall objective of this program is to improve the performance of highly loaded fatigue-sensitive components which use ESR and VSR steels.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: There is a need for high-strength, high- hardness materials in Army aircraft systems. Vacuum slag remelt (VSR) and electroslag remelt (ESR) steels have demonstrated high durability and excellent ballistic tolerance. Due to their inherent brittleness, ESR/VSR steels have S-N curves that change slope abruptly at low cycles. This abrupt change in slope of the S-N curve requires better definition considering sensitivity to environmental, operational (load) and manufacturing parameters. Additional concerns include stress crack corrosion, hydrogen embrittlement and cost.

PHASE I: Improved manufacturing methods and machining techniques require investigation and their effects on performance and tool life need to be defined for various heat treatment conditions. Candidate manufacturing processes will be evaluated by fabricating coupon specimens and conducting and environmental tests. The advantages of using foam filling in hollow components will be quantified.

PHASE II: Representative components will be chosen for fabrication. Several component(s) will be fabricated from both types of steel, then tests will be performed to determine which type of steel demonstrates better performance characteristics. In-service loading and environmental conditions will be simulated for the selected components and their performance evaluated. The selected components will also be candidates for foam filling. The above noted tests will be repeated to quantify the effects of this technique.

A90-146 High Stability Cores

OBJECTIVE: To develop a dimensionally and chemically stable core material for use in the fabrication of advanced high temperature turbine components incorporating highly detailed internal cooling currents.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: This program will involve the development and evaluation of high stability core materials for use in casting small, internally cooled, single crystal turbine airfoils. Candidate materials must ultimately demonstrate the capability to form highly contoured, detailed cores. Candidate core materials must demonstrate significant improvements over current state-of-the-art. The core material developed must remain dimensionally stable throughout the casting process showing no sagging, warping, breakage, or reaction with metal. The core must be easily removed after casting. Phase I effort should involve a survey of potential high temperature core materials. Core materials should be selected with the long-term high temperature exposure of casting single crystal airfoils taken into account. Core material(s) felt to possess the highest potential should be evaluated via trial casting. Trial cores should be complex enough to demonstrate dimensional stability. A post process evaluation should be performed to verify dimensional and chemical stability.

PHASE I: The desired results of Phase I of this effort will be selection of the best core material for production of advanced, complexly cooled, single crystal turbine airfoils. The best core material will exhibit high dimensional stability with no reaction with the base material.

PHASE II: The desired results of Phase II will be the direct demonstration of the selected core material in producing single crystal turbine airfoils which incorporate complex cooling schemes and thin walls.

A90-147 Visualization Techniques For Displaying Cognitive Functions and Heuristic Reasoning

OBJECTIVE: Develop techniques and principles for the effective portrayal of cognitive activity and heuristic behavior as part of a user interface for computational models of human performance in a 3-D color graphic Computer Aided Engineering (CAE) environment. These techniques must be suitable for displaying a wide range of non-quantitative behavior in an intuitive manner to designers with little background in cognitive psychology or Artificial Intellegence (AI) methods.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Scientific visualization of complex analytical methods (e.g. Computational Fluid Dynamics and Finite Element Analysis) has been one of the key factors in the widespread acceptance of computer models and tools. Presenting such results in a visual manner though the use of color, patterns, and dynamic rendering has made such tools accessible by personnel with minimal understanding of the sophisticated techniques which may underlie the presentation. However, a majority of such advances have been made in traditional engineering applications with quantitative results and processes. AI research has provided numerous models of heuristic reasoning (e.g. scheduling, planning, search, learning, and decision making) which are useful to many man-machine integration efforts. However, the presentation of the space, the propagation of constraints, the generation and consideration on alternatives, and the application of rules of behavior are largely disclosed only through tedious tracings of the code or constructing network-like graph structures. Guidelines, sample methods, and a paradigm for presenting the process and results of such cognitive activity would greatly aid their utility and application to man-machine integration design.

PHASE I: This phase should result in the in-depth study of one or two applicable models for expository purposes, the isolation of salient attributes of the model's processes and results, and a detailed description of how such models could be effectively displayed in an interactive CAE environment.

PHASE II: This phase should produce a working demonstration of the display techniques using the model(s) selected above, along with published guidelines and techniques for display interface design which will generalize to a wide range of non-quantitative models and analysis. Some experimental testing may be appropriate to gather empirical evidence to support design choices or optimization.

A90-148 Field Repair Techniques and Equipment for Fiber Optic Components

OBJECTIVE: This project shall develop repair requirements for optical fiber and connectors installed in Army helicopters. It shall perform an assessment of current repair techniques for adequacy in meeting these requirements. Repair methods and tools required to repair fibers and connectors in an Army helicopter shall be identified and/or developed.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Fiber optic sensors have been demonstrated to have many benefits over existing sensors. However, hesitancy exists in fielding these sensors in Army helicopters due to a lack of adequate maintenance procedures and tools. This effort shall define maintenance requirements and develop repair methodology and equipment for field repair of optical fibers and connectors in an Army helicopter environment.

PHASE I: The phase I effort shall define requirements for maintenance of fiber optic connectors in an Army helicopter environment. It shall perform an assessment of current techniques and tools for adequacy in

meeting those requirements. This effort shall recommend new tools and repair methodology that will improve maintainability of fiber optics within the tight confines of the Army helicopter.

PHASE II: The phase II effort shall expand on the phase I results. Necessary tools and methodology will be developed to provide a comprehensive fiber optic connector repair system for Army helicopters. The repairs shall be capable of being performed with minimal skill requirements in the tight confines and highly explosive atmosphere of the Army helicopter and the performance of said repairs shall not degrade with the effects of the Army helicopter environment i.e., temperature extremes, humidity, vibration, etc.

A90-149 Fiber Optic Components for Turboshaft Engine Control Systems

OBJECTIVE: To develop components of a fiber optic engine control system. The components include fiber optic sensors, fiber optic data bases, optical multiplexing schemes, and electro-optic interfaces.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Due to the ever increasing threat of electromagnetic interference (EMI) and electromagnetic pulse (EMP), it is necessary for future turboshaft engines to incorporate EMI immune fiber optics in the engine control system. It will be necessary for all engine sensors to be fiber optic; torque, speed, temperature, pressure, position, and fuel flow. Data will need to be multiplexed in order to take full advantage of the fiber optic's wide band widths. Much work needs to be done in creating small, more durable and less expensive electro- optic interfaces between the data transmission systems and the electronics in the control.

PHASE I: To uncover the most promising new technologies that will be used to replace electrical components of a gas turbine engine control system with fiber optic components.

PHASE II: To design, fabricate, and test prototype fiber optic control components.

A90-150 Fatigue Effects of Thermoplastic Helicopter Components with Embedded Delaminations

OBJECTIVE: To determine the effects of delaminations in thermoplastic composite rotor components when subjected to fatigue loadings.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Little is know of the effects, if any, that manufacturing flaws/might have on rotor thermoplastic component strength and stiffness (as pertains to structural performance) after an extended number of flight hours. Existing quality assurance standards which are appropriate for thermoset composite rotor components might be too conservative for thermoplastic composite rotor components because of the thermoplastic composite materials improved fracture toughness. An experimental database of fatigue effects on a thermoplastic composite rotor component's service life in the presence of manufacturing defects is required.

PHASE I: The phase I effort would entail the identification of candidate rotor components most likely to benefit by being fabricated with thermoplastic composite materials. A rotor component will be selected in

concert with the selections of three thermoplastic composite material systems. Coupons will be fabricated and used for testing to generate tension-tension fatigue S-N curves for the three thermoplastic composite material systems. Additional coupons will be fabricated with embedded delaminations, and these coupons will be tested to examine the effects, if any, on the generated S-N curves.

PHASE II: The phase II program will be an expansion of the phase I program in that the three thermoplastic composite material systems will be used to fabricate coupon specimens with embedded delaminations of varying size and degree. A quality assurance criteria for delaminations will be established and the criteria tested through full-scale fabrication and fatigue testing of one rotor component design. A nearly void-free thermoplastic rotor component will be selected as the baseline and a sufficient number of specimens (6) will be used to establish the tension- tension S-N curve. The quality assurance criteria will then be verified through the full-scale testing of sufficient number of the selected thermoplastic rotor components with embedded declamations.

A90-151 Nondestructive Inspection of Metal Matrix Composites for Gas Turbine Engines

OBJECTIVE: To validate and develop a novel nondestructive inspection system that can be effectively used in sub-surface inspection of metal matrix composite parts for gas turbine engines.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Titanium or titanium-aluminide based metal matrix composite (MMC) rotating components are a key technology in the development of future gas turbine engine cold sections. These gas turbine engine rotating parts will involve bonded MMC inserts and integrally bonded MMC/homogeneous metal parts. Therefore, advanced nondestructive evaluation/inspection (NDE/NDI) techniques are needed which can effectively analyze subsequent bond line and encased MMC area. This means that NDI techniques which are applicable to surface characteristics only shall not be considered. The proposed method must be able to detect flaws and characterize bond areas which are will beneath the surface. Any proposed method should be a unique system or unique modification of an applicable technique which makes the system more effective. It should also be a relatively coast effective technique.

PHASE I: Phase I work performed shall involve development and verification of involve NDE/NDI as applied to MMC gas turbine engine parts. The proposed NDE techniques shall be verified to adequately detect flaw characteristics and material properties with repeatability on representative MMC specimens or parts.

PHASE II: Phase II work will entail further development towards a production version for systems which show promise. This development will also involve effort to allow NDE of complex shapes such as compressor rotors or impellers.

A90-152 Semi-Automatic Scriber for Measuring Bearing Defects

OBJECTIVE: Develop a semi-automated scriber which can measure bearing surface defects accurately and consistently. Demonstrate the performance of the system on candidate refurbishment bearings and implement the system at bearing companies and Government overhaul depots.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Current methods of inspecting aircraft- quality bearing components for surface defects rely on a labor- intensive manual process using a hand-held scriber. IN many cases, especially where marginal defects are involved, the ability to perform an objective evaluation is hindered by several uncontrollable human factors such as force exerted on the defect, speed of crossing the defect, distraction, and fatigue. It is desired that a computerized semi-automated scriber system be developed to replace the current hand-held scriber. The semi- automated scriber system be developed to replace the current hand-held scriber. The semi-automated scriber should contain the necessary transducers to acquire defect data as the scriber is passed in the usual manner over suspected defects. The data should be transmitted and processed by a computer system which contains a preprogrammed library of defect signatures and rejection criteria, from which repeatable defect assessments are made. The device should be utilized in the same manner as the current hand-held scriber. From an operator acceptability standpoint, the device should produce a tactile feedback similar to the currently used scriber.

PHASE I: Develop a breadboard system which demonstrates the concept. Develop preliminary computerized defect analysis data base. Demonstrate performance on samples of pitted aircraft bearings.

PHASE II: Develop integrated system for potential marketing. Greatly expand computerized library of bearing surface flaws.

A90-153 Advanced Methods for Prognosis of Failure of Critical Rotorcraft Components

OBJECTIVE: Develop and demonstrate new methods for prognosis of failure to support the concept of a Predictive Aircraft Maintenance System for Army Aviation.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Army Aviation currently has a requirement to develop a Predictive Aircraft Maintenance System. This concept of maintenance would utilize to the maximum extent possible prognostic rather than the existing diagnostic methods. New methods of prognosis need to be explored and tested to support this maintenance concept. This effort will develop new prognosis methods that are applicable to rotorcraft components impacting flight safety or mission essential functions.

PHASE I: Phase I of this effort would fully develop and analytically or rig test a new method of failure prognosis. Benefits, applicability and weaknesses of the method would be defined.

PHASE II: Phase II would implement and test the prognosis method on aircraft hardware. The result would be a verified prognosis method that could be retrofitted into existing aircraft or incorporated into future designs.

A90-154 A Technique to Assess the Cognitive Complexity of the Man-Machine Interface

OBJECTIVE: The objective is to assist designers of man-machine systems by developing a computational method of assessing the cognitive complexity associated with operating those machines. This complexity metric will be used in a Human Factors Computer Aided Engineering (CAE) workstation to give the designer feedback

during the conceptual design phase on the ease of use and ease of training for various designs under consideration. Ideally, it can also be used to help locate design flaws which are due to excessive complexity.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The driver for this requirement is aircraft crewstation design using computational human factors knowledge in a CAE workstation; specific area is in the design of advanced helicopters. The current trend toward aircraft management using a glass cockpit has increased the cognitive demand on the pilot; there is considerable concern about the pilot's ability to handle these demands during periods of high workload. A tool to assess the cognitive complexity involved in operating the aircraft having a specified cockpit design would be most helpful to the designers during the conceptual design phase in predicting the operability and trainability of the design. The approach selected should be applicable to analysis of advanced cockpits, with emphasis on Multi-Function Displays.

PHASE I: This phase should result in a detailed description of the definition for cognitive complexity and the approach chosen as well as a conceptual description of how it could be implemented on the computer.

PHASE II: This phase should result in a working version of a computerized analysis tool for assessing task cognitive complexity based on display and operational requirements associated with various cockpit designs.

A90-155 Knowledge Base Development For Rotorcraft Situation Assessment (SA)

OBJECTIVE: Develop a knowledge base for a portion of the Situation Assessment for the Day/Night Adverse Weather Pilotage System (D/NAPS).

CATEGORY: Advanced Development

DESCRIPTION: General - The major objective of the D/NAPS program is to flight-demonstrate enhanced mission effectiveness and survivability for day/night adverse weather operations through innovative integration of advanced technology to include sensors, computing methods, and controls/displays. The D/NAPS program will demonstrate a representative set of capabilities which will enhance pilotage tasks (vehicle operation, communication, defensive system operation, crew/team coordination, navigation, and mission/tactical planning) during day/night adverse weather operations. The D/NAPS mission entails low-level, contour, and nap-of-the-earth flight to a destination within hostile territory while avoiding and/or surviving threats within a pre-specified arrival time window, and return to a friendly base with a specified probability of survival. The subject SBIR effort will augment the D/NAPS program as indicated below:

PHASE I: The Phase I effort shall culminate in a description of the knowledge base for a portion of the knowlege base for a portion of the D/NAPS Situation Assessment, a software development plan a D/NAPS interface description, and a test and evaluation plan.

PHASE II: The results of Phase II shall be verified software with a demonstrated capability in a software engineering environment to perform a portion of the D/NAPS Situation Assessment functions described as follows: The SA expert function shall provide a coherent and timely estimate of external objects and events based on available on-board and Command, Control, Communications, and Intelligence (C3I) sensor data. The SA fu ction shall include the assessment of threat potential and intent, obstruction avoidance and sensor utilization planning. Sensor utilization encompasses variations in sensor performance due to light levels and adverse weather phenomena and reducing susceptibility to detection. The SA function shall assess own- ship

usceptibility and vulnerability by determining threat detection and lethality zones. The rule of engagement is threat avoidance.

A90-156 Piezoelectric Vibration Cancellation System

OBJECTIVE: Develop means of active cancellation of noise and vibration associated with rotorcraft mechanical drivetrains.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Piezoelectric vibration cancellation systems have been shown to be very effective in controlling shaft lateral vibrations. Another potential application is in cancellation of noise and vibration associated with transmissions. This would require a new look at the peizoelectric actuator and high voltage amplifier to respond to higher frequencies than those encountered in shaft dynamics problems for which they were developed. Also, the vibration cancellation systems would have to contend with a broader frequency spectrum.

PHASE I: System configuration and design completion; bench validation testing of critical components.

PHASE II: System fabrication, demonstration and delivery.

A90-157 Torque Sensors for Turboshaft Engines

OBJECTIVE: Improve accuracy and reliability of torque sensing systems on Army turboshaft engines.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Magnetostrictive Torque Sensors are used on the T53 and T55 engines. In the past they have not been very reliable or at least not very accurate. For two engine helicopters the torque must be leveled to reduce the load on the combining transmission. The Army has a need for a fundamental in torque sensors that would produce a more reliable and accurate sensors.

Several new candidate torque measuring techniques have been developed recently. Improved magnetostrictive systems that are more linear and not so prone to drift as the presently used systems have been carried through advanced development. Also available for application are monopole torque measuring systems and a recently conceived capacitive system.

PHASE I: Bench test validation of torque measuring principle. Final detail design of system for engine application.

PHASE II: Fabrication, calibration and delivery of torque measuring system for turborshaft engine.

A90-158 Dynamic Stall Control

OBJECTIVE: Develop and demonstrate the ability to predict the quantitative features of retreating-blade stall on modern high- performance helicopter, using advanced computational fluid dynamics (CFD) techniques.

Provide capability to design a superior blade for increased performance, reduced vibrations, and greater maneuverability.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Dynamic stall on the retreating blade of a helicopter rotor blade produces a loss of lift; an increase in power required; increases in pitch-link loads and vibratory stresses; and in sever cases, catastrophic stall flutter. This complex aerodynamic phenomenon severely limits the performance, maneuverability, and operational limits of helicopters, but it cannot be predicted satisfactorily by any methods available today. At best, semi-empirical techniques give rough guidelines for rotors which do not deviate significantly from past designs. To improve the next generation of Army helicopters, improvements must be made in blade design, and this requires that the viscous flow fields on the retreating blade be analyzed and modified by exploiting the rapidly-advancing capabilities of supercomputers and advanced CFD codes. The flow is compressible, viscous, unsteady, three-dimensional, and subject to significant centrifugal forces, and none of these aspects can be neglected. Therefore, the numerical simulation must accurately and efficiently solve the unsteady, three-dimensional, Reynolds-averaged Navier-Stokes equations with rotating, blade-fixed boundary conditions. It must capture all the essential details of the complete viscous flow field, including the tip vortex, the vortex wake, and the stalled flow in the centrifugal field of the retreating blade, The numerical procedure must allow for complex tip geometries and innovative airfoil sections to be studied as a means of modifying and improving the stall behavior of helicopter blades.

PHASE I: Two principal results should be achieved during the Phase I study. First, innovative new three-dimensional, viscous technology should be developed and demonstrated for the relatively simpler model problem of dynamic stall on an oscillation three-dimensional rectangular wing in subsonic flow. Second, the governing equations and boundary conditions appropriate to a rotating blade should be derived, and a satisfactory explanation of how the rotating-blade formulation will be implemented in the eventual numerical code must be given.

PHASE II: The first part of the Phase I study might include preliminary validation of the numerical method by comparisons with experimental results. A more detailed validation shall be undertaken in Phase II, for which the Aeroflightdynamics Directorate experimental data will be made available. If appropriate, adjustments to the turbulence model may be made at this stage. The extension of the numerical methodology to a rotating blade in viscous compressible flow shall be accomplished, including the tip vortex, the vortical near wake, and the stalled flow in the centrifugal field of the retreating blade of a rotor in high-speed forward flight. In this phase, innovative methods of coupling the near-field aerodynamic calculation to the mid- and far-field wake should be investigated. Comparison with and validation by means of comparison with model or full-scale rotor experiments is highly desirable.

AIRMICS

A90-159 Ada Programming Support Environment (APSE) Definition

OBJECTIVE: The objective of this task is to develop and implement and APSE for the command based on the command's development, enhancement, and maintenance characteristics. APSE's should be formed for these three major domains, with emphasis on large, medium and small systems.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Numerous CASE tools have been introduced into the marketplace over the last few years. Coupled with the fact there are multifaceted functions and level of efforts within the development, enhancement and maintenance arenas for Management Information Systems (MIS), a detailed study is needed to professionally infuse tools, environments, and methodologies for each of the MIS life cycle phases into a productivelv matrix. Phase I would be to perform the research to identify tools, environments and methodologies, and produce a "how they all fit together" matrix. Therefore, in choosing an environment and a method, the appropriate tools from the matrix should dictate an appropriate APSE for an MIS/"business data processing" domain. Phase II would be to demonstrate APSEs.

PHASE I: Phase I would be to perform the research to identify tools, environments and methodologies, and produce a "how they all fit together" matrix. Therefore, in choosing an environment and a method, the appropriate tools from the matrix should dictate an appropriate APSE for an MIS/"business data processing" domain.

PHASE II: Phase II would be to demonstrate MIS related APSEs.

A90-160 Application of Neural networks to Executive Information or Support Systems

OBJECTIVE: Apply the techniques of neural networks to database retrieval, command interpretation (voice or keyboard), presentation of data, and/or determining relationships between variables for high level decision maker.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Neural networks are reported to be able to solve problems that defy the capabilities of traditional serial machines. This is an immature technology that does show promise in several application areas. At the same time, there is growing demand within the Army for the development and deployment of Executive Information Systems (EIS) or Executive Support Systems (ESS). EIS/ESS provide timely information that does not take long to collect or understand for high level decision makers. EIS/ESS provide answers to the question "What is happening in my organization now?".

PHASE I: Phase I would identify high payoff applications of neutral networks and demonstrate the usefulness on a limited problem.

PHASE II: Phase II would apply neural network techniques to the application(s) identified in Phase I to a real Army decision making environment.

Corps of Engineers

A90-161 Self-Contained Portable/Mobile Soil Testing Field Units

OBJECTIVE: The final product will be modular soil-testing technologies which can be packaged into portable/mobile field units for field testing of soil properties. Army installations and other public and private organizations will benefit from rapid, in-house analysis of soil parameters needed for environmental management and engineering purposes.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Modular technologies would be developed and packaged into application-specific, self-contained portable/mobile field units which would be used to test soil samples onsite for selected soil physical/engineering properties. Soil properties if interest include: shear strength, liquid limit, plastic limit, compaction, deformability, porosity, hydraulic conductivity, water content, capillary suction, and clay mineralogy. The purpose is to enable military engineer units, Directories of Engineering and Housing, environmental protection personnel, add training land managers to obtain in-house, reasonably accurate data needed for their missions with a minimum expenditure of time, money and technical personnel. The field unit could be combined with other existing technologies which test for particle size and chemical properties (fertility, pollutants, hazardous materials). This would give installations cost- and time-effective capability to detect and manage soil and water pollution problems, manage natural resources, and maximize success of engineering projects. The technology would also be applicable for other public and private agencies, such as the Park Service, Forest Service, University research, or private industry.

PHASE I:

a. Select specific soil properties to be tested by modular units, using new technology applications. Selection criteria include, but are not limited to:

- feasibility, given current or short-term foreseeable component technology,
- importance of soil parameter to management applications,
- estimated cost/time effectiveness of field-testing technology as opposed to laboratory technology.

b. Select one or a few possible technology approaches for each soil parameter chosen in step (a).

c. Explore possibility of incorporating existing field soil- testing technology into suite of available modules.

d. Develop the modular concept design for field units. The units could be tailored for specific applications and for different operational scales ranging from backpack size to truck-mounted field laboratory.

PHASE II: The expected product development will be a flexible modular system of soil testing capabilities, where units can be assembled according to buyer's desired applications and operational scale. This approach will allow for after-purchase replacement of single modules with upgraded ones as new technology becomes available, without requiring expensive replacement of an entire field unit. Development will include new technologies and/or new applications of existing technologies available on the market could be packaged with newly-developed capabilities. New technology development should not include re-inventing already available field testing apparatus, unless such apparatus are generally considered inadequate for desired uses.

A90-162 Laser Paint Removal

OBJECTIVE: The overall objective of this contract is to establish the ability and efficiency of paint removal from substrate with a Carbon Dioxide laser. This is a viable idea which would compete favorably with conventional paint removal techniques, such as sandblasting, with possible economic and practical superiority.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: THe current status of research in this area is the successful proof of laser paint removal feasibility as a function of the beam power densities, total surface energy and paint thickness. Research has shown that steel an masonry are ideal substrate from which to remove paint by laser. The research has not identified the ideal parametric variables to give optional efficiency, thus enabling the resolution of the practicality of this machine, and constructing a field operable unit.

PHASE I: Phase I of the project should culminate in the determination of the economic and practical feasibility (as wells the safety factors) of the laser, after having found the optimal efficiency which minimizes cost and maximizes the speed and degree of the removal of paint. Consideration should be given to the user of the laser for the removal of lead based paints from steel. (Current practice of sandblast removal of these coatings creates large volumes of hazardous waste and associated disposal costs.)

PHASE II: Phase II of the project would be concerned with developing a prototype to be used in field testing, that includes a microprocessor to control the beam of the laser.

A90-163 Ventilation Effectiveness Testing Method

OBJECTIVE: The end product will be a comprehensive testing procedure for determining the ventilation effectiveness of an HVAC system. The required instrumentation and analysis techniques must be practical for field use and suited for building commissioning.

CATEGORY: Basic Research

DESCRIPTION

GENERAL: Indoor air quality has become an increasing concern in recent years. The American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) is revising the current ventilation standard (ASHRAE 62-1981R) in order to address the issue. The increased ventilation rates proposed in the new standard may have significant impact on the design and energy consumption of HVAC systems. A practical field method of determining ventilation effectiveness will assure a healthy environment for occupants as well as facilitate the minimal amount of energy consumption for conditioning air and providing ventilation.

PHASE I: Work accomplished in Phase I will investigate current measurement technology. Emphasis will be placed on the feasibility of developing a practical device which will provide accurate information on ventilation effectiveness.

PHASE II: At the end of Phase II, a fully developed procedure including required measurement device (s) and analytical techniques will be developed. The procedure will be field tested on a variety of building types and accompanied by a complete set of documentation and instructions.

A90-164 Design Features Based Project Data Organization Model

OBJECTIVE: To develop and test the construction project data organization concept where key project data (cost estimates, specifications, and construction activities) are linked to hierarchically organized project design features (e.g., structural frame, foundation, exterior, interior, etc.). If this concept proves to be feasible, then an integrated construction information base supporting all construction disciplines is possible.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Currently, the key project data (cost estimates, specifications, quantity take-offs, construction activities) supporting the same project are prepared and maintained disjointly and independent of each other. This makes project progress monitoring and change control an extremely difficult task.

PHASE I: In this phase, Contractor will develop a design feature based project data organization concept that unifies key project data and demonstrate the concept by actually reformatting the data from a completed project. USACERL will select and actual project and furnish appropriate data.

PHASE II: This phase depends on the outcome of the work of Phase I. The essential elements of this phase is to refine and generalized the Phase I work and develop a computerized project data organization model for marketing.

CRREL

A90-165 Ice Accretion and Persistence at Unmanned Sites

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for continuously and automatically measuring atmospheric ice accretion and persistence at unmanned sites as a function of time.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Currently available instruments do not measure ice accretion load directly, but instead measure instantaneous ice accretion rates, often on a probe that is periodically deiced. Since such instruments provide a measure of the icing rate only on surfaces that are totally or nearly ice-free, they do not provide a measure of total natural ice load accumulated through several storms or throughout a season not do they indicate how long ice naturally resides on a surface (ice persistence).

Equipment is required that will reliably, automatically, and continuously measure and record atmospheric or sea spray ice load magnitudes with time on surfaces under natural or laboratory conditions. The instrumentation should be ominidirectional, and should measure rime, sea spray ice, or freezing rain without bias when it originates from any compass direction or slant angle from the horizon to the zenith. The probe or sensing elements should be interchangeable to allow different shapes or surface materials to be tested. The instrumentation should measure accurately during extremes of temperature (+25 to -40 C) and have additional design goals for a compact, inexpensive, lightweight (back packable) unit that has a high ice collection efficiency in a natural range of droplet sizes from a minimum of 5 microns and wind speeds to a maximum of 80 meters/second. These units should operate reliably in remote locations from a self-contained power supply for up to 8 months. Ice mass should be measured to a resolution of 0.1 g/cm2 of accretion surface. Measurements should be recorded in digital form at 15 minute intervals or less and should be unaffected by snowfall and by motion such as a ship's movement.

This equipment is intended for long-term measurements of ice loads on small structural elements of different shapes and orientations. Electrical transmission cables, structural steel components, antenna elements, or tree branches might be mounted on the sensing unit. An additional desirable feature would be the ability to measure ice density or thickness.

PHASE I:

a) Determine the feasibility of instrumentation to meet the above standards,
b) Develop a working "breadboard model" of instrumentation which will measure ice loads on different shapes as stated above, and
c) Develop and demonstrate calibration and validation methods to verify the proper performance of the "breadboard model."

PHASE II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product to be a validated and calibrated prototype instrument which will be used in field experiments to demonstrate the potential applications in its intended environment.

Engineering Topographic Laboratory

A90-166 Development of Automated Methods of Change Detection for combat Support Using Digital Synthetic Aperture Radar (SAR) Imagery

OBJECTIVE: The objective is to develop an automated system that will have the capability of accurately determining short term changes in digital SAR scenes in support of tactical operations. The features to be detected will be primarily man-made objects and the system will be developed on a Sun computer using the UNIX operating system and C programming language.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Battlefield commanders need to know about terrain conditions on the battlefield to include location and status of targets. They need the most up-to-date information available that can be obtained using an all weather, day/night imaging system such as synthetic aperture radar To detect changes in the enviroment/terrain, methods need to be developed that will rapidly register digital SAR imagery and determine changes in sequences of images. Steps in this process include, but are not limited to (1) data acquisition, (2) image-to-map and/or image-to-image registration, (3) feature extraction of cultural/man-made features, and (4) determination of differences between previous images and most recent images.

PHASE I efforts will concentrate on selection of suitable SAR data sets, development of methodologies to use in solving the change detection problem, determination of available or soon-to-be developed methods of image registration and preliminary demonstration of image processing methods presently suitable for change detection. Emphasis will be on low level raster processing and then raster-to-vector methods of feature extraction. Initial testing will be done using these features: buildings, bridges, and vehicles (broad category- no specific identification of type of vehicle).

PHASE II will continue with more sophisticated methods/algorithms for feature extraction and change detection. Software developed must be delivered to the government and demonstrated on-site on equipment owned by the government.

PHASE III will concentrate on adjustment, testing, and verification of software developed in Phase II.

A90-167 Detection of Long Term Changes for Updating Digital Terrain Data Bases From All Source Imagery

OBJECTIVE: The objective of this effort shall be to design, develop, test, and implement an automated system of change detection capable of detecting those military significant long-term (6 mo. to 1 yr) and/or seasonal changes. The system should provide a means of updating a digital terrain data base.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The need for timely and reliable information about military significant changes in image features plus the voluminous amount of digital imagery has created a need for automated change detection programs. Presently change detection is accomplished by time and labor intensive tasks, of which some of these can be performed best by a computer.

Phase I shall;

1. concentrate on the feasibility of automating photogrammetric processes such as, but not limited to, registration and rectification which may be required to effectively conduct change detection in two images of the same area but whose sensor parameters (direction, azimuth, depression single, etc.) may not be the same.

2. determine how image statistics such as texture, max., min., and moments may abe sued to verify changes and to screen large portions of imagery that do not contain significant changes,

3. determine the limit of how much sensor parameters may be allowed to vary between two images before severe change detection degradation occurs,

4. Develop computer algorithms for tasks 1 and 2 on a 'SUN' computer utilizing the UNIX operating system, "='C' programming language, and 'X-Windows' system.

Phase II shall concentrate on the development, testing, evaluation, verification, implementation,m and demonstration of computer algorithms for the tasks in Phase I.

A90-168 Application of Artificial Neural Networks to Object Detection from All-Source Imagery

OBJECTIVE: Identify, test and evaluate existing and/or new models of artificial neural networks (ANNs) in detecting objects in digital imagery. Develop the best model(s) into a usable system that can be trained and ideally operate in real or near Real time.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Great amount of digital imagery from various sources must be processed in near-real time to meet national defense needs. Detecting objects is especially important to maintain updated information about important regions. Artificial Neural Networks (ANNs) show great promise in the area of recognition, which directly applies to object detection. Research to date shows that ANNs can be trained can learn from their mistakes, and once trained can operate at or near real-time. ANN technology is young and merits serious inquiry and development.

PHASE I: will involve the following:

a. Review and evaluate existing ANN models, objectively comparing them on an object detection application.
b. Create new or hybrid models if any insights occur as a result of this work, and compare these new models with the existing ones.
c. Decide which model or models is the decisions is not clear-out performs best on object detection.
d. Document experiments and conclusions in a report.

PHASE II: will involve developing the best model or models into a usable system for object detection. A transportable software system will be fully developed, tested and implemented. The software documentation and necessary demonstrations/training for others to use the system will be expected at the end of Phase II.

A90-169 Mission Planning Workstation

OBJECTIVE: The objective of this effort is to develop and demonstrate a terrain based mission planning/mission management workstation that will allow battlefield commanders to effectively plan, conduct and manage tactical combat operations. The workstation will provide advanced capabilities for integrating analyzing and displaying Military Geographic Information (MGI) and terrain and intelligence products.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The tactical battlefield of the future will be highly dynamic, geographically diffuse and extremely lethal. Battlefield commanders will require detailed information about friendly and enemy force deployments, weapons emplacements and terrain and environmental conditions to plan and conduct highly mobile combat operations. Current techniques for merging and presenting this information are inadequate to support the sophisticated mission planning and mission management requirements of the tactical commander on the quick response battlefield. Recent advancements in the state-of-the-art in two-dimensional Electronic Map Display (EMD) techniques, realtime three-dimensional Computer Image Generation (CIG) techniques, Artificial Intelligence (AI) decision making capabilities, Global Positioning Systems (GPS) and Geographic Information Systems (GIS) combined with increasingly more powerful and more compact computational, display and data storage capabilities make it feasible to develop and demonstrate advanced capabilities for mission planning and mission management. The main thrust of this effort is the evaluate the capabilities that currently exist in the government and industry, develop a methodology for integrating these capabilities and to assemble a laboratory testbed for demonstrating these capabilities.

PHASE I: The first phase of this project shall consist of a six month effort to (1) determine the functional requirements for a mission planning/mission management capability, (2) assess the applicable state-of-the-art within the government and industry, and (3) develop a conceptual design and implementation plan for a laboratory demonstration capability to be assembled under Phase II. The Phase I effort shall also contain an assessment of the status of other mission planning efforts within DOD (if any) and an evaluation of the potential for fielding of these capabilities to tactical users within the next 5-10 year period.

PHASE II: Under Phase II, the contractor shall develop and demonstrate in the laboratory a workstation capable of performing the functions defined in the functional requirements and conceptual design documents. As a minimum the demonstration system should incorporate capabilities for exploitation of electronic map data, digital terrain data (DTD), satellite and aerial imagery, and environmental and intelligence data. It shall contain sophisticated GIS and AI capabilities for analyzing these data and for generating tactical decision aids and shall be capable of simultaneously generating coupled two and three-dimensional graphics in near-real-time. If feasible, it shall also contain hooks for realtime positioning of tactical assets using GPS

technology. The government will furnish as GFE electronic map display software, three-dimensional CIG software, GIS software and tactical decision aid software if desired by the contractor. The total effort for Phase II shall not exceed 24 months and shall be performed over a period of three fiscal years.

WES

A90-170 Camouflage Materials

OBJECTIVE: The objective is to develop and test low cost disposable, light weight, camouflage netting/screening materials made of natural fibrous, possibly wood fiber, materials. The material(s) should be weather resistant, chemical agent resistant, have high tensile strength, be suitable for long term storage and have, or made to have with minimum cost effective treatment(s), properties suitable for visual, near infrared, thermal infrared, millimeter and microwave camouflage signature alteration.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: Current camouflage and concealment materials, largely derived from petroleum based products, are relatively expensive (approximately $0.25 to $1.40 per foot square). There exists within the Department of Defense a critical need for a lower cost, non-strategic and renewable source of camouflage and concealment netting materials.

PHASE I: Identification of candidate materials. Phase I will include the survey, identification and collection of samples of candidate materials. Where possible, engineering and spectral properties will be determined from existing literature.

PHASE II: Development and testing. If suitable candidate materials were identified during Phase I, additional testing and development of techniques for improving their mechanical and multispectral properties will be conducted. Phase II will include field testing of prototype materials.

Army Research Institute

A90-171 Aircrew Member Task Allocation

OBJECTIVE: Develop a method for optimally allocating tasks among aircrew members (pilots and copilots) so as to control workload and improve performance.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: During the system design process tasks that must be performed for successful system operation are allocated to either the hardware or the human operator(s). Among those tasks allocated to humans, the suballocation to specific crewmembers is primarily based upon traditional pilot/copilot duties. This results in varying levels of workload being placed upon the crewmembers, such that at some times one crewmember is relatively unloaded. The proposed study would examine the allocation of tasks to crewmembers and attempt to develop a method for optimal task allocation.

PHASE I: The initial effort would be primarily a review of previous efforts (if any) at crewmember task allocation successful Phase I might: (1) find that some method exists for crewmember task allocation; (2) it appears useable in aviation settings; (3) no specific method exists, but other techniques are available, which when modified or combined could produce the desired results; or, (4) specify the process through which a method could be developed. A highly successful Phase I might also result in the demonstration of an appropriate technique (or its approximation) in a laboratory setting.

PHASE II: This phase would produce a useable method for crewmember task allocation, validated against laboratory and/or simulator performance measures. The method would be sufficiently developed and described to permit rapid transfer to systems development agencies and contractors. One possible implementation would be as a computer model which accepts task and workload listing from existing models (such as TAWL or HOS IV) and produces proposed optimal allocations.

A90-172 Cognitive and Temperament Predictors of Executive Ability

OBJECTIVE: To expand understanding of the contribution of cognitive and temperament predictors of executive performance, to (1) aid officer education policy formulation, and (2) create tools for developmental assessment of postcompany grade officers.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: The Army has a strong need for technologies to enhance the development of cognitive/conceptual skills required at senior levels of command. Convincing research evidence has now accumulated that cognitive skills are uniquely important for successful performance at higher organizational levels, and that these skills are orders of magnitude more important there than at lower levels. This is essentially in agreement with assertions made by Katz and Kahn some years ago. However, very little systematic understanding exists of adult cognitive development processes, and how they can be influenced. In addition, little understanding exists of the relation between temperament dimensions, and cognitive development. (That is, are there temperament individual differences that relate to cognitive/conceptual skill development, with intelligence held constant)? The overall project should accomplish the following: (1) develop a comprehensive statement of the current knowledge about adult cognitive development; (2) develop or identify temperament and conceptual skill measuring instruments developed; and (4) develop theoretically sound recommendations for methodologies to accelerate development of the cognitive skills required at high organizational levels.

PHASE I: The work to be undertaken in Phase I would consist of steps (1) and (2) above. The product would be a report laying out the work accomplished, the conclusions reached, and a plan for Phase II.

PHASE II: The work to be undertaken in Phase II would consist of steps (3) and (4) above. The product would be a series of research reports detailing the research findings, validated cognitive skill and temperament measurement tools, and theoretically sound recommendations for approaches to enhance cognitive skill development.

A90-173 Aids for Situation Development

OBJECTIVE: Develop computer based aids for the IEW task, situation development, that can be integrated in the AI based system currently being developed by USAICS.

CATEGORY: Exploratory Development

DESCRIPTION:

PHASE I: After gaining an understanding of the procedures required to conduct the situation development task and the cognitive limitations of the analyst performing the task, develop prototype concepts of candidate decision aids. These aids should include the graphic representation of data, methods for reducing the memory requirements of the analysts techniques for overcoming the strong tendency to regard confirming information as more important than disconfirming information.

PHASE II: Learn about the objective status, plans and design features of the situation development aid now in development at USAICS. Develop the software needs to incorporate the decision aids in the USAICS system. Evaluate the aids using MI officers and modify them as indicated by the evaluation.

A90-174 Personnel & Organizational Factors Affecting Organizational Performance.

OBJECTIVE: Phase I of this research calls for the development of a conceptual model that will articulate the interactions of personnel and organizational factors identified as affecting organizational performance. Phase II will seek to apply this conceptual model within the context of a "para-military" organization in order to "test" the effect of the model on organizational performance/effectiveness.

CATEGORY: Basic and Exploratory Development

DESCRIPTION:

GENERAL: The fields of organizational, industrial and personnel psychology have identified factors or variables that are thought to have a direct impact on the functioning/performance of organizations. Such factors as, for example, individual aptitudes, individual motivation, supervisory/leadership styles, organizational climate, personnel turnover/turbulence, have been identified as affecting the performance effectiveness of organizations. What is lacking, however, in this arena is a broad conceptual model or framework that attempts to "integrate" each of these disparate factors/variables and to apply this conceptual model or framework within the context of a demonstration project.

PHASE I: The requirement for Phase I of this SBIR program calls for the development and articulation of a conceptual model/framework that takes into account the direct and interactive effects of the identified "predictor" factors.

PHASE II: The requirement for Phase II of this SBIR program calls for the execution of a demonstration project that will apply the model developed in Phase I within an organization. Given the inherent difficulties associated with conducting such a "demonstration project" within a military unit (i.e. an Army Battalion) it is proposed that the demonstration project seek to execute the model within a "para-military" organization such as a local police or firefighting element. It is felt that the ability to "transfer the lessons learned" from such a "para-military" organization to the military will provide a "best" test of the model.

A90-175 Morale, Social Climate, and Job Satisfaction Indicators for the U.S. Army

OBJECTIVE: The objective of this research is provide a model of the climate of the Army. Normative, base-rate information is needed for tracking the climate of service members and family members over time, and for sub-group comparisons for a variety of research efforts.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: There are a number of important constructs central to organizational research on the Army for which norms have not been developed. Research on the Army has advanced by the development of unique scales for each effort or by ad hoc adaption of scales developed for civilians. Because there is often insufficient time in each research effort to develop psychometrically sound scales with normative information, and to avoid duplication of effort in separate research efforts that need to use a scale for the same construct, a handbook of measures and scales is needed by Army researchers.

PHASE I: The objectives of Phase I is the identification of constructs for which scales and norms have been developed as well as constructs for which measures are needed. Take together, these measures and scales should provide a model of the climate of the Army that covers such areas as job satisfaction, career maturity and satisfaction, morale, cohesion, organizational commitment, quality of life, family satisfaction and support, etc. Needs for, and the availability of, normed measures should be based on a review of the available civilian and military literature as well as from information gathered by interviews and/or surveys from personnel in Army and other military organizations that should have knowledge of such. The product of Phase I will be a report on (1) the psychometric properties and available (civilian, military, and Army) norms for scales which have been developed, (2) constructs for which measures are needed, and (3) a research plan for the development of needed scales complete with psychometric assessments and normative information. Plans for gathering normative information should focus on Army norms.

PHASE II: Will consist of the execution of the research plan developed in Phase I, or that portion of the plan that can be executed within available resources. Phase II products include:

a) A handbook of the scales identified in Phase I and those that are developed, scaled, and normed in Phase II.

b) A final technical report on the development, scaling, and norming of the measures as well as recommendations for future efforts.

A90-176 Measurement of the Performance of Army Tactical Units

OBJECTIVE: To establish methodology for improved measurement of performance of Army tactical units.

CATEGORY: Basic Research and Exploratory Development

DESCRIPTION:

GENERAL: The Army needs to be able to adequately measure the performance of its tactical units in order to estimate the Army's combat capability, diagnose training requirements, and determine the resources required to support training. Measurement is also essential for evaluating new weapons systems, tactics, and organizational designs. Measurement needs to address all levels from squad through battalion task force.

The Army traditionally has used mission/task analyses to establish the attributes of performance which should be trained and evaluated. While useful, by its very nature the analytic approach leads to emphasis of "fractional" parts of performance and often fails to capture the dynamic, emergent, interactive and tightly coupled aspects of unit performance. Additional approaches are needed which emphasize synthesis and more integrated, molar performance indices. the natural of such molar indices amy be suggested by the high level constructs contained in, for example, "combat fundamentals", "tenets of the airland battle", etc., described in

military history and doctrine. Alternatively or complementarily, it may be useful to apply mathematical and modeling techniques to the problem of identifying and measuring molar aspects of unit performance.

PHASE I: The objectives of this phase are to: (1) formulate hypotheses, theories, or models which identify molar aspects or attributes of unit "performance" which should be observed and measurement operations and analytic techniques which permit their testing and validation: (3) conduct analyses to demonstrate the feasibility and potential utility of the methodology. Data from the National Training Center (NTC) and Joint Readiness Training Center (JRTC) can be made available for these analyses. The final report will fully describe the process and result of this phase.

PHASE II: The objective of this phase are to validate and refine the methodology and measures. This will involve extensive application of the methodology to real data and comparison of the results with results from other methods of describing and assessing unit performance, The final report will fully describe the process and results form both phases.

Medical Research and Development Command

A90-177 Medical Countermeasure Against Low Molecular Weight Toxins

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Low molecular wright toxins, such as saxitoxin and blue-green algal toxins, have been suggested as potential threat agents. The molecular site of action of many of these toxins have been identified, e.g., binding to and blocking the sodium channel, however appropriate therapy and prophylaxis still needs to be addressed. research proposals designed to investigate potential medical countermeasures such as vaccines, antibodies or drug prophylaxis and treatment regimes are strongly encouraged.

A90-178 Monoclonal Antibodies Against Low Molecular Weight Toxins

OBJECTIVE: Develop human monoclonal antibodies against low molecular weight toxins and nerve agents.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Using novel techniques of in vitro stimulation of human spleen or peripheral cells or recombinant conversions of mouse monoclonals, produce human monoclonal antibodies with specificity for important toxins and threat agents. Analogs are available.

PHASE I: Preliminary data that the system proposed works to produce human monoclonals with desired specificity.

PHASE II: Full development of human monoclonals against a specific agent.

A90-179 Medicinal Chemistry - Synthesis of Potential Drugs Effective Against Toxic Agents of Biological Origin

OBJECTIVE: The objective is the design and synthesis of chemical compounds which potentially will prevent or counteract the toxic effects of agents of biological origin.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Toxic agents of biological origin such as botulism, anthrax, betrachotoxin, tetradotoxin, breve-toxin, anatoxin A, Ricin, etc. are potentil treat agents. There is an interest in chemical compounds which potentially will prevent (pretreatment) and/or counteract (antidote-treatment) the toxic effects of such, or any individual, agents(s). Topical 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 to the U.S. Army Medical Research and Development Command (USAMRDC) for biological evaluations. The submitted compounds are to be fully characterized and be of high purity (>99.5%).

PHASE I: Submission of potential drugs in the appropriate quantity and quality to USAMRDC for screening against the targeted threat area.

PHASE II: Submission of additional quantities and analogs of active molecules will be accomplished this phase.

A90-180 Detection, Diagnosis and Therapy for Toxin Exposure

OBJECTIVE: Develop systems to detect/diagnose toxins in biological samples. Develop pharmacologic therapies efficacious in man.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Development of means of detection or diagnosis of exposure to toxins of interest that are sensitive, specific, reliable, and rapid for field use are needed. This system should be applicable to biologic such as blood, urine or other clinically attainable samples.

Development of pharmacologic therapy efficacious prophylactically and post-exposure and safe in mans is also needed. Therapy that is effective for multiple intoxications is desirable.

Toxins of principal interest include, ricin, microcystin, palytoxin, saxitoxin and lyngbyatoxin as well as other low molecular weight, peptide, and protein toxins. Channel active toxins, pre and post synaptic toxins, and protein synthesis inhibitors are of interest.

PHASE I: Show proof of principle of systems to detect/diagnose toxins in biological samples. Show proof of principle of an efficacious pharmacologic therapy.

PHASE II: Prove either system using multiple toxins.

A90-181 Diagnosis of Natural and Induced Diseases of Military Importance

OBJECTIVE: Develop, standardize and produce systems for rapid identification and diagnosis.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: This effort is designed to provide state-of-the-art technology to develop a system for rapid identification and diagnosis of agents or diseases acquired naturally or by exposure to biological weapons. The system will provide for rapid identification of agents/diseases through examination of clinical specimens such as blood, urine, spinal fluid and throat washings. The system should be extremely sensitive, specific and reliable. There is interest in production of both monoclonal antibodies, and development and production of synthetic polypeptides for use as antigens. method utilizing labeled molecular probes for the identification and analysis of microbes or their products are also of interest.

PHASE I: Develop proof of principal of a new state -of-the-art system for identification/diagnosis of agents/diseases.

PHASE II: Prove the system using multiple agents and clinical samples.

A90-182 Medicinal Chemistry - Synthesis of Potential Antimalaria Drugs

OBJECTIVE: The objective is the design and synthesis of chemical compounds potentially orally effective against malaria.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Malaria continues to be a major health problem in many parts of the World. The utility of current drugs for the treatment of malaria is becoming less effective due to the development off drug resistant parasites. New and improved drugs are needed, especially drugs effective against resistant strains of the parasite. The emphasis is on the development of orally active drugs effective against resistant Plasmodium falciparum malaria. The compounds proposed should be based on a biological rationale and the compounds prepared are to be submitted in 3-5 gram quantities to the U.S. Army Medical Research and Development Command (USMRDC) for biological evaluation. The submitted compounds are to be fully characterized and be of high purity. (>99.5%)

PHASE I: Submission of potential drugs in the appropriate quantity and quality to USAMRDC for screening against the targeted threat area.

PHASE II: Submission of additional quantities and analogs of active molecules will be accomplished during this phase.

A90-183 Detection of antibody to, antigen of and/or nucleic acid of the virus of enterically transmitted non-A non-B hepatitis (Hepatitis E virus)

OBJECTIVE: Develop tests by which antibody to, antigen of and nucleic acid of the virus of enterically transmitted non-A, non-B hepatitis (Hepatitis E virus) may be detected in clinical and laboratory specimens.

CATEGORY: Exploratory Development

DESCRIPTION:

GENERAL: HEV has been demonstrated to be the cause of enterically transmitted non-A, non-B hepatitis in outbreaks in India, Pakistan, nepal, Mexico and the Sudan. Both virus and antibody can be detected at present using immune electron microscopy, a cumbersome and time consuming test. A immunofluorescence assay, using infected liver as the antigen, has been developed but is not widely available. A test based on immunofluorescence, enzyme-linked immunoassay, radioimmunoassay, molecular hybridization or a combination is needed to advance our efforts to manipulate this virus and perform serosurveys.

PHASE I: All work will be done in support of and in close coordination with inhouse investigators working on the same goal. A detailed research plan will be developed. using the very small quantities of antigen, antibody and infected liver available, demonstrate clear evidence of sensitive and specific detection of both. Demonstrate that the test yields appropriate results on coded specimens. Provide all necessary information and training so that Walter Reed Institute of Research (WRAIR) personnel can become expert in performance of the tests.

PHASE II: The test will be produces in quantities suitable for use in screening large numbers of serum and/or stool specimens. Large numbers of specimens will be tested. All aspects of the technology, including reagents, standards, controls, instructions will be transferred to WRAIR for further evaluation development and application.

A90-184 Expression of flavivirus genes and production of proteins suitable for testing as vaccine candidates

OBJECTIVE: Express flavivirus genes and purify protein products which are immunogenic and which protect against disease caused by flavivirus in available animal model systems.

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: Expression of flavivirus E and NS1 glycoproteins as recombinant proteins has been achieved in several systems including E. coli, baculovirus and vaccinia. THese have been evaluated for protection in the mouse model. Generally, none of the recombinants protected as well as inactivated virus. Development of a system or systems for expression of high levels (> 10 mg/liter of cells) of immunogenic, fully protective proteins is required. Possible systems include those mentioned above and any others such as yeast or mammalian cells. Any expression system used should be suitable for eventual human use in that the product(s) should be amenable to purification.

PHASE I: All work will be done in support of and inclose coordination with in-house investigators. A detailed plan will be developed. All genes, sequence information and antibodies for detection of recombinant proteins will be provided by Walter Reed Army Institute of Research WRAIR. Incumbent will engineer genes into a form suitable for expression, clone genes into high-level expression vector(s) and express the genes. Incumbent will verify authenticity of expressed proteins and their antigenicity and will provide WRAIR with known quantities of protein for immunogenicity and protection testing (at least 1 to 10 mg will be required). Proteins, which in unpurified form are as immunogenic and protective as inactivated or live, attenuated virus are desired.

PHASE II: Based upon results of protection tests, production of proteins will be scaled up for purification and protection testing of purified materials. If optimal levels (e.e. >10mg/liter) of expression are achieved and the

product is fully protective, purification of the product to a degree suitable for human use will be undertaken by the incumbent. Testing of the purified product(s) will be done by WRAIR.

A90-185 Medicinal Chemistry - Synthesis of Potential Antivesicant and Anticyanide Drugs.

OBJECTIVE: The objective is the design and synthesis of chemical compound which have potential use as drugs against the effects of vesication agents and/or cyanide poisoning.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Vesicants, especially sulfur mustard, and cyanide have recently been used on the battlefield in various parts of the World. The current course of treatment for the effect of sulfur mustard and other vesicants, and the toxic effect of cyanide poisoning are not ideal. Better drugs are needed to offset the effect of these toxic agents. Both treatment and pretreatment approaches are desired. Topical 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 g quantities to the U.S. Army Medical Research and Development Command (USAMRDC) for biological evaluation. The submitted compounds are to be fully characterized and be of high purity (>99.5%).

PHASE I: Submission of potential drugs in the appropriate quantity and quality to USAMRDC for screening against the targeted threat area.

PHASE II: Submission of additional quantities and analogs of active molecules will be accomplished during this phase.

A90-186 Ion Exchange Unit

OBJECTIVE: Produce a small water purifier based on ion exchange.

CATEGORY: Engineering Development

DESCRIPTION:

GENERAL: There is need for a device, based on ion exchange, to produce high purity water in the field from a potable water source. This device must be no larger than a 12 oz. beverage can, must have an exchange capacity of at least 1 g as sodium chloride, must produce water with a specific resistance of at least 1 megohm, and must be operable in any position (i.e., horizontal or vertical) without loss of exchange capacity (i.e., without excess channeling).

PHASE I: Phase I will require demonstration of the principle by which such a device could be made.

PHASE II: Phase II will require meeting the numerical limitations.

A90-187 Instrument to Measure the Oxygen Equilibrium Curve

OBJECTIVE: Develop an instrument to measure, record, and analyze the oxygen equilibrium curve of blood and/or hemoglobin solutions

CATEGORY: Engineering Development

DESCRIPTION:

GENERAL: No standard method is available as a commercial instrument to measure, record, and analyze the oxygen equilibrium curve of blood and/or hemoglobin solutions. Such methods have been developed in this laboratory, but only "breadboard" instruments are available. The objective of this project would be to implement existing methods in a single instrument package consisting of a thermostatted reaction cuvette, computer- controlled oxygenation and data recording and display, and evaluation of data by computer programs provided by this laboratory. This instrument would be used by laboratories evaluating the properties of hemoglobin-based red cell substitutes.

PHASE I: Construct a working version of the instrument existing in our laboratory.

PHASE II: Construct a precommercial version that could be mass- produced by a commercial vendor.

A90-188 Biologically Compatible Adhesive

OBJECTIVE: Develop a biologically compatible adhesive that will successfully maintain the adherence of a dermal dressing to moist (perspiring) skin on active soldiers working in hot humid environments without producing adverse reactions (rash, itching).

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: The adhesive should be compatible with and applied to a semi-occlusive material so that it will function successfully in keeping a dermal dressing adherent to the skin for at least three days on active perspiring soldiers. The semi-occlusive material to be used is designed to protect the underlying wound from exogenous contamination (dirt, bacteria, water) yet allow adequate air and water vapor exchange to keep the wound moist without pooled fluid accumulation and allow the skin to "breathe" so that a rash doesn't develop. The adhesive should not interfere with these properties. The adhesive should not interfere with these properties. The adhesive must be strong, water resistant, hypoallergenic. and nonirritating to skin.

PHASE I: Demonstrate the feasibility of producing a adhesive which will adhere to skin under severe humidity conditions.

PHASE II: Develop adhesive which adhers to skind under severe humidity conditions and is biocompatible and will not produce adverse skin reactions.

A90-189 Microencapsulation/Passive Dosimeter Development

OBJECTIVE: The objective is to develop a passive dosimeter badge for HC1 using the technique of microencapsulation.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Operators of military weapons systems which use perchlorate based propellant can be exposed to short term high concentrations of HC1. In order to assess the adverse health effects and predict the performance decrements associated with exposure to HC1, accurate methods need to be developed to measure the peak concentrations. Passive dosimetry is particularly attractive because of portability, ease of operation and cost considerations.

PHASE I: Various combinations of pH sensitive dyes and buffers will be microencapsulated and incorporated into a badge. These badges will be tested for response to peak concentrations of HC1 as well as real time response. When favorable laboratory results have been obtained, the next phase of the project will be initiated.

PHASE II: The HC1 dosimeter badges will be tested under field conditions in conjunction with several other techniques for monitoring HC1. If there is good agreement between the results of the HC1 dosimeter badges and those approved methods, the badges will be produced in large quantities for routine monitoring of HC1 exposure.

A90-190 Development of a Bench-top Industrial Hygiene Test Chamber

OBJECTIVE: To design and build an air-tight bench-top test chamber for generating a known built-up concentration and air dilution under controlled conditions for testing of aerosols, particulate, gases and vapors

CATEGORY: Exploratory, Advanced and Engineering Development

DESCRIPTION:

GENERAL: Many test chambers of various sizes, shapes, complexities, and designs have been custom-made for academic use in industrial hygiene training. Most of them require elaborate set up and complicated computations prior to use. A small, simple test chamber with features for dynamic dilution, controlled contaminant generation mechanism, and controlled air dilution has always been a desired industrial hygiene item. In this laboratory, such chamber can simplify efforts involved in developing field sampling techniques. The chamber can be used for generating and containing particulate and aerosols for particle size determination. Exposure situations relating to ventilation inside armored vehicles can be simulated. Efficiency of respiratory protection against certain substance of interest can be verified. In field application, the chamber can also be used as dynamic dilution chamber, offering efficient calibration of direct reading air monitoring instruments.

PHASE I: The calculation of the dynamic concentrations in a chamber of given dimension needs to be simplified and designed into the test chamber. Given a desired dilution dynamic concentration, one can follow a simple set of instructions to determine the amount of test substances needed, the rate of generation, and the rate of air flow. The substance generation and the air flow rates can be selected by adjusting the control mechanisms equipped with the chamber. THe chamber needs to be constructed of steel frame for sturdiness, of rubber seals to ensure air tightness, and of plexiglass for viewing, and with access door for testing equipment and for cleaning.

PHASE II: The test chamber needs to be field tested for a variety of industrial hygiene equipment, and the accuracy and reliability must be proved and documented.

A90-191 Development of a Rapid Field Water Microbiological Detection Capability

OBJECTIVE: Develop real time or very rapid field method to detect and quantify microbiological pathogens (virus protozoa and bacteria). Detection must be sensitive to pathogens levels which, if consumed in field water, would cause illness.

CATEGORY: Basic Research and Exploratory Development

DESCRIPTION:

GENERAL: Current preventive medicine methods for determination of field microbiological water quality are limited to detection and quantification of total coliform bacteria which has significant limitations in the detection of waterborne viruses and protozoa. The current methods require a minimum of 18 hours sample incubation before results are known. A new improved testing capability has been identified in an o&o plan titled "Family of Medical Water Quality Monitoring Equipment." This project will develop new indicators by field Army preventive medicine personnel.

PHASE I: New technologies or methods must be demonstrated to be capable of detecting and quantifying common, representative waterborne, bacteria, viruses and protozoa. Feasibility studies should show that the methods can provide answers within 60 min of the test. Methods must not require sophisticated or major analytical equipment that can only be used in a dedicated laboratory facility.

PHASE II: Expand studies to detection of all major groups of pathogenic waterborne microorganisms. Develop instrumentation or methods for use in a field environment which minimizes weight, cube, power requirements, meets RAM requirements, and is easy to learn and use by 91S MOS personnel.

A90-192 Ocular Protection from Laser Hazards

OBJECTIVE: Devise fabrication and testing

CATEGORY: Advanced Development

DESCRIPTION:

GENERAL: A requirements exists to provide ocular protection to troops at risk from laser energy exposure and ballistic fragments. The US Army is interested in research and development to improve concepts, devices and mechanisms that offer substantial ocular protection from multiple laser wavelengths without degrading essential visual performance. Techniques developed should be adaptable to standard spectacle, goggle, and visor configurations. End items should be resistant to abrasion and impact from ballistic fragments.

Particular emphasis should be given to the synthesis or development of absorbing dyes or chromophores that can be incorporated into or onto polycarbonate eyewear that reject wavelengths greater than 700 nm.

PHASE I: Identify a viable concept or device with sufficient laboratory data to demonstrate feasibility.

PHASE II: Further develop the concept of device and deliver a device for Government testing.

Army Strategic Defense Command

A90-193 Electronics Materials

OBJECTIVE: The objective of this topic is to provide the necessary advances in electronic materials in order to improve the technology base designing and developing lightweight, radiation hard, high performance electronic circuits for use in interceptors, active and passive sensors, and data/signal processing devices used in anti-satellite applications.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Novel ideas which improve radiation hardness, performance, power requirements, capability and/or weight of intergrated circuits, detectors, sensors and other electronic or electro-optical componemts are sought in areas such as: quantum- well/superlattice structures which support "band gap engineering", new organic and polymer materials with unique electronic/electro-optical properteis, microstructure waveguides, solid state lasers, optical detectors, exploitation of single crystal diamond electronic properties, and high frequency transistors.

PHASE I: This phase should demonstrate the feasibility and scientific or technical merit of the proposed idea in order to reduce the risk incurred with a Phase II effort. The demonstration should consist of an experiment or simulation that clearly shows the potential of the concept, ie..the fabrication and charicterization of a light emitting diode usu=ing new materials, novel processing or new concepts.

PHASE II: This phase should address critical issues and result in a well defined product or process ready for the commercial development of a specific application. For example: activities would consist of determining performance as a function of process variables and addressing the critical issues, which could include the intergration of, perhaps a transistor with the other elements of a logic circuit for a given application.

PHASE III: This phase should consist of applying the technology developed in the previous phase to a specific application, such as, fabricating components which would be incorporated in a neural network system for data/signal processing in an ASAT interceptor or other commercial application.

A90-194 Neural Network Software/Hardware for directed and Kinetic Energy Antisatellite (ASTA) Weapons System

OBJECTIVE: To develop new and innovative neural network algorithms and architectures that will aid in developing a real- time, economical and reliable kinetic and directedenergy antisatellite (ASAT) weapons system.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Directed Energy (DE) and Kinetic Energy (KE) antisatellite weapons system is a vital candidate system to our nation's defnse. This weapons system has a need for knowledge base systems that are economical and provide accurate information in real-time. A neural network is a computational structure modeled on biological processes. Some of the key features of the neural network are it's trainability and speed. Neural networks are a powerful tool that can increase the power of DE and KE antisatellite weapons knowledge base systems by helping the system learn faster and with less human programming. Approaches are sought to extend or improve present ASAT concepts, facilitate and reduce the cost of the concepts. Elements of the systems include but are not limited to weapons pointing, beam control, acquisition, tracking, sensor focal

planes, signal and data processing, guidance and control algorithms, control of cryo- coolers, array image processing and other ASAT system components.

PHASE I: The first phase will conclude the feasibility of the concept thru simulation and/or prototype and the applicability of the concept to ASAT weapons system. It will also show the merit of furthering the concept to a phase II.

PHASE II: The second phase will incorporate the principle developed in phase I into a prototype or show proof of principle and feasibility for incorporation into the ASAT demonstration phase commercial applications will be considered.

PHASE III: Results of Phase I and II shall lead to a Phase II that will incorporate the developed principles into a specific ASAT test application and/or lead to specific commercial application.

A90-195 Sensor Signal and Data Processing

OBJECTIVE: New and innovative approaches offering order-of- magnitude improvements to sensor signal and data processing performance, power, weight, size, and cost are desired.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Modern sensors produce vast amounts of electronic signal information which must be processed quickly and accurately to perform surveillance and target tracking functions. Signal processing of the sensor data is first performed to identify object detections. Data processing is then performed to handle target tracking and other high level functions. Advances are needed both in hardware architecture and in algorithms to handle nuclear effects mitigation, structured background removal, object dependent processing, and multiple target tracking.

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 to the components. This will include design and simulation of the improvement and proof of its technical merits.

PHASE II: Phase II will develop the signal or data processing improvements from Phase I for a more detailed simulation/prototype demonstration of the advantages of the resulting hardware or algorithm.

PHASE III: This Phase will involve the application of the processing innovation to real systems with possible industry or government cooperation. The product that emerges from the Phase I and II research shall such that in Phase III either more research is required to finalize the development or it is ready to be introduced into the ASAT demonstration program and/or introduced into the private sector commercial market.

A90-196 Optical Computing and Optical Signal Processing Technology

OBJECTIVE: Develop innovative optical materials, devices, components, architectures, and algorithms that will advance the technology. The innovative concept shall lead to a product that will increase performance for a specific function and/or reduce the power, weight, size, etc., of a component required by the ASAT system. this can be in any aspect of BM/C3, surveillance, acquisition, trck or kill assessment, etc.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Orders of magnitude advancement in performance is needed in hybrid opto-electronic and in all optical computing and signal processing systems. This requires new and significantly enhanced nonlinear materials and photonic devices; acousto and electro-optic components; optically and elctronically addressed SLMs and array processors; holographic techniques; reconfigurable interconnects; massive fan-in/fan-out and tectures. Applications include neural-network processors as well as general-purpose analog and digital computers and special-purpose coprocessors.

PHASE I: The results of this effort will provide proof-of- concept feasibility by means of preliminary design, simulation, and laboratory experimentation. The product should e directly linked to some subsystem of the ASAT program and have potential commercial application.

PHASE II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working, but not necessarily optimized, bread-board model. Consideration must be given to, and direct application shown, for improvement to some element of the ASAT program. Phase II must provide insights into the Phase II program which can be further government funded development (a procurement) or private sector commercialization.

PHASE III: This effort will be the commercialization, as well as military application in missile interceptors and satellites, of high-density high performance optical signal and data processing systems or subsystem.

A90-197 Robotics and Artificial Intelligence

OBJECTIVE: The objective of this research is to explore innovative, novel decision aid concepts and robotic technology for ASAT application including the BM/C3 functions.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Innovative ideas for research designed to enhance an ASAT system decision making capability under severe environments are sought. Also, innovative concepts for robotic techniques which will either aid in the maintenance of a deployed ASAT system or in the manufacture of components for an ASAT program are requested. Genetic algorithms and other self adapting concepts which both reduce the time required to reach a decision and improve the decisions made are of particular interest.

PHASE I: During this phase, an innovative concept will be investigated and feasibility established via mathematics, computer simulation, prototyping or a combination of these. The concept must be shown to lead to a product that can go into a Phase II and have potential for a Phase III.

PHASE II: A robotic technique or AI concept must be developed towards a clearly identified ASAT requirement. It must further be shown to have the potential for commercialization for either or both the government not the private sector. A robotic manufacturing demonstration, or a demonstrated expert decision system for the BM/C3 function are examples of a Phase II program.

PHASE III: The results of Phase I and Phase II will be integrated within an ASAT system that will be used in an actual ASAT demonstration and validation experiment/or lead to a specific commercial application.

A90-198 Computer Architecture, Algorithms, and Languages

OBJECTIVE: Demonstrate novel or innovative approaches for ground and space computer architecture, algorithms, and language to support target acquisition, tracking, classification/discrimination, kill assessment, and battle management/command, control, and communication (BM/C3).

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The U.S. Army is pursuing the development of a kinetic energy antisatellite (ASAT) vehicle. The ASAT program includes both ground support and interceptor vehicle. This surface based ASAT program demonstrates current technology and will initiate product improvements as new technology becomes available. In support of this program, the following areas of interest are identified.

Computer architecture shall improve processing speed, be parallel or distributed in layout, be more secure, with increased fault- tolerant capabilities, and have higher reliability. Algorithms shall increase data processing with fault tolerance; incorporate neural, artificial intelligence, or other "learning" techniques; or implement novel numerical techniques. Languages shall optimize operating systems for computer architectures, demonstrate improved man-machine interfaces, and allow for easy software updates and system testing.

PHASE I: To investigate and analyze the various approaches toward solving a particular problem area and recommend a single defined method. The method should be based on innovative concepts that will provide benefits to the ASAT program.

PHASE II: To determine the Phase I method through a design, fabrication and/or encoding, and testing. During demonstration, the procedures to implement the method, schedules, resource requirements, and testing are documented and evaluated. Periodic testing provides a means of assuring that method can be successfully implemented.

PHASE III: This phase shall lead to components or systems that can be integrated into the ASAT prototype or demonstration program. Also, this phase should provide new products for civilian markets based on the technology transfer.

A90-199 Laser Communications

OBJECTIVE: Research technologies which will enhance the feasibility of a laser communications network for elements of the ASAT program.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: A critical element of the ASAT program is a communications network. Highly desirable characteristics of a communications network are: high data rate, high resistance to jamming, rapid acquisiton and tracking, switchable links, wide field of view, and secure links. This program is structured to explore the relevant technology areas which support laser communications links. These support technology areas include, but are not limited to: lasers, laser beam steering/control; modulation techniques/systems; receiver techniques/systems; and networking concepts.

PHASE I: New and innovative concepts are sought which will enhance the feasibility of laser communications links/networks. The Phase I effort should be structured to determine the feasibility of the proposed concept by the end of the Phase I performance period.

PHASE II: After the feasibility of the proposed concepts has been established in Phase I, the evolution of the concept will be continued during the Phase II effort. The concepts will be implemented in software/hardware to demonstrate the engineering feasibility of the concept and any critical engineering bottlenecks will be addressed and solved.

PHASE III: Following a successful Phase II effort, proposed concepts should have evolved to the point that full scale engineering development can begin to incorporate the concepts into a firm design as a component or major subsystem of a laser communications link/network.

A90-200 Propulsion and Propellants for ASAT

OBJECTIVE: Develop innovative propulsion materials, devices, and components to provide substantial performance improvement and weight/volume reductions for kinetic energy weapons that utilize solid propellant rockets or hybrid liquid-solid energies.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Orders of magnitude advancement in performance is needed in advanced rocket propellant materials, motor cases and nozzles, and processing technology. This requires new and significantly enhanced energetic polymers, novel oxidizers; high strength to weight materials for rocket motors and nozzles; miniaturized devices and components, and improvement in automation science for chemical processes that contribute to safe mixing and flow of inprocess, highly toxic and energetic propellant ingredients.

PHASE I: The results of this effort will provide proof of concept feasibility by means of preliminary design, simulation, and laboratory experimentation.

PHASE II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working preliminary breadboard model.

PHASE III: The hardware should be developed to the stage where it can be demonstrated in a flight test.

A90-201 Nuclear and Non-nuclear Power and Power Conditioning

OBJECTIVE: The goal of this program is to provide advanced, light-mass, compact nuclear and non-nuclear power sources for ground and space based components of the ASAT system.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Both steady-state and burst models of power, ranging from kilowatts to megawatts, will be required. This will include high-efficiency energy conversion cycles, high performance thermal management concepts and other power related technologies. High energy density systems are required for sustained power

but innovative concepts that deliver extremely high power pulses in short periods of time for weapons systems will also be considered.

PHASE I: The results of this effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

PHASE II: The results of this effort will include detailed design, fabrication, evaluation of a working, but not necessarily optimized, breadboard or brassboard model.

PHASE III: The results of this effort will include hardware or components developed to a state where they can be demonstrated in a flight experiment.

A90-202 Sensors, Detection, Tracking and Kill Assessment

OBJECTIVE: The objective of this program is to develop innovative sensors and related technologies for the ASAT program.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The objective of this program is to develop innovative sensors and related technologies for the ASAT program. Sensors and their associated systems will function as the "eyes and ears" of an ASAT system providing target detection, target tracking and kill assessment. New and innovative approaches to these requirements using advanced concepts are encouraged across the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for acquiring and tracking targets against a variety of backgrounds are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the areas to be addressed are: advanced focal plane arrays, range- doppler ladar and radar, imaging (different wavelengths), improvement of detector efficiency, sensor fusion, gamma, x-ray and neutron detection, detection, agile lasers, radiation sources, and countermeasures to sensor of are sought. Entirely new concepts as well as those significantly improvements are solicited.

PHASE I: The results of this effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

PHASE II: The results of this effort will include hardware or components developed to a state where they can be demonstrated in a flight experiment.

A90-203 Materials and Structures

OBJECTIVE: Development ofg advanced materials that fall into the following categories: metallic and nonmetallic composites, electronic and optical, diamond technology, space structures, superconducting, optical, and nuclear hard components.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: The objective of this program is to develop advanced materials useful for systems applications. ASAT system requirements emphasizes lightweight, nuclear hard high power hardware and components. These diverse needs will benefit from the development and incorporation of advanced materials into all aspects of the ASAT program, including ground support, surveillance, and terminal kill.

PHASE I: The results of this effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

PHASE II: The results of this effort will include detailed design, fabrication, evaluation of a working, but not necessarily optimized, breadboard or brassboard model.

PHASE III: The results of this effort will include hardware or components developed to a state where they can be demonstrated in a flight experiment.

A90-204 Directed Energy

OBJECTIVE: Develop innovative concepts for materials, components, design or architectures that will enhance the state of technologies for directed energy.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Orders of magnitude advancement in energy, on target propagation, beam control, target interaction and kill assessment are needed. Advancements in the areas of high-energy lasers, particle beams, microwaves or other directed energy devices are needed. Major enhancements in component technology such as: ion sources, beam control devices, accelerators, neutralizers, optics, amplifiers, lasing materials, and plasmas are requested.

PHASE I: The results of this effort should prove feasibility through calculations, simulations, designs and preliminary experiments.

PHASE II: The results of this effort will include the detailed design, fabrication, demonstration, and testing and evaluation of a working preliminary breadboard model.

PHASE III: The hardware should be developed to the stage where it can be demonstrated in a flight test.

A90-205 Surveillance and Early Detection

OBJECTIVE: Develop innovative sruveillance and early detection sensors, devices, materials, components and architectures to advance the technology.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: Advances in surveillance and detection platforms, sensors, components, materials and architectures are needed. Significant evolutionary or revolutionary improvements in concepts or technology are required. Examples of ares to be explored are active and passive sensors, staring arrays, advanced radar concepts, surveillance plkatform concepts, advanced optics, detector materials, cryocoolers, platform stabilization and sensor pointing.

PHASE I: The results of this effort will provide evidence of concept feasibility through preliminary design, calculations, modeling and preliminary experiments.

PHASE II: The results of this effort will include detailed design, fabrication, demonstration and testing of a working, but not necessarily optimized breadboard model.

PHASE III: Hardware or component should be developed to a state where it could be demonstrated in a flight experiment.

A90-206 Kinetic Energy Concepts and Technology

OBJECTIVE: Defense against satellites requires a highly efficient interceptor system. The goal of this research is to investigate and exploit concepts for advancing the state of the art in kinetic energy technologies.

CATEGORY: Basic Research

DESCRIPTION:

GENERAL: This program will focus on developments in all technologies, systems, and subsystems which may be utilized in ground, air, and space-based satellite interceptors. Propulsion, airframe and materials, guidance, control, and warheads are the principal subtechnologies of prime interest.

PHASE I: The Phase I effort will provide proof of principle reasonability by means of preliminary design, simulations, and/or laboratory experimentation.

PHASE II: The Phase II effort will build upon the feasibility of the Phase I results to provide demonstration through design, fabrication and testing of a breadboard/brassboard model.

PHASE III: Hardware or component will be developed to the flight demonstration state.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of the Chief of Naval Research. The Navy SBIR program manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR program manager's attention and should be addressed to:

Office of the Chief of Naval Research
ATTN: Mr. Vincent D. Schaper, Navy SBIR Program Manager
800 North Quincy Street, BCT #1, Room 934
Arlington, VA 22217-5000
(202) 696 4286

The Navy has identified 310 technical topics to which small R&D businesses may respond. A brief description of each topic is included along with the address of each originating office. This information is contained on the ensuing pages.

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's mission is to maintain the freedom of the open seas. To that end the Navy employs and maintains air, land and ocean going vehicles and personnel necessary to accomplish this mission. The topics on the following pages provide a portion of problems encountered by the Navy in order to fulfill its mission and are an increase over previous years.

Selection of proposals for funding is based upon technical merit and the evaluation criteria contained in this solicitation document. Because funding is limited the Navy reserves the right to limit the amount of topics funded under any topic and only those topics considered to be of superior quality will be funded.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Topic Nos. N90-001 through N90-010

Administrative SBIR Contact

Mail/Handcarry Address:

Office of Naval Research
Attn: ONR Code 1131M, Room 607
SBIR Program, Topic No. N90-____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5000

Dr. D. Polk
(202) 696-0283

Topic Nos. N90-011 through N90-020

Mail/Handcarry Address:

Office of Naval Technology
Attn: ONT Code 20T, Room 502
SBIR Program, Topic No. N90-____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5000

Mr. D. Harry
(202) 696-4453

Topic Nos. N90-021 through N90-044

Mail Address:

Commanding Officer
MCRDAC, SBIR Program, Topic No. 90-____
Amphibious Warfare Technology Directorate
Quantico, VA 22134-5080

Mr. J. Johnson
(703) 640-2761

Handcarry Address:

MCRDAC, SBIR Program, Topic No. N90-____
Amphibious Warfare Technology Directorate
Lucas Hall, Room 9
Marine Corps Base
Quantico, VA 22134-5080

Topic Nos. N90-045 through N90-049

Mail Address:

Commander
Space and Naval Warfare Systems Command
Department of the Navy
Attn: SPAWAR 10D, SBIR Program, Topic No. N90-____
Washington, DC 20363-5100

Ms. B. Geesey
(202) 692-6091

Handcarry Address:

Space and Naval Warfare Systems Command
National Center #1, Room 1E58
2511 Jefferson Davis Highway
Attn: SPAWAR 10D, SBIR Program, Topic No. N90-____
Arlington, VA 22202

Topic Nos. N90-050 through N90-057

Mail Address:

Commander
Naval Supply Systems Command
Department of the Navy
Annt: PML-5505, SBIR Program, Topic No. N90-____
Washington, DC 20376-5000

Ms. L Whittington
(202) 692-2554

Handcarry Address:

Naval Supply Systems Command
Attn: Code PML-5505, SBIR Program, Topic No. N90-____
Crystal Mall #3, Room 515A
1931 Jefferson Davis Highway
Arlington, VA 22202

Topic Nos. N90-058 through N90-059

Mail Address:

Commanding Officer
Naval Medical Research & Development Command
Code 402 SBIR Program, Topic No. N90-____
Bethesda, MD 20814-5044

Commander R. Wolf
(202) 295-1131

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INDEX
DEPARTMENT OF THE NAVY
FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

OFFICE OF NAVAL RESEARCH

N90-001 Signal Processing Using Artificial Neural Networks (ANN)

N90-002 Image Compression

N90-003 Ground Based Remote Sensors

N90-004 Compact Underwater Autonomous Laser Doppler Velocimeters for Use in Shallow Water Environments

N90-005 Expendable Particle Sensor

N90-006 Ferroelectric Nonvolatile Radiation-Hard Memories

N90-007 Sacrificial Electrodes

N90-008 Neural Networks for Autonomous Motor Control

N90-009 Metal-Ion Selective Sensors

N90-010 Focused Ion Implantation for Optoelectronic Integrated Circuits

OFFICE OF NAVAL TECHNOLOGY

N90-011 Noise Reduction System for Shipboard Spaces

N90-012 Tactical Data Quality

N90-013 Efficiency Enhancement of Impact Avalanche and Transit Time (IMPATT) Diodes

N90-014 Integrated Planar Magnetics for High Power Density Electronic Power Supplies

N90-015 Advanced Materials Technology for Electronic Component Applications

N90-016 Naval Applications of Massively Parallel Processing

N90-017 Low Cost Underwater Acoustic Sensors

N90-018 Automated Lithium Liquid Metal Handling Station

N90-019 Seismic Detection of Buried Mines

N90-020 Coated Boron Particles

U.S. MARINE CORPS

N90-021 Application of Neural Networks to Amphibious Command and Control

N90-022 Joint Operations Interoperability System for Marine Corps Communications/Information/Command and Control (C^3I) System

N90-023 Multi-level Security System for Amphibious Operation Command and Control

N90-024 Integral Electric Motor/Waterjets for High Speed Amphibians

N90-025 Interchangeable Motor and Alternator Electrical Rotating Groups for High Speed Advanced Assault Amphibians Vehicles (AAAV)

N90-026 Compressible Fluid Strut for Wheeled Vehicles

N90-027 Engine Cylinder Bank Deactivation

N90-028 Lightweight Cooling Component Development

N90-029 Lightweight/High Power Density Engines

N90-030 Lightweight Air Compressor

N90-031 Mobile Water Production by Extraction of Atmospheric Moisture in Desiccant

N90-032 Polymeric Cartridge Cases

N90-033 Standoff Minefield Marking for Very Shallow Water (VSW) Surf Zone, and Beach

N90-034 Use of Neural Nets in Predicting Personnel Attrition

N90-035 Focal Plane Filters for Infrared (IR) Detector Array

N90-036 Study to Obtain a Simulant for Testing VX Conversion Filters

N90-037 Test Kit Development for Agents of Biological Origin

N90-038 Study of Stability of Fluorinating Reagents on Various Membranes/Filters

N90-039 Fiber Optic Weapons Sight

N90-040 Air Permeable Sorbent Fabric Systems Based on Adhered Sorbent Particle

N90-041 Air and Water Vapor Permeable/Aerosol and Liquid Impermeable Shell Fabrics for Chemical Protective Garments

N90-042 Hand Held Mine Detector Imager/Discrimination

N90-043 Diversion Device/Incapacitant

N90-044 Mechanical Breaching Device

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N90-045 Force Level Analysis Tool Support and Software Module Development

N90-046 Advanced Systems and Concepts for Future Naval Warfare

N90-047 Non-Acoustic Underwater Imaging

N90-048 Non-Acoustic Submarine Tactical Communications

N90-049 Warfare Systems Architectures

NAVAL SUPPLY SYSTEMS COMMAND

N90-050 Artificial Intelligence System for Source Code Compliance to Data Rules

N90-051 Central Management of Multi-Site ADP Capacity Planning

N90-052 Integrated Users Support System for Shipboard Uniform Automated Data Processing System (SUADPS) Resystemization

N90-053 Automated Aid for Hazardous Material Control

N90-054 Extreme Cold Weather and Fuel Resistant Protective Handware

N90-055 Indexing of Technical Information for Computer Aided Acquisition and Logistics Support (CALS)

N90-056 Durable Press Finish for Fire Retardant Treated (FRT) Cotton Fabric

N90-057 Reverse Program Data (RPD)

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND

N90-058 Recombinant DNA Cloning of Enzymes Essential for the Enzymatic Removal of Carbohydrate Antigens from Human Erythrocytes for the Production of Type "O" Red Cells from Type "B" Cells

N90-059 Production of Biosensor Based Techniques and Equipment for Essential Clinical Assays to be Performed in the Military Field Environment for Combat Casualty Care

NAVAL AIR SYSTEMS COMMAND

N90-060 Coating System for High Temperature Titanium Alloys

N90-061 Assessment of Heat Damage in Composite Materials

N90-062 Remote ASW Sound Sources

N90-063 Anti-Jam Methods for RF Receiver

N90-064 ASW Non-Acoustic Sensors

N90-065 Low Probability of Intercept Anti-Jam (LPI/AJ) Voice/Data Link

N90-066 Optical Fiber Compatibility with Advanced Electronic/Structural Materials

N90-067 Long Duration Performance of Aircraft Inertial Navigation System

N90-068 Impact of Using Dispersed Sensors for Navigation

N90-069 Passive Fiber Optic Components for Severe Environments

N90-070 Portable Koalas: The Knowledgeable Observation-Analysis Linked Advisory System

N90-071 Innovative Graphics Architecture Concepts for Advanced Simulators

N90-072 Detection of Wideband Radar Signals

N90-073 Passive Non-Cooperative Target Recognition Sensor

N90-074 Secondary Sensor for Anti-Radiation Missiles

N90-075 Improved Infrared Search and Track (IRST) Sensor

N90-076 Electro-Optic-Infrared (EO-IR) Sensor Application in Anti-Air Warfare

N90-077 Buffet Vibration Absorber

N90-078 Operational Exploitation of Active and Passive Sensor Information by U.S. Navy Tactical Aircraft Operating in a Multi-Platform Tactical Situation

N90-079 Automation of Digital Data Review and Verification

N90-080 Minimization of Environmental and Health Hazards Through the Use of Innovative Materials and Maintenance Process

N90-081 Probability of Flaw Detection for Non-Destructive Inspection of Advanced Materials

N90-082 Ferrite Choke for Cartridge/Computer Aided Design (CAD) Application

N90-083 Automated Integration of Reliability Centered Maintenance (RCM) Analysis with the Logistics Support Analysis Record (LSAR)

N90-084 Automated Integration of Level of Repair Analysis (LORA) with Logistics Support Analysis Record (LSAR)

N90-085 Aircraft and Engine Preservation Techniques

N90-086 Automated Technology for Conversion of Existing Paper Technical Manuals into a Form Suitable for Interactive Electronic Display

N90-087 Standardized Interactive Electronic Presentation of Weapon-System Troubleshooting

N90-088 Automatic Diagnostic Link Between Aircraft and Their Avionics Systems, and Automated Maintenance Aids

N90-089 Fretting Damage Detection Device

N90-090 Wall Thickness Measurement Technique for Turbine Blades and Fuel Nozzles

N90-091 Digital Imagery Verification System

N90-092 Interoperability of Navy Range Operations with Air Traffic Control Facilities of the Federal Aviation Administration (FAA)

N90-093 Mini-Air Surveillance Radar Tracker and Identify-Friend-or-Foe System (MASURATI)

N90-094 Microminiature Filter Techniques

N90-095 Automated Feature Extraction and Pattern Recognition Algorithms

N90-096 Microwave Powered System for High Altitude Long Endurance (HALE) Aircraft

N90-097 Turbine Engine Response Design Sensitivities

N90-098 Determination of Critical Parameters in Airborne Early Warning

N90-099 Multiple Chaff Cartridge "SQUIB"

N90-100 Activated Metal Decoy for Low Infrared (IR) Signature Aircraft

N90-101 Multispectral Electro-Optical/Infrared Real Time Sensor

N90-102 Emission Location System for Cuing of Standoff Electro-Optical Sensor

N90-103 Electronic Soldering Quality Improvement

N90-104 Aircraft Survivability and Mission Analysis Computer Model

N90-105 Extending Tactical Sensors Through the Use of Signal Enhancement

N90-106 Marine Attack Helicopter Night Targeting System Training System

N90-107 Four-Bladed Main Rotor System for Marine Attack Helicopters

N90-108 Integrated Strike Planning System Evolutionary Upgrade-General Purpose Explanation Capability for Knowledge-Based Support Systems

N90-109 Total Quality Management (TQM) Control Criteria Applied to Long Term Test Programs

N90-110 Software Maintenance Cost Estimating

N90-111 Self-Protect Weapon Seeker Enhancement

N90-112 Measurement of Airborne Surface Search Radar Performance Characteristics

N90-113 Operational Support Aircraft Management Planning System

N90-114 Sensor Fusion for Non-Cooperative Target Recognition (NCTR)

N90-115 Pulsed Power for Underwater Neutralization

N90-116 Underwater Towed System Monitor

N90-117 MV-22/HV-22 Weapons Systems Integration and Armament Control

N90-118 Ribbonized Organized Integrated Electrical Wiring Interconnect System for the V-22 Osprey

NAVAL SEA SYSTEMS COMMAND

N90-119 Gateway Processors for Information Systems

N90-120 Next Generation Radiation Detection Indication and Computation Equipment (RADIAC)

N90-121 Shipboard Communications Systems Network Model

N90-122 Submarine Quiet Announcing Systems

N90-123 Shipboard Non-Detectable Portable Communications Systems

N90-124 Translation of Interface Design Specifications (IDS)/Protocols into Mathematical (Boolean) Expressions

N90-125 Development of Transducer Coatings with Low Volatile Organic Compound

N90-126 Non/Low Magnetic Signature Engines

N90-127 Acoustic Propagation Path Determination

N90-128 Azimuthal Noise Variation Effects

N90-129 MIL-STD-480B Expert System Tool Compound

N90-130 Shipboard Medical Waste Treatment System

N90-131 Non-Vapor Compression AC System

N90-132 Integrated On-Line Reliability and Maintainability (R&M) Design Program

N90-133 Rotational Propulsor Concepts for Surface Ships

N90-134 Ship Design Tools - Measures of Effectiveness

N90-135 High-Efficiency Thermoelectric Material

N90-136 Fiber Optic Current and/or Voltage Sensor

N90-137 Composite Flexible Pipe Coupling for Surface Ships

N90-138 Cavitation Suppression Technologies for Surface Ship Propulsors

N90-139 Novel Materials for Shipboard Fire Barrier Applications

N90-140 Realizing the Potential of Total Platform Sensor Data Fusion

N90-141 Shipboard High Speed Optical Data Transport Network (HSODTN)-Compartment Area Network (CAN)

N90-142 Ice Phobic Coatings for Ship Antenna Applications

N90-143 Non-Corrosive Composites for Electromagnetic Interference (EMI) Shielding Applications

N90-144 Equipment Readiness Status Monitor and Recorder (RSMR)

N90-145 Microwave Monolithic Transmitter/Receiver Designs for Naval Electronic Warfare

N90-146 Versatile Signal Recognizer

N90-147 Deinterleaving Pulse Trains in Severe Multipath Environments

N90-148 High Power, Short Pulse Jammers

N90-149 Radiometric Detection of Targets at Sea

N90-150 Tailoring Tool for Assuring Effective Reliability/Maintainability/Quality Assurance (R/M/QA) Clauses in Acquisition Documents

N90-151 Testing of Shipboard Electronic Warfare (EW) Equipments

N90-152 Passive Ranging with Limited Data

N90-153 The Use of Artificial Intelligence for Torpedo Detection

N90-154 Neural Networks for Torpedo Detection

N90-155 Preset Capability for Expendable Countermeasure Devices

N90-156 Automatic Radar Scan Recognizer

N90-157 High-Efficiency Low Noise Hovering Systems for Underwater Devices

N90-158 Low-Noise Microwave Receiver Using High Temperature Superconductors

N90-159 Advanced Machinery Monitoring Sensors

N90-160 Undersea Fiber Optic Communications Network

N90-161 Pressure Compensation Systems for Moving Coil Projectors

N90-162 High Order Spectrum Applied to Time Delay Estimation

N90-163 Automated Groundwave Recognition for High Frequency (HF) Communication

N90-164 High Frequency, High Power Transparent Transducer

N90-165 Electronic Precision Focusing for the Type 18 Periscope

N90-166 Pulse Power Supply for Submarine Electromagnetic Launch

N90-167 Directional Hydrophone for Acoustic Towed Arrays

N90-168 Non-Electronic Shipboard Systems Diagnostic Concepts

N90-169 Wave Characterization System

N90-170 Inflatable Craft Design Developments and Improvements

NAVAL SURFACE WEAPONS CENTER/WHITE OAK

N90-171 System Design Methodology for Massively Interconnected Models

N90-172 Statistical Testing of Model Hypothesis in Binomial Regression

N90-173 Improved Methods for the Manufacture of Pentafluorosulfanyl Components

N90-174 Discontinuously Reinforced Magnesium for Missile Components

N90-175 Phased Array Antenna

N90-176 Detection of Hidden Corrosion Under Aircraft Skin

N90-177 Nonlinear Transforms for Optical Signal Processing

N90-178 Embedded Training Capability for Afloat Cryptologic Systems

N90-179 Cryptologic Expert System Man-Machine Interfaces (MMIs)

N90-180 Distributed Operating System Design Assistant

N90-181 Modeling of the Human Decision Maker in Support of Command/Control/Communication/Information (C^3I)

N90-182 Optical Neural Networks

N90-183 Advanced System Architecture for Target Tracking and Recognition

N90-184 High Energy Melt-Castable Explosive

N90-185 Acousto-Optic Signal Processing

N90-186 Advanced Damage Model Development

N90-187 Design Guidelines for Touch-Sensitive Screens

N90-188 High Speed Photodetector Switching to Avoid Backscatter

N90-189 Crack Detection in Explosives and Rocket Motor Propellant

N90-190 Time-Resolved Radiation Diagnostics for 0.6-1.3 Mev Peak Bremsstrahlung (X-Ray) Generators

N90-191 Stable Silver Oxide (AgO) Battery Electrodes

N90-192 Active Mine Batteries with Long Shelf-Life

N90-193 1750A Microprocessor Optimized for Low Power Digital Signal Processing

N90-194 Development of High Energy Density, Pressure Tolerant Batteries

N90-195 Unmanned Aerial Vehicles (UAV) Compatible Sensor, Processing, and Communication Systems

N90-196 Electronic Cooling System Electrolytic Corrosion

N90-197 Development of Test Methods for Graphite Fibers

N90-198 Electronic Safe and Arming Devices

N90-199 Infrared Background/Clutter/Target Signature Model

N90-200 Advanced Automatic Target Recognition Techniques for Infrared Search and Track (IRST) Systems

N90-201 Synthesis, Chemistry and Reactions of Energetic Phosphazenes

N90-202 High-Speed Launcher for Fragment Simulator

N90-203 Procedures for the Design of Software Controlling Systems

N90-204 Ruggedized Fiber Optic Switch

N90-205 High Power Fiber Optic Sources

N90-206 Laser Initiation of Secondary Explosives

N90-207 Theoretical Study of "Cold Fusion" Using Quantum and Statistical Mechanics

N90-208 Development of High Power Microsecond Two-Stage Free Electron Laser Source

N90-209 Programmable Linear Digital Beamformer

N90-210 Thin-Wafer Components for Thermal Battery Cells

N90-211 Non-acoustic Underwater Influence Sensors

NAVAL WEAPONS SUPPORT CENTER (CRANE)

N90-212 Radiation Hardened Robot Positioner for Test Samples in Proton Experiments

N90-213 Instrumentation for Logic Upset Detection in Transient Environments

NAVAL WEAPONS CENTER/CHINA LAKE

N90-214 Optical Component Measurement for Multispectrum Guidance

N90-215 High Temperature Radome Adhesives

N90-216 Optimized Antennas for Multispectrum Guidance

N90-217 Infrared (IR) Background Modeling and Analysis

N90-218 Spectral Analysis of Stray Light

N90-219 Multispectrum Guidance Target Generators

N90-220 Passive Fuel Vapor Detector Device

N90-221 Measurement of Explosive Outputs Electronically

N90-222 Safe-Arm Indicator for In-Line Fuzes

N90-223 Electronic Retard Sensor for Bomb Fuzes

N90-224 Long Wave Infrared Nonmechanical Electronic Scan

N90-225 Solid Fuel-Air Explosive (FAE) Detonation Mechanism Model

N90-226 Compaction and Rapid Dispersion of Powdered Fuels

N90-227 Replication of Aircraft Structure for Ballistic Vulnerability Testing

N90-228 Inertial System Expert System

N90-229 Determine the Aggregate Heat Transfer Coefficient into Objects within an Expanding Supersonic Rocket Plume

N90-230 Laser Brazing Ceramics to Metals

NAVAL AIR DEVELOPMENT CENTER

N90-231 Applications of Anti-Jam (AJ) Direct Sequence Spread Spectrum (DSSS) Waveforms to High Frequency (HF) Communications

N90-232 Multi-Tadil Task Force Connectivity/Communication Systems Capacity Processor

N90-233 New Techniques to Enhance Anti-Jam (AJ) in Spread Spectrum Communications

N90-234 Constraints and System Primitives in Designing Operating Systems for Real Time Distributed Warfare Systems

N90-235 Global Positioning System (GPS) Specification for Shipboard TACAN Replacement

N90-236 Machinability of AF1410 High Strength Steel

N90-237 Cognitive Workload Measurement Device

N90-238 Thermographic Non-Destructive Evaluation

N90-239 Drag Reduction on an Ejection Seat During High Speed Ejection

N90-240 Design for Pre-Tensioning Restraint Straps for Crash Protection

N90-241 Elastomeric Pitch Link Bearings for Helicopter Rotor Heads

N90-242 Airborne Low Frequency Sonar Cable

NAVAL UNDERWATER SYSTEMS CENTER

N90-243 Periscope Laser Eye Protection

N90-244 Single-Sided Flextensional Transducer

N90-245 Single-Sided Electrodynamic High Power, Underwater Projector

N90-246 Turbulent Boundary Layer Drag Reduction

N90-247 Live Plankton Characterization in Fluid Flow

N90-248 Multi-Line Array Retrieval and Stowage System

N90-249 Prelaunch Electric/Acoustic/Optic Communications

N90-250 Development of Miniature High Temperature, High Pressure Steam Throttle Valve

N90-251 Automated Sound Velocity Profiler

NAVAL AIR ENGINEERING CENTER

N90-252 Optical Correlator for Aircraft Recognition

N90-253 Radar Cross Section (RCS) Validation

N90-254 Derivation of Functional Testing Requirements from Weapon System Mission Requirements

PACIFIC MISSILE TEST CENTER

N90-255 New Emitter Sorting Techniques

N90-256 New Electronic Support Measures (ESM) Classification and ID Techniques

N90-257 Airborne Imaging Spectrometer for Measurement of Low-Observable Aircraft Infrared Signatures

N90-258 Radar Reflectivity Polarization Matrix Measurement Instrumentation

N90-259 Multi-Spectral Target Presentation for Missile Test and Evaluation

N90-260 Microwave Target Presentation for Missile Test and Evaluation

NAVAL TRAINING SYSTEMS CENTER

N90-261 Realtime Photographic Based Terrain Image Generator with Capabilities for 3-D Objects

N90-262 Low Cost Reconfigurable Cockpit for Deployable Aircrew Team Trainers

N90-263 On-Line Diagnostic System for Simulator Performance Monitoring

N90-264 Training Optimized Utilization Resource Scheduler

NAVAL COASTAL SYSTEMS CENTER

N90-265 Video Data Compression

N90-266 Underwater Covert Communication Links for Short Distances

NAVAL CIVIL ENGINEERING LABORATORY

N90-267 Heat Resistant Airfield Pavements

N90-268 Development of Wall Composite Materials to Prevent Sympathetic Detonation Between Weapons Storage Cells

N90-269 Diver-Installed Recoilless Propellant Embedded Anchor (RPEA)

NAVAL AIR PROPULSION CENTER

N90-270 Turbine Engine Component Deterioration Model

N90-271 Compressor Boundary Layer Control

N90-272 Fuel Atomization Analysis for Advanced Gas Turbine Combustors

NAVAL OCEAN SYSTEMS CENTER

N90-273 Sensor for the Detection of Buried Cable From a Remote Tethered Submersible

N90-274 Tools to Assist in Modification and Reuse of Ada Software

N90-275 Miniaturized Radio Relay for Ultra High Frequency/Very High Frequency (UHF/VHF) Communications

N90-276 Multi-Function Shipboard Antennas

N90-277 Communication Devices and Techniques for Naval Special Warfare

N90-278 Miniaturized Antennas and Radio Frequency (RF) Components

N90-279 Solid-State X-Band Radar Transmitter

N90-280 Message Compression

N90-281 High Data Rate Satellite Communications

N90-282 Small Ship Ultra High Frequency (UHF) Antennas

N90-283 Graser Communication System

N90-284 Network Control

N90-285 Economical Environmental Performance Modifications to Commercial and Non-Development Item (NDI) Equipment for Shipboard Command and Control Functions

N90-286 Tradeoff Issues in Massively Parallel Implementations of Real-Time Federated or Distributed Navy Warfare Systems

N90-287 Workstation Architecture as a Function of Open Systems Architecture in Future Warfare Systems

N90-288 Directional Communication and Electronic Counter-Counter Measures (ECCM) Obtainable Through Architecture in Future Warfare Systems

N90-289 Adaptive Diversity Reception at High Frequency (HF)

N90-290 Natural Operator Input Techniques for Undersea Surveillance Systems

N90-291 A Prototype Ada Repository for Command and Control Software Components

N90-292 Survivable Adaptable Fiber Optic Embedded Network (SAFENET) Performance Evaluation

N90-293 Advanced Receiver Technology

N90-294 Advanced Passive Radio Frequency (RF) Surveillance/Targeting Assessment Methodology

N90-295 Protective Coatings on Aluminum for High-Efficiency Heat-Transfer Applications

N90-296 A Tethered Floating Fiber Optic Periscope for Submarines

N90-297 Voice Messaging and Response for Naval Ashore and Afloat Operations

DAVID TAYLOR RESEARCH CENTER

N90-298 Marine Paints with Icephobic Properties

N90-299 Composite Gearcases for Ship Main Propulsion Gears

N90-300 Optical Fiber Inspection System for Composite Propulsion Shafting

N90-301 Composite Acoustic Enclosure for Intercooled Recuperated (ICR) Gas Turbine Engine

N90-302 Atomized Liquid Filtration for Air Contamination Control

NAVAL AIR TEST CENTER

N90-303 Programmed Control of Seaborne Targets

N90-304 Solid State Digital Voice/Data Recorder

N90-305 Synthetic Rope for Helicopter Rescue Hoists

NAVAL AVIONICS CENTER

N90-306 Threat Missile Simulator Technology

N90-307 High Effective Radiated Power (ERP)

N90-308 Integral Circuit Board/Frame/Heat Sink

N90-309 Generic Configurable Microprocessor Simulation Methodology

N90-310 Aircraft Storeloader

OFFICE OF NAVAL RESEARCH

N90-001 TITLE: Signal Processing Using Artificial Neural Networks (ANN)

CATEGORY: Research

OBJECTIVE: To develop new artificial neural networks for use in real time automatic target recognition.

DESCRIPTION: Artificial Neural Networks (ANN) are signal processing and computing architectures that are motivated by our understanding of the organizing and computational principles of the central nervous system. These ANN architectures offer great promise for increasing the information processing capabilities of Navy/DoD systems, as encountered in pattern recognition, image/target recognition, associative computer memories, robotic and telerobotic control, and radar/sonar signal processing. Various technologies can be used to implement these ANN architectures, including silicon VLSI, GaAs, integrated optoelectronics, and optics. The goal of this program is to analyze and develop new ANN architectures and learning algorithms, and to investigate their implementation using state-of-the-art technologies.

During the Phase I program, research will address (1) new ANN architectural concepts and learning algorithms; and (2) materials, devices, and circuit architectures that are necessary to ultimately achieve the 10(12) interconnects/second for application to target recognition using multidimensional inputs.

During the Phase II effort, the Phase I concepts will be further developed to the point of feasibility demonstration for real-time automatic target recognition.

N90-002 TITLE: Image Compression

CATEGORY: Research

OBJECTIVE: To accomplish image compression using the mathematics of affine transformations.

DESCRIPTION: Recent advances have combined the mathematics of fractals with the concept of a dynamical attractor to achieve highly compressed images of natural pictures, e.g., landscapes, faces, etc. Iterated function systems comprised of affine transformations are derived which produce sets which are in the form of images. Upon iteration, the proper transformations cause the image to play the role of an attracting set. Compression is achieved because the amount of bits needed to describe the affine transformations are orders of magnitude less than the number of pixels in the image. The goal of this program is to automate this image compression scheme and apply it to systems of Navy interest, including satellite receiving, storing, and transmitting of pictures, (e.g., of the ocean surface). Inherent in this procedure is the task of pattern recognition as one picture can contain many images. A further objective is to develop algorithms which can pick man-made objects out of natural backgrounds.

N90-003 TITLE: Ground Based Remote Sensors

CATEGORY: Research

OBJECTIVE: To develop new techniques for real time, remote sensing observation and display of profiles of temperature, moisture and/or wind in the Marine Atmospheric Boundary Layer and/or ocean surface values of these parameters.

DESCRIPTION: Temperature, moisture, and wind profiles in the Marine Atmospheric Boundary Layer (MABL) strongly influence ocean and marine atmospheric processes and Naval operations. Examples of the former include ocean waves, and fluxes. Examples of the latter include surface ship operations and the use of electromagnetic and electro-optical weapons. Emerging techniques to remotely measure temperature, moisture and/or wind profiles from the surface include the use of optical, microwave, radar and/or acoustic frequencies in single and/or multiple configurations. The techniques should show promise for application at sea. Dominant features of interest include MABL parameters, mesoscale atmospheric features and/or synoptic scale features including tropical cyclones. Important operational features include high vertical resolution, long operating life, and low unit cost.

N90-004 TITLE: Compact Underwater Autonomous Laser Doppler Velocimeters for Use in Shallow Water Environments

CATEGORY: Research

OBJECTIVE: To develop a compact laser doppler velocimeter package capable of measuring turbulence in dynamic shallow water environments.
DESCRIPTION: Increased Naval operational emphasis on shallow water shelves has spurred the need for systems capable of measuring environmental parameters in these difficult, highly dynamic regions. Recent breakthroughs in the use of sea floor laser velocimetry to measure near bottom velocities has provided the opportunity to characterize the small scale turbulence in continental shelf regions. Therefore, the need exists for small autonomous underwater laser doppler velocimeters for use in a variety of ocean environments, including the Arctic's shallow seas. The instruments will be used to observe sediment movement, under ice/water interaction and air-sea transport processes. The system would have to be small and programmable with internal processing of signals. Two components of velocity would have to be recorded along with a solid state memory and semiconductor diode lasers for reduced battery consumption. It is hoped that the eventual combination of these sensors into a package of sensor arrays easily deployable in shallow water high energy environments will be feasible.

N90-005 TITLE: Expendable Particle Sensor

CATEGORY: Research

OBJECTIVE: To develop an expendable means of rapidly quantifying the suspended particle concentrations in natural marine environments.

DESCRIPTION: An ubiquitous and major component of ocean surface waters is suspended particles. In coastal waters this component is comprised of terrestrial and shelf sediments, aeolian transported material and biogenic particles. In the central ocean the particulate component is predominantly biological in origin. Characterization of the spatial and temporal variance in distribution of suspended particles is a critical factor in every discipline within oceanography. Marine particles are indicators of geological, chemical, and biological processes (e.g., primary production, coprecipitation and scavenging, and benthic resuspension) and also serve as quasi-conservative tracers of physical dynamics in the sea (e.g., off-shelf transport). Nevertheless, currently there exists a very limited number of commercially available techniques for in-situ characterization of the marine suspended particle load. The available instrumentation is expensive and time-consuming in its deployment at sea. Synoptic coverage of the particulate distributions requires that there be an ability to rapidly assess the three-dimensional particulate distributions at sea in a manner similar to that presently used for characterization of the temperature structure, where expendable bathythermographs are deployed. A capability to define the synoptic particle structure should not be dependent on the solar light field for illumination, but should be applicable regardless of ambient lighting conditions or sea state.

N90-006 TITLE: Ferroelectric Nonvolatile Radiation-Hard Memories

CATEGORY: Research

OBJECTIVE: Devise innovative methods to deposit thin films of ferroelectric materials integrated with semiconductor circuitry to produce a nonvolatile radiation-hard digital memory.

DESCRIPTION: The combat effectiveness of ships, planes, and missiles relies increasingly on electronic signal processing. A critical component in such signal processing chains is a memory that retains data throughout loss of power in high radiation environments. Recent advances suggest that semiconductor memories using thin films of ferroelectrics, either as capacitors or FET gate dielectrics, offer a solution to this critical defense need. Research issues remain in identifying the appropriate material system, deposition technique, and patterning methodology, as well as in understanding the origins of switching fatigue that limits the lifetime. The purpose of this program is to address these issues related to the ferroelectric film deposition. While the research focus lies on preparing the ferroelectric film of sufficient quality, an important constraint on any solution is compatibility with semiconductor processing technologies, as this will be critical to commercialization.

N90-007 TITLE: Sacrificial Electrodes

CATEGORY: Research

OBJECTIVE: To develop sacrificial electrodes to enhance the conductivity of sea water to improve the efficiency of electromagnetic thrusters for underwater propulsion.

DESCRIPTION: In an electromagnetic thruster (EMT), the power developed is proportional to the conductivity of the flowing fluid. In applying the EMT concept for sea water propulsion, high magnetic fields are required due to the low conductivity of sea water. However, by using a sacrificial electrode, the conductivity can be increased, resulting in acceleration of the submersible. This concept is particularly suited for torpedo propulsion using EMT. The goal of this program is to conduct research on

electrode materials, coatings and/or capping, and particle discharge during conduction, to acquire the understanding required to develop controlled time-delayed sacrificial electrodes in a continuous electrode configuration for use in electromagnetic thrusters. The parametric study for the electrode will involve onset of particle ejection, ejection rate, resulting conductivity of the flow field, conductivity distribution, selective discharge, and signatures.

N90-008 TITLE: Neural Networks for Autonomous Motor Control

CATEGORY: Research

OBJECTIVE: To develop neural network techniques that can provide adaptive control of robotic systems.

DESCRIPTION: Current adaptive control theories have difficulty with dynamic interactions across many links during robotic movement in real time. To be useful, an autonomous controller must learn and maintain its own calibration. Currently, autonomous robots are controlled by either direct program control, inverse kinematics or classical adaptive control techniques. Neither of the first two methods are adaptive, and classical adaptive control techniques require a model of the robot plant and actuators which may be difficult to obtain before-hand. Also, multi-joint inverse kinematic computations are computationally intensive, which considerably slows down the control process. Many of the above problems can be solved through the application of neural network algorithms and approaches. Neural network techniques should allow a controller to generate accurate stable motor control of multi-joint robot arm links without information about link mass, link length, direction of gravity, and with fuzzy information about payload and actuator limits. A "neural controller" should be able to move a multi-joint arm carrying an unforeseen payload from any starting joint angle to any ending point without end-point oscillations. Ultimately, these devices should prove of great utility whenever autonomous robotic devices are required.

N90-009 TITLE: Metal-Ion Selective Sensors

CATEGORY: Research

OBJECTIVE: To develop sensors for metal ions based on a biomimetic approach.

DESCRIPTION: The goal of this research is to develop a working prototype of an electrochemical sensor which is based either upon an electrochemical model of the molecular mechanism of the transmembrane ion transport or an ion-dependent enzymatic reaction. The proposed studies could be carried out by functional transfer of ion-sensitive molecules into artificial bimolecular membranes, monolayer and multilayers. This configuration may present advantages of enhanced selectivity and stability over conventional liquid junction membrane electrodes. The electrical and optical properties of multilayers could be selectively modified and controlled. The structure of the multilayer and the nature of the layer by layer deposition could allow the construction of films of controlled architecture. Chemically-sensitive electronic devices as a substrate for the sensitized monolayers or multilayers could also be used.

N90-010 TITLE: Focused Ion Implantation for Optoelectronic Integrated Circuits

CATEGORY: Research

OBJECTIVE: To develop a viable focused ion beam technology to fabricate optoelectronic integrated circuits for use in signal processing systems.

DESCRIPTION: The submicron focused ion beam (FIB) process has recently received a great deal of attention as a technique for a microfabrication of semiconductor devices. The most promising application of the technique is for maskless ion implantation. Maskless ion implantation in conjunction with various crystal growth and device processing technologies will open up new possibilities for fabricating the integrated device structures for optoelectronic integrated circuits (OEICs). The goal of this program is to develop a viable focused ion beam technology to fabricate the various optoelectronic components (e.g., lasers, waveguides, mirrors, detectors, etc.) and to pursue their on-chip integration. Specific research objectives include: (1) development of proof-of-concept integrated optoelectronic circuits; (2) fabrication of quantum well lasers by prevention or induction of chemical disordering; (3) investigation of FIB fabrication parameters for optimum laser fabrication and their effect on laser operation; (4) fabrication of optical waveguides and mirrors using FIB induced changes in index of refraction.

Phase I of the program should provide the proof-of-concept demonstration of OEICs by FIB technology with fabrication of selected devices and device combinations.

Fabrication and optimization of actual device structures envisioned in specific research objectives above will be pursed in Phase II.

OFFICE OF NAVAL TECHNOLOGY

N90-011 TITLE: Noise Reduction System for Shipboard Spaces

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to develop techniques for active noise cancellation applicable to manned spaces aboard ships allowing personnel to work safely and effectively in high noise environments.

DESCRIPTION: High noise environments in shipboard spaces represent potential personnel hazards which seriously limit the ability to operate and maintain Fleet equipment while underway. Conventional noise reduction techniques are expensive and heavy. Passive hearing protection is not very effective. An improved active cancellation system would allow personnel to hear alarms, communicate with the bridge and move freely about the space. Development must be suitable for retrofit to ships already in the fleet. Installation concepts should be part of the proposal. The innovative research should result in a demonstration of improved capabilities. The Navy's operational Surface Effects Ship (LX-515) is available for evaluation of this system. Factors of cost, feasibility and applicability to naval combatant vessels should receive careful consideration in development of proposed techniques.

N90-012 TITLE: Tactical Data Quality

CATEGORY: Exploratory Development

OBJECTIVE: Develop a method to characterize tactical data quality that can be used to determine the degree of relevancy and importance of the data for the tactical decisionmaker.

DESCRIPTION: There is a need to establish the quality of tactical data presented to the decisionmaker in order to: 1) reduce the data overload problem resulting from multiple-target, multiple-sensor tracking, 2) reduce the need to transmit large volumes of data over limited-bandwidth circuits, and 3) enable time-critical decisions to be made in a timely manner. A metric for determining data quality would be useful for screening available information so that only pertinent data that are immediately at hand are presented to the decisionmaker. The quality of tactical data should reflect the following features:

Source:	Where did data originate?
Latency:	How old is the data? Is it overtaken by events?
Priority:	Is the data sufficiently important to present for the decision at hand?
Relevance:	Is the data relevant to the decision at hand?
Validation:	Does the data require confirmation from independent sources?
Security:	What is the security level of the data?

The method for establishing tactical data quality should be implementable on an automated, real-time decision aid for the tactical decisionmaker. It should be sufficiently generic so that command and control mission applications at different command levels and platforms are possible.

N90-013 TITLE: Efficiency Enhancement of IMPATT Diodes

CATEGORY: Exploratory Development

OBJECTIVE: Conduct investigations (i.e., theoretical analysis, material growth, fabrication, testing and evaluation) to determine the feasibility of developing high conversion efficiency Impact Avalanche and Transit Time Devices (IMPATTs) in Ka-Band. The goal at 35 GHz is discrete pulsed power IMPATT diodes capable of 15 watts peak; 5 watts average with 32 percent or greater efficiency; and pulse, 500 nS.

DESCRIPTION: IMPATT diodes are used in Navy weapons and are proposed in the implementation of high power solid state missile seeker transmitters. Present IMPATT state-of-the-art technology using Gallium Arsenide (GaAs) in Ka-band offers 7 watts of peak power (3 watts average) with 16 per cent (maximum) efficiency. Recent advances in semiconductor materials growth technology indicate that it should be possible to realize 32 percent or greater DC to RF conversion efficiency in Ka-band by using new heterojunction IMPATT structures with low-bandgap material for the avalanche zone and a large-bandgap material for the drift zone (references available from Defense Technical Information Center). To achieve the specified goals, the research in this program shall include: 1) Theoretical investigations, including computer simulations, to identify potentially promising IMPATT structures and semiconductor materials; 2) Material growth of the selected IMPATT structures; 3) Characterization of the growth material; 4) Fabrication of discrete and packaged IMPATTs using appropriate heat-sinking technology and bonding techniques; and 5) Testing and evaluation of the IMPATTs using an appropriate test oscillator mount and a biasing pulse modulator. The

deliverable items shall include: 1) Ten discrete and packaged IMPATT diodes; and 2) a technical report detailing the development of these heterojunction enhanced-efficiency IMPATTs.

N90-014 TITLE: Integrated Planar Magnetics for High Power Density Electronic Power Supplies

CATEGORY: Exploratory Development

OBJECTIVE: To explore the technical feasibility of magnetic device planar construction, improved power efficiency, higher energy density and low cost simplicity for megahertz operation in power density power supplies. A base line for improvement is 5 to 10 megahertz frequency, transformer power rating of 100 watts @ 99% efficiency, with a volume not to exceed one tenth cubic inch. Inductor base line is 300 volt-amperes @ 5 to 10 megahertz, with a power factor not to exceed 0.003 and a volume not to exceed one-tenth cubic inch using a profile (i.e., height divided by the product of length times width) of no more than 3/100.

DESCRIPTION: There is a need to simplify the design and construction of low voltage electronic power supplies. The Navy and the Air Force are presently contracting for development of higher efficiency and higher power density power supplies to provide reliable power to very high speed, high density integrated circuit systems. Excessive size would result with the use of the best available modern commercial low voltage power supplies. Presently-available power supplies would exceed the remaining volume of the systems; a rule of thumb is for the power supply's volume not to exceed 25% of the volume of the system. A major problem in power supply packaging and circuit assembly is presently design-mandated (i.e., near cubical) shapes of their components. Magnetic devices do not lend themselves to easily conform to high density solid planar structures; rather, they are commonly built as separate coil/core structures which, when assembled, are space-wise inefficient and will not easily conform to the printed circuit layout used for system integrated circuits. Either circuit card spacing must be increased or added components are required in conventional approaches to this problem. Low profile, high performance magnetic components are highly valued.

Phase I should explore the technical feasibility of low profile, highly efficient magnetic devices; evaluation samples and their characteristics and design principles are required.

Phase II should explore ways and means for low cost production of high reliability components, culminating in a pilot run to prove the production concept.

N90-015 TITLE: Advanced Materials Technology for Electronic Component Applications

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate the effectiveness of new materials technology applied to electronic components.

DESCRIPTION: New innovations in materials technology are appearing in composites, intermetallics, polymers and ceramics. This solicitation requires the application of such innovations to electronic component technologies. Future requirements for such components include improved reliability, reduced weight and cost, miniaturization and heat removal. Opportunities for improvement exist in dielectrics, heat sinks, solder, thermal vias, etc. Electronic packaging is limiting to system performance. The offeror should show the application of the innovation to a specific Navy device and should project the impact on system capability, reliability and/or survivability.

N90-016 TITLE: Naval Applications of Massively Parallel Processing

CATEGORY: Exploratory Development

OBJECTIVE: Define and show feasibility for the selection of an optimum computer architecture(s) best suited to solving signal/data processing problem types (e.g., unimodal, multimodal or combinatorial) inherent to the performance of Navy missions.

DESCRIPTION: In the past 5 years, the field of U.S. high performance computing has been fundamentally transformed by the variety of commercial and experimental non-Von Neumann multi-processor architectures with various connectivity strategies now available for naval applications. Anecdotal evidence shows that compute time can be dramatically decreased in some cases by converting existing programs from scalar to parallel structures. Types of parallel processing include, but are not limited to, 1) vector processing; 2) multiple instruction-stream, multiple data-stream (MIMD); or 3) single instruction-stream, multiple data-stream (SIMD). Key features of signal and data processing problems common to anti-air warfare, anti-submarine warfare and anti-surface warfare need to be identified and subsequently related to the computer architectural characteristics most likely to yield efficient, real-time solutions.

N90-017 TITLE: Low Cost Underwater Acoustic Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost underwater receivers for future Navy air, sea and surveillance applications.

DESCRIPTION: Proposed future underwater surveillance systems will cost too much to be affordable, unless innovative technology can be used to reduce total costs of such systems. The types and designs of acoustic sensor components affect a large portion of such costs. This task would identify and develop low cost alternative acoustic sensors for future underwater applications. Security clearances at the SECRET level are required.

N90-018 TITLE: Automated Lithium Liquid Metal Handling Station

CATEGORY: Exploratory Development

OBJECTIVE: Develop a liquid metal handling station for use in refining lithium and economically placing it in specified containers.

DESCRIPTION: Systems presently under development by the U. S. Navy make use of vessels that are prefilled with lithium; normally, the metal is melted, poured as a liquid and allowed to solidify. The process must be carried out in an inert environment to promote safety and insure the purity of lithium placed in the containers. A system is sought to perform this function for a series of cylindrical containers from one to several feet in diameter. The system developed should be safe, automated and able to achieve the filling process at minimum cost. It is also desireable to design the apparatus so that heavier impurities are separated from the lithium during the filling process.

N90-019 TITLE: Seismic Detection of Buried Mines

CATEGORY: Exploratory Development

OBJECTIVE: Develop a method of detecting mines buried in the ocean bottom.

DESCRIPTION: Investigation of seismic techniques developed by the oil exploration industry is desired for the purpose of evaluating the effectiveness of these techniques in detecting buried mines at depths of 3 to 4 meters below the sea floor.

Phase I investigations would be theoretical in nature with demonstration and documentation of the processing techniques or simulated data. Successful completion and reporting of this preliminary investigation would lead to a Phase II demonstration detecting mines during field tests in areas prepared by the U. S. Navy.

N90-020 TITLE: Coated Boron Particles

CATEGORY: Exploratory Development

OBJECTIVE: Prepare magnesium and aluminum coated boron particles and measure reaction rates with air and water vapor.

DESCRIPTION: Ignition delays during metal combustion are detrimental to metal fuel performance. Ignition of uncoated boron particles is inhibited by the formation of a boron oxide layer which places a physical barrier between the metal and oxidizer. It is postulated that two-stage ignition occurs with boron, because the rate of oxidation is slowed by the oxide formation, with subsequent evaporation of the oxide layer and reheating. Coated boron particles will permit the coating metal to react first, which may provide the heat necessary to raise the temperature of the underlying boron above the boron oxide volatilization temperature; therefore, it is important to obtain uniformity and quality of coating while also maintaining a thin coating. The need for pure, dense, spherical and small-size particles (diameters less than 5 microns) is also important, and it is known that impurities in boron reduce volumetric heat release.

Phase I research should address the technology of depositing thin (micron or less) reactive magnesium and aluminum coatings onto pure boron particles including an understanding of the preferential coating process, particle size effects, metal coating concentration effects and temperature effects on the rate of coating and thickness. Preliminary experiments should be set up to measure reaction rates of coated particles with air and water vapor. Phase I experiments may be conducted on 94% purity boron provided the metal coating is of high quality.

Phase II research should focus on the ability to control and scale-up the coating process. Quarter-pound to one-pound samples of the coated boron should be supplied for evaluation. A major part of the Phase II research should be devoted to studying the reaction rates of the coated boron particles with air and water vapor, with comparisons made to uncoated particles.

U.S. MARINE CORPS

N90-021 TITLE: Application of Neural Networks to Amphibious Command and Control

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic will be to convert state of the art work that has been completed in Neural Networks to software, which can be used for information processing and decision making in a command and control network in the Marine Corps operating environment.

DESCRIPTION: Command and control on the battlefield of the future - i.e., 2000 and beyond - will require extremely fast reaction times and the handling of vast amounts of information. In amphibious operations, this problem is complicated by the transition from sea to beach to land operations. Neural networks have promise for providing significant improvements in reaction times by providing quantum leaps in the ability to quickly process information and perform decision aid tasks.

Phase I would be the development of a systemized plan and limited demonstration software for applying neural networks to the Marine Corps command and control system.

Phase II would be the development and testing in a field environment of working software, which could be used in Non Development Item (NDI) hardware procured for the Marine Corps command and control system.

N90-022 TITLE: Joint Operations Interoperability System for Marine Corps C^3I System

CATEGORY: Exploratory Development

OBJECTIVE. The objective of this topic is to develop software and hardware for interface between Marine Corps communications information/command and control systems and other service/foreign country and commercial systems.

DESCRIPTION: The Marine Corps has developed a protocol system, the Marine Corps Tactical System (MTS) which is the standard for the interface of communications, information and command and control systems. Although much work is being done to implement Joint intraoperability standards and the MTS is to conform to these standards, many systems developed by other services cannot operate in the Marine Corps environment without modifications to hardware/software. In a commercial environment, there are programmable systems, which can be adapted to allow various systems to interoperate. There is a need for a similar system designed for the Marine Corps, which can be inserted internally to other service systems and programmed to allow integration of these systems into the Marine Corps MTS and also allow interoperability during joint operations.

Phase I would be development of a demonstration system for one demonstration system and proof of the ability to develop an adaptable programmable system.

Phase II would be the development and field testing of an adaptable programmable system, which could be integrated internally in any hardware.

N90-023 TITLE: Multi-level Security System for Amphibious Operation Command and Control

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this topic is to develop software, which would allow the Marine Corps to process information with various levels of classification in a battlefield command and control system.

DESCRIPTION: On the battlefield of the future i.e. 2000 and beyond, the intelligence will be critical for planning and decision making. The command and control system must be able to interface with the intelligence staff in real time without the screening that is presently required due to the risk of compromising sources and revealing intelligence capability to the enemy. In addition there are various requirements for classified information on the battlefield, but there is a risk to compromising information due to the lack of security techniques in central processing units (CPUs) and local area networks (LANS). This problem is complicated in an amphibious operation environment, where the information requirements change during the transition from sea to beach to land.

Phase I would review work performed by DOD agencies, such as NSA and DIA, development of a proposed software system and proof of concept for providing multilevel security for intelligence information in the Marine Corps command and control system. Phase I selectees will require the ability to obtain security clearances at the Top Secret level and access to compartmented information. Prior experience working with NSA and DIA will be helpful.

Phase II would be the development of multilevel security software and field testing in a field environment on Non Developmental Item (NDI) equipment projected for the Marine Corps command and control system.

N90-024 TITLE: Integral Electric Motor/Waterjets for High Speed Amphibians

CATEGORY: Exploratory Development

OBJECTIVE: This effort will be directed at the development of feasibility designs to show packaging, layout, system requirements, efficiencies, weight and volume requirements for high speed amphibian integral electric motor/waterjets.

DESCRIPTION: Current waterjets that propel high speed and low speed amphibious vehicles utilize separate drive motors and waterjets located in a stern mounted transom flap coupled together to make up the propulsive output section of the drivetrain. This provides a heavy arrangement with duplicative components that could be combined to save weight and volume.

The proposed effort would be for the development of an integral waterjet with an electric motor internally contained in the waterjet hub/shaft assembly. Technical requirements are: thrust of 4000 pounds, diameter not to exceed 16 inches, length not to exceed 60 inches (including inlet and exhaust nozzles). A system voltage level of less than 1000 volts is desired.

Phase I would be the development and delivery of proposed alternative layout drawings and engineering calculations to demonstrate feasibility and show packaging layout, system requirements, efficiencies, weight and volume requirements for the proposed system.

Phase II would be refinement of the design and the delivery of a prototype design with engineering calculations and breadboard test results to support selection of the design.

N90-025 TITLE: Interchangeable Motor and Alternator Electrical Rotating Groups for High Speed Advanced Assault Amphibians Vehicles (AAAV)

CATEGORY: Exploratory Development

OBJECTIVE: This effort will be directed at the development of feasibility designs to show packaging, layout, system requirement, efficiencies, weight and volume requirements for a high speed advanced amphibian interchangeable motor and alternator electrical group.

DESCRIPTION: If a future high speed amphibian utilizes engine driven alternators to power transom flap mounted motors that drive waterjets, commonality of electric components offer the possibility of reduced initial procurement costs and operating costs. This will provide a reduction in the numbers of components, and a reduced component cost as the motor and alternator will utilize a common electrical rotating assembly.

During high speed waterborne operation for the AAAV, most operation will be a steady state power setting where the speed of the waterjet motor is matching the speed of the engine driven alternator. A separate motor and alternator for each alternator is prescribed so that failure of one motor/alternator/waterjet system will not affect the others. Since motor output power, speed and speed-range closely match alternator input power, speed and speed-range, utilization of common rotating groups for the motor and alternator provide logistics cost savings.

Technical requirements are: a high efficiency system, motor output levels of 400-450 horsepower, diameter not to exceed 16 inches, lengths not to exceed 18 inches. System voltage levels of less than 1000 volts are desired, using moderate risk technology.

Phase I will be the proposed alternative layout drawings and engineering calculations for the hardware systems to demonstrate feasibility and show the proposed alternative packaging layout, system requirements, efficiencies, weight and volume requirements.

Phase II will be the refinement of the design and delivery of final drawings with breadboard test data and calculations to support the selection of the design.

N90-026 TITLE: Compressible Fluid Strut for Wheeled Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: The development of designs to demonstrate packaging, layout, system requirements, proper operation, efficiencies, weight and volume requirements for a compressible fluid strut for wheeled vehicles.

DESCRIPTION: With the myriad of cargos that wheeled vehicles carry and the many vehicle variants that evolve (each with their unique loaded weights), heavier than normal vehicles used in the Marine Corps must accept reduced performance that limits mobility because vehicle suspension system designs are tuned for only one weight. Conventional torsion bars, coil springs and shock absorbers are also designed for one weight.

A suspension that can be tuned and readily adjusted for differing vehicle weights (springing force) and different ride characteristics (dampening) will enhance the mobility and survivability of the vehicle. Linear struts that utilize a compressible fluid for both springing and dampening have potential to offer performance gains at production level costs comparable to conventional systems.

Phase I would be the development of layout drawings and engineering calculations to demonstrate feasibility and show packaging, layout, system requirements, efficiencies, weight and volume requirements. The baseline configuration would be for an eight wheeled USMC LAV-25 vehicle with a wheel loading of 4000 pounds each, jounce travel of 7.28 inches, rebound of 6.1 inches and variable dampening rates.

Phase II will be the delivery and testing of a prototype with data from test results to demonstrate successful

operation.

N90-027 TITLE: Engine Cylinder Bank Deactivation

CATEGORY: Exploratory Development

OBJECTIVE: The objective is the development of a feasibility design to show packaging, layout, system requirements, proper operation, efficiencies, weight, and volume requirements for an engine cylinder bank deactivation system, which might be used in a new system or adapted to an existing system.

DESCRIPTION: Future tracked amphibious vehicles may have large power mismatches between the level of power required to propel the vehicle in the water versus the level of power required while the vehicle is on land. In order to achieve 20+ knot water speed, a 30 ton vehicle must have a powerpack capable of delivering 2200 horsepower (HP). On land only 750 HP is required. If a single high powered diesel engine is used (in order to minimize installed volume, fuel consumption, etc.), it will efficiently provide the necessary power for marine mode. When used for Land mode, however, the engine must be derated considerably, since only a fraction of the marine mode horsepower is necessary to drive the vehicle. Thus the engine is not efficient for land use.

If the number of cylinders could be reduced in the transition from sea to land operation, a potential gain in efficiency would improve fuel consumption. A method to decouple a number of the cylinders is one approach to this problem.

Phase I is the development of a method to decouple the cylinders and providing alternative drawings and engineering calculations for decoupling systems to demonstrate feasibility with packaging, layout, system requirements, efficiencies, weight and volume requirements.

Phase II is refinement of the design and selection of the best alternative with engineering drawings, results of tests and calculations to support the design.

N90-028 TITLE: Lightweight Cooling Component Development

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop lightweight cooling components for military combat vehicles to replace components provided by OEM suppliers, which are not designed for military applications.

DESCRIPTION: Military combat vehicles operate over a range of different terrains, temperature ranges and at varying power levels. the vehicles also must power numerous auxiliary systems that are located away from the vehicles prime mover

Most modern land combat vehicles utilize air-to-liquid heat exchangers to reject heat generated by the engine and other vehicle auxiliary systems. USMC tracked amphibious vehicles also utilize liquid to liquid heat exchangers during water operation. The source of supply of components to date have been over-the-road OEM equipment suppliers, where weight is not as critical as in a combat vehicle.

Lighter weight, higher efficiency cooling systems and components are required for both land and water operation of military vehicles. Anticipated land rated horsepower (HP) of the prime mover is 750 HP, 500 HP of which goes to the transmission (with its losses) and the remainder to hydraulic and electrical systems. In the water, a 2200-2300 HP prime mover will be utilized. 2000 HP of which will go to the transmission and the remainder to hydraulic and electrical systems.

Phase I will be development of drawings and engineering calculations for lightweight components that demonstrate feasibility and include packaging, layout, system requirements, efficiencies, operation, weight and volume requirements.

Phase II will be delivery of test articles and test results of laboratory tests designed to measure performance and efficiency.

N90-029 TITLE: Lightweight/High Power Density Engines

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop a proposed design for a lightweight/high power density engine for a high water speed amphibious vehicle.

DESCRIPTION: The Marine Corps is developing a high water speed vehicle that may utilize up to 2300 HP during water operations, but will require only 750 HP during land operations. The forward mounted engine will provide power during water operations through a transmission (hydraulic,electric or mechanical) to aft mounted waterjets to propel the vehicle. During land operation, only partial power will be required

Current diesel engines are heavier and larger than desired, partly due to their anticipated extended use. Military vehicles see far less use. Therefore, a smaller and lighter diesel burning engine system could be designed to direct power aft mounted water jets, if the engine were small enough to fit on an aft mounted transom flap or in the rear of the vehicle without

reducing troop carrying space.

Phase I is the development of alternative designs with drawings and engineering calculations, which demonstrate feasibility and show packaging, layout, system requirements, efficiencies, mode of operation, heat rejection rates and methods, weight and volume requirements.

Phase II is the selection of the best alternative and refinement of design with final engineering drawings and supporting calculations and laboratory test results to support the design selection.

N90-030 TITLE: Lightweight Air Compressors

CATEGORY: Exploratory Development

OBJECTIVE: The objective is the development of a feasible design for a lightweight Air Compressor for an in-water propulsion system, the Water Piston Propulser.

DESCRIPTION: The Marine Corps is involved in the development of a revolutionary in-water propulsion system named the Water Piston Propulser for propelling future high water speed amphibian vehicles. This system also has application to other high speed naval and commercial vehicles. This system also has application to other high speed naval and commercial vehicles. The system works on the principal of compressed air igniting with diesel fuel in a combustion chamber to produce a high temperature, high pressure exhaust gas that is reacted against a continually supplied column of water. The combustor and rotor (the rotating member that supplies the water column) are located external to the vehicle. Inside the vehicle is the engine driving an air compressor and the fuel supply that feed the combustor. By directly generating thrust, vice using an internal combustion engine with a transmission and waterjet system, higher efficiencies are theoretically attainable.

Phase I would be the development of alternative designs for the air compression system that would be driven by the vehicle's prime mover. The requirements are for a lightweight, saltwater environment capable compressor that can produce 18.5 pounds per second of air at 225 psi. Input horsepower will be between 750 and 1000 SHP at 3000 rpm.

Phase II will be the selection of a final design, and delivery of drawings and engineering calculations that demonstrate feasibility and show packaging, layout, system requirements, efficiencies, mode of operation, weight and volume requirements.

N90-031 TITLE: Mobile Water Production by Extraction of Atmospheric Moisture in Desiccant

CATEGORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate feasibility of concepts to produce potable water from atmospheric sources independent of surface or ground water sources.

DESCRIPTION: USMC missions require support of highly mobile expeditionary forces in arctic, desert, and tropical climatic conditions. These forces must have potable water for consumption and medical care and uncontaminated water for personal sanitation and vehicle support. Recent advances in desiccant technology provides opportunity for efficiently extracting water from the atmosphere, eliminating the need for ground feed water sources. System characteristics of a USMC Atmospheric Moisture Collection System (AMCS) include extracting moisture from air with relative humidities as low as 5% and production of 7-10 gallons of water per gallon of fuel consumed. Overall AMCS constraints include a ISO 8x8x20 envelope enclosing a capability to produce several hundred gallons of water per hour. AMCS design considerations should focus upon minimum Logistics burden, operator skill level and maximum reliability.

Phase I: Development of drawings and engineering calculations for components that demonstrate feasibility of this technology to include packaging, layout, system requirements, efficiencies, operations, weight and volume. Conduct market survey to determine likely contractors, which may have the potential to produce the AMCS.

Phase II: Procurement or fabrication of test AMCS, delivery of test articles, and results of AMCS evaluation designed to measure performance and efficiency against Phase I projections.

N90-032 TITLE: Polymeric Cartridge Cases

CATEGORY: Advanced Development

OBJECTIVE: Development and demonstration of a 5.56 mm round with a polymeric cartridge case that is equivalent to the current M855 round.

DESCRIPTION: Small caliber handgun ammunition using a "plastic" cartridge case has been marketed commercially for a number of years. The feasibility of developing the 5.56mm service round has been demonstrated with the M193 round (to be phased out). This program will provide the means to develop a functionally equivalent M855 round. When developed, this cartridge could

potentially offer cost savings of 30% and weight savings of 50%. It is estimated that 190 million rounds of this cartridge will be procured annually. That would translate into a 15 million dollar annual savings in tri-service use, not counting the logistical savings due to the lighter weight. The Marine Corps will benefit directly from this technology in cost savings, reduction of the individual Marine's load and increased mobility.

Phase I would include material selection, part design, mold design and fabrication,production of 2000 cartridges, ballistics testing and a functional demonstration in the M16A2 and M249 rifles.

Phase II will consist of a scale up production to demonstrate the economic feasibility of the technology developed in Phase I. During this phase 20,000 units will be produced with processing parameters and quality control measures identified. A complete ballistics testing and full scale functional demonstration will be performed.

N90-033 TITLE: Standoff Minefield Marking for Very Shallow Water (VSW) Surf Zone, and Beach

CATECORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate the feasibility of developing a minefield marking system capable of marking cleared lanes in very shallow water, in the surf zone, and across the beach from a standoff of at least equal distance to minefield neutralization systems.

DESCRIPTION: Soviet and Warsaw Pact forces possess a formidable capability to mine the very shallow water, surf zone and beach area. Successfully breaching these minefields and moving assault forces without loss of momentum across the beach with acceptable losses is critical to a successful amphibious operation. Currently, there are breaching systems in full scale development, which will provide a capability to clear lanes. However, no means exist to mark these lanes, so that assault vehicles and landing craft may be guided safely to the beach. Hence, a standoff marking capability is a necessity. This system should visibly mark the approximate center of the breached lane location, be identifiable in both day and night operations and provide identification of the cleared lane for approximately two hours.

In Phase I, drawings and engineering calculations for components that demonstrate feasibility of the technology to include packaging, layout, system requirements, operations, weight and volume will be developed.

In Phase II , equipment will be procured and fabricated for a demonstration system, which will be delivered and tested against the Phase I projections for performance and efficiency.

N90-034 TITLE: Use of Neural Nets in Predicting Personnel Attrition

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop a manpower planning loss forecasting tool with an accuracy superior to conventional forecasting techniques.

DESCRIPTION: The greatest challenge in military strength planning lies in forecasting losses, the state of the economy, unemployment rates, civilian vs. military job renumera , etc. A number of traditional methods have been employed in the forecasting routines built into the major manpower ing computer programs. These include time series forecasts, econometric models, "bootstrapping" methods involving yearly iterative adjustment of loss parameters, and a few others. None of these methods has emerged as the "preferred" approach to forecasting for manpower planning.

Phase I will involve a study/proof of concept to test the applicability of the neural net approach to personnel loss forecasting for manpower planning. Operationally, the study will entail training a neural net on thousands of records pulled from a basic file of personnel records and developing a system to make forecasts, comparing results to actual historical events and forecasts by current manpower planning programs in order to determine the efficiency and validity of the method.

Phase II will be the development of a usable personnel loss forecasting system for the Marine Corps. The system should be able to input a variety of parameters (such as, but not limited to, length of service, pay grade, demographic group and time remaining on contract) and predict, for each individual, the probability of attriting within a year and/or failing to reenlist at the end of a contract. Much of the research would be geared toward identifying the variables, which have an impact on the reenlistment decision and it is anticipated that reduced time for processing and analysis with a neural network approach will allow the trial of many data sets to prioritize the use of different variables in this type of forecasting. Once successful with individual forecasting, the system should be usable for analyzing the entire Marine Corps force structure to provide aggregate loss forecasts.

N90-035 TITLE: Focal Plane Filters for IR Detector Array

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative low cost solution to multiband filtering of FLIR images and demonstrate an IR Detector Array Filter in common module FLIRs and thermal images.

DESCRIPTION: The Focal Plane Filters for IR Detector Array concept will provide spectral sensitivity on a custom FLIR detector array. A small window with discrete bandpass filters applied would be mounted directly above the detector chips.

Phase I will demonstrate feasibility by fabrication of at least two different narrow bandpass (0.5 micron FWHM bandwidth) filters within the 8-12 um region to the dimensions listed below on a thin suitable window material. The individual filters will be of the same approximate size as the detector chips (700 X 63 microns) with a commensurate spacing (10 microns) to that between chip elements. Window materials must be transparent in the detector dewar and thus must be capable of operation at 80°K and storage at 300°K. Temperature cycling from room to liquid nitrogen temperatures will be performed to test filter/window assembly thermal stability.

Phase II will serve to optimize the concept of focal plane filters for use in agent detection and demonstrate practicality of integration in common module FLIRs and thermal images.

N90-036 TITLE: Study to Obtain a Simulant for Testing VX Conversion Filters

CATEGORY: Exploratory Development

OBJECTIVE: To find a simulant to replace VX when testing VX conversion filter reactivity after storage under various conditions.

DESCRIPTION: This project if successful will lead to safer, less costly, screening of conversion filter materials for application in agent sensors. Phase I will involve experimental work to find a simulant to replace agent VX for testing VX conversion filter reactivity after storage. Fluorinating reagents will be tested with potential simulants of VX after storage on various substrates. The reagent testing results will be compared with actual live agent testing for verification of simulant utility. Phase II work will continue with simulant identification work with primary focus on establishing agent/simulant test correlation data.

N90-037 TITLE: Test Kit Development for Agents of Biological Origin

CATEGORY. Exploratory Development

OBJECTIVE: The objective of this project is to exploit presently available commercial immunoassay technology for the development of a field detection/identification system for agents of biological origin.

DESCRIPTION: Within the past few years, new immunoassay formats have emerged, which are very rapid (several minutes), require a minimum of reagents and handling, and are very sensitive. These formats typically use an antibody which is immobilized to a porous membrane to trap the antigen, while an antibody conjugated to an indicator molecule (enzyme, dye, etc.) is used to visualize the reaction. This type of system could be used as a field detection/identification kit for pathogens or toxins in environmental samples.

Attempts at such a device were made through the Identification System, Biological Agent, Rapid, Field (IDSBARF) Program initiated by the U.S. Army Medical Research and Development Command during the mid 1980s; however, this program failed to yield a fielded product. A new approach has been taken by MRDC, whereby commercially available technology will be utilized for medical diagnostic tests and not for environmental or field samples. This project will help to fill the void for environmental samples. These kits can be readily developed for reconnaissance and hazardous area demarcation and as a means of identifying samples in the forward area. The kits could be integrated into the forward area NBC laboratory program, which has been initiated by the Marine Corps.

This project has a high probability of success. There are already several commercially available test kits for pathogens available in the clinical diagnostic market. These products have undergone rigorous screening by the Food and Drug Administration for safety and efficacy. It is only necessary to evaluate them for agents, which are of interest to the Marine Corps and other military services.

Phase I would be "Proof of Principle" type work to demonstrate the technology to detect two agents using government furnished reagents.

In Phase II the testing will be expanded to 7 agents. If successful, the kit could be transitioned into a development program or production.

N90-038 TITLE: Study of Stability of Fluorinating Reagents on Various Membranes/Filters

CATEGORY: Exploratory Development

OBJECTIVE: Determine the stability, in air of various fluorinating reagents on different membranes exposed to a variety of conditions.

DESCRIPTION: This work will decrease the time required to determine the best reagent/membrane combination for the VX

conversion filter, which is being developed under the Marine Corps Chemical/Biological Defense Technology program.

Phase I experimental work will focus on determination of stability for a range of filter materials coated with fluorinating reagents. Laboratory tests will be used to determine the reactivity of different fluorinating reagents after storage under several different climatic conditions. Initial testing will use some method, e.g. ion specific electrodes, to determine the amount of active reagent still available. Actual fluorination of a simulant will be used as a confirmatory test.

Phase II work will optimize selected filter materials/reagents and demonstrate applicability to improving sensitivity and response time for electrochemical agent sensors.

N90-039 TITLE: Fiber Optic Weapons Sight

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate a rugged optical sight for use on individual and crew served weapons that would be simpler, cheaper, and lighter than existing optical sights and more effective than existing iron sights.

DESCRIPTION: Sighting a weapon with iron sights requires that the eye focus in three objects - the rear sight, the front sight, and the target. Simultaneous focusing in three planes is impossible and must be supplanted by scan-focusing in each of the three planes in rapid succession - a task that requires a young eye and substantial training. Telescopic sights (scopes) are optical instruments which solve this problem by making the target and the aiming reference coincide with the plane of the shooter's retina. This is achieved by a precise complex, and relatively fragile system of lenses, reticles and adjustment controls mounted in a fairly large tube.

Emerging fiber optic (FO) technology involving monolithic bundles of multiple fiber optic cables (FOC) extruded to variable diameter permits image magnification without the use of lenses. Further, it permits off-axis viewing by bending the FOC conduits without the use of prisms and mirrors, and permits erecting an inverted image by twisting the FOC bundle, without the use of erector lenses. This approach should make it feasible to design a simple, tough, inexpensive sight consisting of just one lens, a monolithic FOC bundle of appropriate shape, and a housing. This sight could have all the performance advantages of a telescopic sight and the cost/durability advantages of iron sights.

Phase I will develop engineering calculations and drawings for the FO weapons sight and will fabricate six test items that will be mounted on the M16A2 rifle. This design will ensure interface compatibility with the rifle and a ballistic match with the M855 5.56 mm service ammunition. Phase I will test a representative shooting regime to gather data pertinent to feasibility assessment.

Phase II will fabricate 50 second generation sights for use in an extensive troop test under quasi-operational conditions for comparison with existing baseline sights. Phase II will further optimize size/weight/manprint related designs and will propose a cost-efficient manufacturing process.

N90-040 TITLE: Air Permeable Sorbent Fabric Systems Based on Adhered Sorbent Particle

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to produce an improved air permeable sorbent fabric system for use in chemical protective garments.

DESCRIPTION: This new material will be used in lieu of the current active carbon powder impregnated polyurethane foam laminate currently used as a sorbent liner in standard chemical protective overgarments. These improvements will include reduced weight and thickness; greater comfort based on reduced physiological heat stress; and greater durability after wear and laundering.

Material systems have been marketed internationally based on proprietary technology using adhered hydrophobic active carbon spheres in an air permeable sorbent fabric system. These material systems show promise, but have presented the following problems:

1. The use of such proprietary technology can result in excessive procurement costs because normal competition is not in effect.

2. There have been problems with inadequate adhesion of carbon spheres on these fabric systems.

Other hydrophobic sorbent particles, such as active carbon granules or carbonaceous sorbent beads, should be considered for adhesion to fabrics. However, particular attention should be given to avoidance of particle encapsulation or poisoning by adhesives.

The Phase I effort should demonstrate the feasibility of employing hydrophobic sorbent particles and existing adhesion technology through the production of laboratory demonstration samples with test results which demonstrate that the materials have the physical properties necessary for garment fabrication and are capable of providing protection in a chemical agent contaminated battlefield.

Phase II would focus on optimizing the properties of the most promising Phase I materials and the production of pilot quantities to be used in test uniform fabrication.

N90-041 TITLE: Air and Water Vapor Permeable/Aerosol and Liquid Impermeable Shell Fabrics for Chemical Protective Garments

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop a shell fabric system which introduces the new feature of aerosol penetration resistance in addition to the previously available features of air and water vapor permeability and resistance to penetration of liquid water and liquid toxic military agents.

DESCRIPTION: Military Specification, MIL-C-44031C, Class 2, dated 2 September 1987, describes a water and oil repellent treated, nylon and cotton, twill fabric used as the outer shell for chemical protective overgarments. This fabric is permeable to air and water vapor and thereby provides for heat stress relief by means of warm air convection and evaporative cooling. Furthermore, it resists the penetration of liquid water and liquid toxic military agents. Unfortunately, this material does not resist penetration of small aerosol particles.

New approaches to aerosol filtration in permeable fabrics should be considered. These include incorporation of microfibers, fibers with electrical (static) charges, and other potential techniques for trapping particles.

The Phase I effort should demonstrate the feasibility of a given technique for aerosol filtration in an otherwise satisfactory shell fabric.

The Phase II effort would focus on optimizing the properties of the most promising Phase I materials and the production of pilot quantities to be used in test uniform fabrication. Awardees must have appropriate security clearances to work in this area.

N90-042 TITLE: Hand Held Mine Detector Imager/Discrimination

CATEGORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate a proof of concept model of a mine detector imaging/discrimination system using commercial/Government hand held landmine detectors.

DESCRIPTION: A serious deficiency exists in the ability to detect buried mines. Current technology developments and capabilities have been developed that should greatly enhance the ability to detect mines (both metallic and non-metallic) and reduce the false alarm rates. Development of a proof-of-concept demonstration model will greatly benefit the Marine Corps in its attempts to improve mine detection capability.

Phase I is a practical examination of existing documentation concerning all facets associated with mine detection and classification, metal detection, anomaly detection, soil densities and compaction characteristics, interfaces between man-made and natural objects, signals return rates and radiated variables. Those technologies most compatible leading toward in-ground imaging/discrimination will be reduced to their mathematical components for further statistical analysis using probability curves. A feasibility model will project likelihood of a successful system.

Phase II will develop a prototype system and determine through experimentation the systems's physical characteristics, refine hardware and software requirements and develop the power source. A field test will be conducted to provide the basis for a potential Phase III through development and production.

N90-043 TITLE: Diversion Device/Incapacitant

CATEGORY: Exploratory Development

OBJECTIVE: Develop the ability to temporarily stun or incapacitate an opponent without injuring nearby innocent personnel.

DESCRIPTION: This effect can be attained by flash blinding, concussion by overpressure or rendering the individual unconscious rapidly with noxious gas. Diversion device should not have pyrotechnic characteristics. Previous devices, such as the L610 diversion device propel the internal M218 Bouchon fuze at ballistic speed. The fuze has injured Marines. New generation devices use a small initial detonation to propel a submunition out of the grenade's body. This submunition detonates separately with almost no fragmentation. The by product of the L610 is Antimony-Sulfide, which is quite toxic and can produce significant physical problems later.

Phase I would be proof of concept and or development of a prototype. Respondents should have experience in the development of special operations equipment and the ability to obtain Top Secret clearance. Phase II would be refinement of design and field testing of a number of units to be designated by the Marine Corps.

N90-044 TITLE: Mechanical Breaching Device

CATEGORY: Exploratory Development

OBJECTIVE: The development of non-explosive, positive breaching equipment, which does not emulate currently available tools or pneumatic devices, is man portable, capable of breaching doors/windows/walls/roofs and floors, can be set up quickly and requires little or no user maintenance.

DESCRIPTION: Currently available breaching devices tend to be large and unwieldy. They have limited application to specific targets. A separate device may be required for each type of breach. All of the current devices, rabbit tools, TOHO breaches, Halligan bars and battering rams have specific problems in use.

Phase I would be proof of concept and or development of a prototype. Respondents should have experience in development of special operations equipment and the ability to obtain a Top Secret clearance. Phase II would be refinement of the design and field testing of a number of units to be determined by the Marine Corps.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N90-045 TITLE: Force Level Analysis Tool Support and Software Module Development

CATEGORY: Advanced Development

OBJECTIVE: Develop modeling tools for multi-warfare, multi-platform warfare.

DESCRIPTION: The Space and Naval Warfare Systems Command (SPAWAR) is currently developing methodologies and tools for assessing force performance. Due to the evolving threat advancing rapidly in scope and capability, it is critical that SPAWAR move forward to develop a set of modeling "tools" capable of assessing the integrated capabilities of U.S. Naval battle forces while they are participating in multi-warfare, multi-platform warfare.

For this multi-warfare problem, SPAWAR is evaluating a simulation/modeling development environment. The modeling environment should support the use of a wide variety of computer languages (FORTRAN, Pascal, C, LISP, etc.) and operating systems (VMS, DOS, UNIX, etc.). The simulation architecture is based upon a modular object oriented approach to modeling. Since the simulation format has been developed, elements of this matrix(algorithms and computer code) for a wide variety of naval warfare systems ranging from C***, ASW, AAW, STW, LOG, etc., need to be developed. All source codes must meet specified requirements addressing user needs, equipment, software coding, modeling environment, system security, and configuration management. All source codes which are developed would become property of SPAWAR.

N90-046 TITLE: Advanced Systems and Concepts for Future Naval Warfare

CATEGORY: Exploratory Development

OBJECTIVE: To enhance Navy's future Battle Force Warfare capabilities in C^3I, Undersea Surveillance and ASW.

DESCRIPTION: Navy is seeking new, innovative, high risk/high payoff ideas in technologies and/or advanced systems concepts in support of C^3I, Undersea Surveillance and ASW. The new technologies and systems concepts must address Battle Force Warfare (both low intensity conflict and full power projection) for the years 2005 and beyond. Imaginative, realistic ideas are encouraged. Offerors may submit as many proposals as deemed appropriate to cover their varied ideas.

The Phase I proposal should address: a) the systems concept and technology being proposed; b) the operational utility of the system; c) the scientific principal(s) involved (show quantitative formulation where appropriate); d) the adequacy or maturity of the technical discipline to realize the system; and e) the work planned to demonstrate technical feasibility.

Development of the requisite sub-system and/or new technology to demonstrate the proposed system concept will be addressed in Phase II, if technical feasibility warrants.

N90-047 TITLE: Non-Acoustic Underwater Imaging

CATEGORY: Exploratory Development

OBJECTIVE: To provide the Navy with the capability to covertly detect, classify and identify, in real-time, potential threat submarines.

DESCRIPTION: The Navy is seeking innovative Exploratory Development of non-acoustic underwater imaging techniques to covertly image, in real-time, potentially hostile submarines. (Navy is also interested, to a lesser extent, in non-acoustic techniques to

covertly determine range-only of threat submarines). The imaging systems will be installed aboard submarines, surface ships, helicopters and fixed-wing aircraft. Offerors may want to consider a single technique suitable for all platforms or more than one technique, each being unique to a specific platform. A capability to covertly image underwater to ranges of 6000 yards is being sought.

The Phase I proposal should address: a) the scientific principal(s) involved that supports the underwater imaging technique being proposed (show quantitative formulation where warranted); b) the system concept; c) the adequacy of maturity of the technical discipline to realize the system concept; d) the operational utility; and e) the work planned to demonstrate technical feasibility. Development of the requisite subsystems and/or new technology to demonstrate the proposed imaging technique will be addressed in Phase II, if technical feasibility warrants. (Note: Offerors proposing more than one imaging technique should submit separate proposal for each. Classified proposals are acceptable).

N90-048 TITLE: Non-Acoustic Submarine Tactical Communications

CATEGORY: Exploratory Development

OBJECTIVE: To provide the Navy a capability for covert, real-time, tactical information exchange between submarines and surface combatants.

DESCRIPTION: Navy is seeking innovative Exploratory Development of non-acoustic underwater communications techniques that provide for real-time, covert data communications between submarines at operating depths and between surface combatants and submarines at operating depths. Data and modulation rates should be commensurate with operational and tactical needs. Covert inter-platform data exchanges to ranges of 6000 yards is being sought.

The Phase I proposal should address: a) the scientific principal(s) involved that supports the non-acoustic underwater communications technique being proposed (show quantitative formulation where warranted); b) the system concept; c) the adequacy or maturity of the technical discipline to realize the system concept; d) the operational utility; and e) the work planned to demonstrate technical feasibility. Development of the requisite subsystems and/or new technology to demonstrate the proposed technique will be addressed in Phase II, if technical feasibility warrants. (Note: Offerors proposing more than one non-acoustic communications technique should submit a separate proposal for each. Classified proposals are acceptable).

N90-049 TITLE: Warfare Systems Architectures

CATEGORY: Exploratory Development

OBJECTIVE: To promote innovative concepts for future Naval Warfare Systems.

DESCRIPTION: Naval warfare strategies and system acquisitions are undergoing deliberate changes in the Navy. Stand-alone system, interoperability issues and adverse programming actions are a few of the reasons giving rise to these deliberations. The Navy is presently examining a top-down approach to R&D and acquisition decisions, guided by Top Level Warfare Requirements (TLWRs). The Warfare Systems Architectures focus on TLWR compliance. Rigorous mission analysis, force level perspectives and systems architectures are the end products. They address 12 warfare mission areas: Command (communications), C***, Strike Warfare (SW), Anti-Surface Warfare (ASUW), Mine Warfare (MIW), Electronic Warfare (EW), Special Warfare (SW), Amphibious Warfare (AMW), Anti-Air Warfare (AAW), Anti-Submarine Warfare (ASW), Space, and Logistics. The force structures to implement these warfare missions include the Carrier Battle Force (CVBF), Battleship Battle Group (BBBG), Amphibious Task Force (ATF), Area ASW Force and SLOC Protection Force.

The architectural process involves four steps: 1) Functional decomposition of the mission which entails decomposing the mission into tiers, establishing Required Operational Functions (ROF), devising functional flow diagrams, and building a complete data base. 2) Physical analysis of the current force, e.g., complete understanding of the platforms, systems interdependencies and Battle Force C^2 requirements, allocating ROFs to platforms, composing a baseline warfare systems architecture, establishing functional shortfalls of the baseline architecture and adding Fiscal Year Development Plan programs. 3) Performance which examines the Architecture vs. TLWR via models and war-gaming, establishes performance shortfalls, and identifies shortfall resolutions, such as systems upgrades, notional platforms, etc. This step is reiterated and refined. 4) Architecture Options, which establish WSA&E products such as Force Level Architectures and TLWR compliant options (costs, performance, schedule, risk, technology, payoff).

Proposals for innovative systems architectures should address a single mission area; multiple proposals are acceptable.

Phase I should focus on the architecture and a means to show feasibility of the architecture relative to the four steps of the architectural process discussed above.

Phase II will involve continued analyses (via the 4 step process) to begin realization of the architecture(s).

NAVAL SUPPLY SYSTEMS COMMAND

N90-050 TITLE: Artificial Intelligence System for Source Code Compliance to Data Rules

CATEGORY: Advanced Development

OBJECTIVE: Development of a prototype software system which will analyze software source code for compliance with format rules.

DESCRIPTION: An Artificial Intelligent (AI) System is needed to analyze a program's source code to determine compliance to data rules. Rules would include data validation code, restriction of update to data owners, and naming conventions. The AI system would need to automatically adjust itself as the rules changed.

Phase I would produce a software specification. Phase II would produce a prototype software system.

N90-051 TITLE: Central Management of Multi-Site ADP Capacity Planning

CATEGORY: Advanced Development

OBJECTIVE: Development of a prototype cooperative processing software system for implementation at Naval Supply Systems Command (NAVSUP) activities.

DESCRIPTION: Capacity planning requires expertise in the use of several software packages in addition to knowledge in collecting manually prepared forecast data. The software packages include modeling tools, CPU event reporting tools, disk management software, configuration management software, and a resource management system. In addition, once the basic data has been collected, management analysis must be performed to develop a capacity plan that covers many computer sites. The plan must include information for fine tuning forecasting techniques, identification of performance problems through review of key indicators, determination or reallocation of current resources, and decision on future capacity requirements. An expert system consisting of mainframe components and personal computer cooperative processes is required to facilitate capacity planning. The cooperative processing subsystem would teach capacity planning skills, walk users through the accomplishment of site specific procedures, and interview users for forecast data. The remote site mainframe components would extract data to be sent to the central site. The central mainframe site would provide a data respiratory for the management analysis component.

Phase I would produce a specification for the prototype expert system.

Phase II would result in a prototype expert system.

N90-052 TITLE: Integrated Users Support System for Shipboard Uniform Automated Data Processing System (SUADPS) Resystemization

CATEGORY: Exploratory Development

OBJECTIVE: The project will involve the development of a shipboard training approach which integrates initial, refreshment, and referential training.

DESCRIPTION: The SUADPS Resystemization project is undertaking a zero based redesign of the supply and financial management systems afloat. The objective is to develop a standard hardware and software interface to the sailor aboard ship. An essential ingredient for the system is the integration of training. Although there are plans [illegible]ure classroom training will be available when the new system is ready to be implemented, as well as implementation traini[illegible]s that have not been addressed are as follows: (1) Training of sailors as they come abroad ship. The turnover of crews aboa[illegible]p is extremely high, and not every sailor has the chance to go through training ashore. There is a requirement to train these sailors on the various aspects of the system once they get aboard. (2) Refresher training aboard ship. As sailors move from assignment to assignment aboard ship there is a need to provide a mechanism for them to receive refresher training while onboard. This would have to vary in detail and difficulty depending on the individual subject area, as well as the sailor and (3) Referential training. As part of the onboard training requirement it is necessary to give the sailor access to the reference material needed to properly do his job. The system has to be robust enough to support detailed review of standard reference publications, as well as the use of "expert systems" to guide him through various problems and questions. The project will involve a review of the training area to determine the mix of hardware and software than can be brought to bear to meet these requirements. The training requirement has to be integrated into the new system, and able to support the requirements listed above. Phase I will specify the "training" approach and the system requirements for implementation. Phase II will provide a prototype of the system demonstrating how it can be integrated into the resystemized system.

N90-053 TITLE: Automated Aid for Hazardous Material Control

CATEGORY: Advanced Development

OBJECTIVE: To create a turn-key device to aid in controlling and properly documenting Hazardous Material.

DESCRIPTION: Development of a micro type hand carried system with update capability of all changes to NAVSUP 505 (AFR 71-4) to allow quick up to date knowledge by Navy and Air Force (AF) loadmasters concerning critical rules concerning compatible/incompatible cargo etc. Navy C-9 aircraft loadmasters have a definite need and even AF loadmasters must now scramble to have updates and own copies of regulations which change often--mobile nature of missions to possible isolated areas makes this critical. A belt type flip out type unit would be best (i.e.; ergometrically designed) or stowable in A-4 bags (duffel bags). Phase I will provide a proposed mock-up of the model. Phase II will provide a prototype of the device.

N90-054 TITLE: Extreme Cold Weather and Fuel Resistant Protective Handware

CATEGORY: Exploratory Development

OBJECTIVE: To develop a fire retardant, cold weather glove which provides for warmth and dexterity at temperatures down to -40 F.

DESCRIPTION: The Navy has a need for a cold weather glove which provides for warmth and dexterity at temperatures down to -40 F. The gloves must be fire retardant, water impermeable and exhibit chemical resistance to all classes to liquid fuels. Simultaneously, the glove must allow for rapid transmission of moisture vapor from the skin to the outer surface. The component materials and specific design of the glove must component materials and specific design of the glove must allow for good dexterity/tactility and minimize hand/finger fatigue. The use of novel polymer technology is encouraged. Phase I will be aimed at developing suitable materials for fabrication into gloves. Phase II will produce at least two suitable prototypes.

N90-055 TITLE: Indexing of Technical Information for Computer Aided Acquisition and Logistics Support (CALS)

CATEGORY: Exploratory Development

OBJECTIVE: To develop and test an indexing and data structure methodology for CALS database designs to achieved configuration management of technical information in integrated databases.

DESCRIPTION: Each functional group of technical information possesses its own unique index. These include part numbers, stock numbers, drawing numbers, logistics control numbers, as well as many others. However, the indices for each group are not 100% compatible and therefore can not translate successfully at all times. Automation of the entire technical information system which is mandated by the Department of Defense under the Computer-aided Acquisition Logistics Support (CALS) initiative, requires development of a universal indexing and data structure in order that all information can be managed under one compatible system.

N90-056 TITLE: Durable Press Finish for Fire Retardant Treated (FRT) Cotton Fabric

CATEGORY: Exploratory Development

OBJECTIVE: To develop a durable press finish for fire retardant treated (FRT) cotton fabrics.

DESCRIPTION: The Navy has a need for a durable press finish for FRT cotton fabrics in finished weights up to 6.0 oz/sq yd. The finish shall not adversely affect the material's physical and/or fire retardant characteristics by more than 10%, and the finished fabric shall have a soft hand. The finished fabric shall demonstrate a minimum durable press rating of "3" when tested in accordance with AATCC Method 124-1984. The finish must be durable to multiple laundering cycles. A five-yard sample, minimum 45" cloth width is required for Phase I. One hundred yards of material, finished on standard commercial production equipment is requirement for Phase II.

N90-057 TITLE: Reverse Program Data (RPD)

CATEGORY: Exploratory Development

OBJECTIVE: Explore the feasibility of the Navy Inventory Control Points (ICPs) obtaining timely information of declining programs due to equipment modifications and phaseout. Development of a pilot program to reduce the potential for ordering obsolete spare/repair parts.

DESCRIPTION: Notification of a configuration change is normally accomplished through the receipt of Design Change Notices (DCN). DCN's may notify the Inventory Control Parts (ICPs) that a stocked item is obsolete, will become obsolete or is superseded by a higher reliability interchangeable part. Program support data is another vehicle for notifying the ICPs. However, program support data is not at the part level and, if provided, would apply to field changes, ordnance alterations, ship alternations. Although program support data is required for all significant changes, program support data sheets generally apply to major changes only. An effective formal procedure to ensure against the procurement of obsolete items does not exist. Program change data is integrated with all provisioning backlog and not segregated. All of these conditions contribute to a significant probability of procurement of obsolete items.

Phase I should focus on the feasibility of a system to forecast the impact of declining programs on spare/repair material requirements, identify the most feasible long term system along with the major policy/ADP programs organization and resource changes needed to affect it, and consider a short term pilot program with an actual declining program to demonstrate the proposed system, including a detailed POA&M (Plan of Actions and Milestones).

Phase II is to be a test of the pilot program with a declining program selected by the Navy.

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND

N90-058 TITLE: Recombinant DNA Cloning of Enzymes Essential for the Enzymatic Removal of Carbohydrate Antigens from Human Erythrocytes for the Production of Type "O" Red Cells from Type "B" Cells

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate ability to clone, express and isolate recombinant produced enzymes and scale-up for large quantity production.

DESCRIPTION: A requirement exists for the genetic cloning, expression, and isolation of an alpha galactosidase present in green coffee beans. The enzyme is used for the cleavage of the B carbohydrate surface antigen present on human B erythrocytes for the enzymatic conversion and production of type O red cells from type B erythrocytes. The enzyme has been isolated and purified by conventional techniques from green coffee beans and subsequently used for the enzymatic conversion of type B red cells to type O with successful transfusion of the converted red cells into type A human volunteers. To proceed, expertise is necessary in enzyme cloning, expression, and isolation of the recombinant produced enzyme in sufficient quantities for full scale clinical trials as well as eventual large scale production according to FDA GMP requirements. The Navy has an interest in obtaining an FDA approved red blood cell enzymatic conversion capability to produce type O erythrocytes from any donor red cell units in order that transfusions can be performed without the need for typing and cross matching. Additional reference material can be obtained in the scientific literature.

N90-059 TITLE: Production of Biosensor Based Techniques and Equipment for Essential Clinical Assays to be Performed in the Military Field Environment for Combat Casualty Care

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate feasibility of employing advanced technologies (biosensors, etc.) to determine important medically diagnostic values in the combat environment. The goal is technology implementation that is battlefield durable, reliable and rapid.

DESCRIPTION: The Navy and Marine Corps have the need for the development of clinical diagnostic capabilities in the field based on noninvasive or blood sample assays which utilize biosensors or other advanced technologies that can provide essential clinical assay evaluations for combat casualty care. These devices must be small, rugged, operational in environmental extremes, and independent of reagents that require refrigeration, freezing, or carefully controlled storage conditions. Ideally, devices and techniques should be reagent independent and easily used by medical support personnel in field and shipboard environments. The essential diagnostic assays required to be performed by one or several clinical devices include blood gases, hematocrit, hemoglobin, serum electrolytes, glucose, BUN, and creatinine. Offerors need not address all assay requirements to be considered. The best technical approach for military needs in a field environment will be evaluated for each assay and not simply by instrumentation that performs the most assays in a single unit. Assay speed, reproducibility, and accuracy, as well as the ability to perform tests in close proximity to the casualty, are important considerations.

NAVAL AIR SYSTEMS COMMAND

N90-060 TITLE: Coating System for High Temperature Titanium Alloys

CATEGORY: Exploratory Development

OBJECTIVE: Development of a coating or coating system applicable to titanium base alloys for operation above 1200° F in the oxidizing environment of a gas turbine engine.

DESCRIPTION: Future generations of gas turbine engines for naval aircraft and missile application have strong requirements for high specific thrust ratios and low specific fuel consumption. In order to meet these goals, gas turbine engines must operate at higher temperatures, pressures and speeds using advanced high temperature, lightweight materials. The primary materials candidates, particularly for compressor applications, are advanced titanium alloys and titanium intermetallics, especially titanium aluminide. Nevertheless, evaluation of these materials has shown that significant deterioration in mechanical properties and structural integrity can result from exposure to aggressive, high temperature environments.

An innovative coatings development effort is required to address the problems of rapid oxidation, hot corrosion and hot-salt-induced stress-corrosion cracking of high temperature titanium alloys. This coating system should be applicable to titanium alloys operating up to 1300° F in a gas turbine engine environment, to titanium aluminides operating up to 1800° F in the same environment or to both.

The Phase I effort should demonstrate the feasibility of one on more coating system on at least one appropriate titanium alloy.

Phase II would extend coating development and include characterization of a coated system through materials testing over the temperature regime interest. Specific alloy or intermetallic selection is to be made by the offeror.

N90-061 TITLE: Assessment of Heat Damage in Composite Materials

CATEGORY: Exploratory Development

OBJECTIVE: Characterize the effects of heat on resin-matrix composite materials and develop nondestructive inspection techniques capable of detecting heat damage at the operational level.

DESCRIPTION: The effects of heat damage on resin-matrix composite materials of the type used in naval aircraft have not been fully characterized. Nevertheless, these materials may be exposed to damaging levels of heat as a result of fire or operations. Furthermore, it is desirable that the damage of a severity relevant to the mechanical performance of composites be assessable at the operational level of Navy small fleet aircraft via a simple inspection procedure. Early studies have shown that current carbon-epoxy aircraft composites exhibit degraded mechanical properties following exposures at 300° C for short periods. Under carefully controlled conditions it was possible to correlate discoloration of standard paint coatings with the decrease in mechanical properties.

An innovative development project is required that includes characterization of heat damage in appropriate aircraft carbon-epoxy laminates and the exploratory of nondestructive inspection (NDI) techniques that can identify and assess this damage in the field. The baseline composite material should be Hercules/Fiberite IM6/3501-6. Additional characterization of at least one other fiber-epoxy system during Phase II would be required. The simplicity and field applicability of any developed NDI equipment will be placed at a premium.

N90-062 TITLE: Remote ASW Sound Sources

CATEGORY: Exploratory Development

OBJECTIVE: Develop method for a low flying aircraft to beam sound into ocean water without the use of expendables or mechanical contact with the sea water.

DESCRIPTION: P-3 anti-submarine warfare aircraft, drop passive sonobuoys over large tracks of the ocean and monitor returning RF signals for the presence of submarines. Active sound sources, such as sonar pingers or explosive charges are sometimes dropped in the water and used in conjunction with sonobuoys to actively search for submarines. Both sonar pingers and explosive charges are expendable which must be replenished after use. To save cost and payload weight the Navy is therefore interested in reusable methods of remotely producing sound in ocean water by a low flying aircraft. The method may rely on lasers or other means of projecting energy to the ocean surface where a means must be found to convert the energy to sound in the frequency band of interest.

The Phase I study and/or demonstration should clearly demonstrate both feasibility and anticipated cost and energy levels achievable by the proposed method. The proposal should also include an outline of a proposed Phase II demonstration of the concept.

N90-063 TITLE: Anti-Jam Methods for RF Receiver

CATEGORY: Exploratory Development

OBJECTIVE: Develop a method of extracting low level RF signals from high level background noise and jamming.

DESCRIPTION: Sonobuoys are air-dropped in the ocean in great numbers in anti-submarine warfare operations to detect submarines by means of underwater acoustic signals. The signals are telemetered to aircraft by means of battery-generated RF signals. These signals are susceptible to interference by relatively unsophisticated submarine-deployed RF jamming devices. An anti-jam technique is sought which is capable of distinguishing a signal strength 20 Db below the background RF interference. The technique must not require modification of the sonobuoy transmitter and cannot be modulation dependent. The proposed Phase I study and/or demonstration methodology must be capable of incorporation in an airborne receiver/antenna system. The proposal should also include an outline for a proposed Phase II demonstration of the concept.

N90-064 TITLE: ASW Non-Acoustic Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To devise an inexpensive non-acoustic, non-magnetic, passive, air-dropped buoy for the detection of submarines

DESCRIPTION: The Navy Anti-Submarine Warfare program currently uses air-dropped buoys to detect and track the position and course of submerged submarines. Recent advances in technology have reduced both the noise emissions produced by submarines and their influence on the Earth's magnetic field, thus reducing the range that passive buoys can detect a passing submarine. New methods of passively detecting submarines are, therefore, sought that do not depend on the acoustic emissions made by the submarine or by changes in the Earth's local magnetic field caused by the submarine's passage. The proposed detector of submarines is restricted to deployment within the standard 5 inch diameter buoy housing and must be inexpensive to mass produce. The proposed study and/or demonstration must address feasibility and all technical risk factors. Phase II should demonstrate the concept outlined in Phase I utilizing prototype hardware.

N90-065 TITLE: Low Probability of Intercept/Anti-Jam (LPI/AJ) Voice/Data Link

CATEGORY: Exploratory Development

OBJECTIVE: To develop a LPI/AJ communications link concept and design implementation suitable for covert communication with and between U.S. military aircraft.

DESCRIPTION: Navy aircraft are being designed to reduce their detectability by the enemy. In addition, they have to perform their missions in an environment where communications must be resistant to jamming. What is needed is a jam resistant, covert communication capability to support Naval aviation requirements for attack, fighter, and early warning/force coordination missions.

Phase I should consist of a study outlining a systems concept and basic systems performance tradeoffs.

Phase II should expand on the concepts presented in Phase I to provide detailed tradeoffs resulting in a design implementation, with quantification of expected performance.

N90-066 TITLE: Optical Fiber Compatibility with Advanced Electronic/Structural Materials

CATEGORY: Exploratory Development

OBJECTIVE: To investigate optical fibers embedded in various materials for distributing optical signals.

DESCRIPTION: Optical Fibers can provide an advanced data transmission, diagnostic and sensing capability for future aircraft. Most optical fibers are currently utilized in a cable or ribbon wiring harness. There is a need to provide a monolithic materials capability for distributing fiber optic signals in computer backplanes as well as in aircraft skins and engine/aircraft structures. The thermal, structural, and optical transmission properties of promising ceramic, thermoplastic, composite and/or metal matrix materials require investigation. These investigations should lead to the next generation of optical computer signal distribution backplanes as well as new capabilities for "smart skins" and "smart structures" for aerospace applications.

N90-067 TITLE: Long Duration Performance of Aircraft Inertial Navigation System

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the damping of inertial systems

DESCRIPTION: Currently, naval aircraft missions are of relatively short duration (a-10 hours) with the onboard Inertial Navigation

System (INS) operating in a free inertial mode. Future applications, however, include missions of long duration requiring the aircraft to be on station for several days (e.g. UAV High Altitude Long Endurance (HALE) Airship etc.).

The Phase I study is to address a) determining feasibility/necessity of damping a strapdown inertial system; b) methods of damping; and c) proposed mechanizations with associated tradeoffs in complexity cost, performance, etc.

N90-068 TITLE: Impact of Using Dispersed Sensors for Navigation

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the sharing of inertial sensors between navigation systems

DESCRIPTION: Currently, aircraft having more than one inertial navigation system do not share sensors between those systems. Sharing sensors would increase the redundancy level and the reliability of the navigation suite. The study is to address a) methods of synthesizing a Fail-Op (or better) navigation solution using dispersed sensors; b) assessment of performance degradation resulting from sharing of dispersed sensors; and c) an assessment of inertial sensor accuracy requirements to allow failure isolation to the accuracy level needed to meet basic mission requirements.

N90-069 TITLE: Passive Fiber Optic Components for Severe Environments

CATEGORY: Exploratory Development

OBJECTIVE: To develop fiber optic components capable of withstanding severe aircraft environments.

DESCRIPTION: The application of fiber optic components to military aircraft will require a family of components capable of withstanding environmental extremes. Development of fibers, cables, connectors and couplers capable of withstanding the high temperature and vibration of the aircraft engine environment is required. In addition, high density multi-channel connector and cabling concepts are required for computer interconnects an aircraft interconnection. Lens connectors, silicon V-groove technology, ceramic or composite backshells and other navel materials or design concepts capable of providing hermetic and semi-hermetic interfaces for multiple fiber to electro-optic components or sensors are solicited.

Phase I should outline the specific design for each component including environmental analysis for the aircraft/engine application. Prototype hardware should be included if available.

Phase II should be the final design and analysis and delivery of multiple units to demonstrate reproducibility of the design and environmental capability.

N90-070 TITLE: Portable Koalas: The Knowledgeable Observation-Analysis Linked Advisory System

CATEGORY: Exploratory Development

OBJECTIVE: Develop tools for implementing a portable version of the KOALAS architecture for use on microprocessor-based workstations.

DESCRIPTION: The KOALAS architecture is being developed under an ongoing coordinated R&D program between US Navy and Los Alamos National Laboratory. The KOALAS architecture provides a generic system design for a broad range of tactical decision-making systems and is described in technical reports available in the public domain. The architecture comprises two subsystems: (1) a situation assessment subsystem; and (2) a conventional rule-based advice generator. The heart of KOALAS is an embedded simulation system that comprises the situation hypothesis upon which the tactics advice generator operates. Human performance advantages of KOALAS in the anti-air warfare application include (1) reduced manpower required for surveillance, resource allocation decisions, and intercept control; (2) increased situational awareness; and (3) optimal combat resource management. Engineering advantages of the KOALAS approach include: (1) minimized information processing load on sensor fusion systems; (2) constrains on backtracking in multisensor correlation algorithms; (3) common data structures for training and deployed systems; and (4) robust performance against deception. The project will focus on air warfare, but results will encompass both air and surface platform applications.

The Phase I objective is: (1) Identify specific tools to be developed, such as an interface development tool, an embedded simulation tool, and a frame-based or rule-based advice representation tool; (2) Establish potential market for tool set; (3) Collect available technical data regarding KOALAS architecture; (4) Plan development; (5) Establish close collaborative relationship with user community.

Phase II objective is to develop, document, and produce a basic KOALAS tool set.

N90-071 TITLE: Innovative Graphics Architecture Concepts for Advanced Simulators

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabricate a low cost, high performance graphics architecture capable of supporting high resolution simulation. If successful, mission training, mission rehearsal and mission review would be accessible to many more people, on smaller simulator systems, for greater lengths of time, at a reduced cost.

DESCRIPTION: The use of visual simulators during training, mission rehearsal, and post mission debriefing can greatly increase aircrew performance and mission effectiveness. The size and cost of current simulation systems, however, makes the proliferation and tactical deployment of simulators infeasible. A low cost, small footprint simulation system is needed to support tactical operations. The purpose of this effort is to develop such a system by utilizing recent advances in parallel processing hardware to attain performance/cost improvements. The system will be a desktop simulator capable of real-time generation of visual, infrared, and radar scenes of terrain, cartographic and man-made features. A parallel architecture is envisioned using commercially available processing elements. Key design problems include defining an optimal processor topology, interfacing the processor to high speed disk subsystems, and interfacing the processor to display memory. Another major design hurdle will be the development of a small display device capable of providing the level of realism necessary to support successful mission simulation, while at the same time not sacrificing portability and ease of use. The possible inclusion of innovative display concepts, like helmet mounted displays and fiber optic bundles, should be possible targets for evaluation.

Phase I work will involve the identification of the necessary hardware and software components for this simulator, as well as defining the operational requirements for the prototype system.

Phase II will involve the creation of an advanced development prototype to demonstrate the feasibility of the simulator system. Offerers may submit proposals addressing any or all of the items embodied above.

N90-072 TITLE: Detection of Wideband Radar Signals

CATEGORY: Exploratory Development

OBJECTIVE: Devise a receiver architecture capable of receiving wideband low power radar transmissions suitable for installation in tactical aircraft.

DESCRIPTION: Radar transmitter and signal processing technologies now permit wideband modulation of continuous wave transmissions. These modulations can take a variety of forms. From an electronic warfare point of view, a very difficult modulation is one which appears random, such as a pseudonoise (P-N) sequence of phase reversals of the carrier frequency. The effect of this radar transmission format is a low peak power compared to traditional pulsed radar signals, broad band across which the power is spread, and a signal format which has no obvious identification characteristics. Used in missile seeker radars, these transmissions cannot be detected by current tactical EW systems such as superheterodyne, IFM or channelizer receivers.

An architecture for a realizable EW receiving system which will reliably intercept P-N modulated and other low power, wideband radar signals is needed. The system must be capable of instantaneous bandwidths of 10 to 20% of the carrier frequency, of detection of signal levels well below the noise power level of the signal bandwidth and must be able to test for known modulations of high priority and threat signals. The system must simultaneously retain the sensitivity and selectivity of current EW systems against traditional pulsed radars, be capable of intercept of frequency diversity radars such as pulse-to-pulse frequency hopping and FM-on-pulse and must be capable of extremely high sensitivities (<-100dBm) against threat signals whose parameters are precisely know. The system must be capable of reconfiguration to meet varying search and signal bandwidth requirements and must be programmable to intercept new signals as they emerge.

Phase I should specify the receiver system architecture, including the processing scheme, verify that the system is realizable using commercially available hardware and software and provide a program plan for Phase II proof-of-principle breadboard development and test.

N90-073 TITLE: Passive Non-Cooperative Target Recognition Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Devise a passive non-cooperative target recognition sensor for installation in aircraft and/or missiles.

DESCRIPTION: A proof-of-concept is sought that demonstrates a new method of identifying threat target platforms, as opposed to friendly or neutral platforms. Cooperative systems are limited in usefulness due to their overt nature, the tendency of operators to avoid using them and their vulnerability to exploitation, decoy and spoofing. Non-cooperative systems require no cooperative answer from the suspect platform. Non-cooperative target recognition (NCTR) systems can be active, as in radar modulation techniques, or passive, as in infrared images or infrared signature detectors. A passive NCTR technique is needed that is both robust and implementable in aircraft and/or missiles. A combination of sensors is acceptable if it can be shown that fusion at the sensor level is clearly advantageous. Delivery of theoretical proof-of-concept computations is sought for Phase I, which should be supported by

breadboard demonstration in Phase II.

N90-074 TITLE: Secondary Sensor for Anti-Radiation Missiles

CATEGORY: Exploratory Development

OBJECTIVE: Devise sensor method of targeting critical ground-based radar components. Sensor can not rely on electro-magnetic (EM) emission from targets.

DESCRIPTION: Anti-Radiation Missiles (ARMs) are effective when homing on a radiating electro-magnetic source. However, when the threat EM source is shut off for countermeasures purpose, the ARM must depend on a predetermined course, without additional guidance information from the radiating source. A secondary sensor or shared aperture concept is needed, preferably passive, to supply guidance information during the blackout period. Infrared detection co-axial with the primary radiation detection sensors are currently being considered by the Navy. Novel proposals are sought which do not utilize conventional IR or visible light detection methods. Contractors should consider sensor candidates that could be housed in a missile with a typical diameter of five inches. Total sensor weight, including power supply, should not exceed 15 pounds.

Phase I - perform investigation study of proposed secondary sensor system that provides proof-of-concept using computer simulations and models and/or a partial breadboard system.

Phase II- construct a brassboard system that demonstrates the sensor concept and prepare a documentation package that is suitable for taking the concept to Engineering Development.

N90-075 TITLE: Improved IRST Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Devise improved IRST sensor which eliminates clutter and false targets.

DESCRIPTION: Airborne Infrared Search and Track (IRST) sensors are desired to perform non-imaging infrared missile searches of the horizon to detect incoming low altitude aircraft target missiles. The field-of-view (FOV) extending from 20,000-30,000 feet down to a few milliradians above the horizon is of greatest interest in designing detectors to detect aircraft and missiles that may be traveling within ten feet of the ocean surface. Detection in this FOV is hampered by IR clutter, by clouds, and by the marine barrier layer. Sunlight glints from the edges of clouds are a primary source of IR clutter producing false detection of targets. The marine barrier layer of evaporative duct is caused by the steep water vapor gradient within a hundred feet of the ocean surface. This gradient has the effect of magnifying image motion caused by small movements of the platform resulting in anotner source of false IRST target identifications. An improved design concept is sought which eliminates clutter and false targets from scanning IRST detectors.

Phase I should provide an analysis which demonstrates the new concept and presents a proposed IRST sensor design.

Phase II should include a breadboard demonstration of the concept.

N90-076 TITLE: EO-IR Sensor Application in Anti-Air Warfare

CATEGORY: Exploratory Development

OBJECTIVE: Research application of evolving EO-IR technology to meet anti-air requirements.

DESCRIPTION: EO-IR technology has evolved in detectors and materials that promise to offer significant improvement in sensitivity and inherent angular discrimination. These features coupled with high capacity processing to reject background and countermeasures will offer low false alarm and high performance tracking of airborne targets. Utility of these emerging technologies will depend on the operational environmental conditions (i.e. probability of cloud free line of sight and atmospheric particles) and any countermeasure degradations. Research is sought to investigate the application of modern EO-IR sensors in the previously described environmental areas using environmental data and projected countermeasures to assess performance effects.

Phase I will be a study/report/algorithm investigation.

Phase II will be algorithm application (software/hardware).

N90-077 TITLE: Buffet Vibration Absorber

CATEGORY: Exploratory Development

OBJECTIVE: To suppress the buffeting vibrations of aircraft aerodynamic surfaces. Demonstration of the feasibility of such a

device would lead to flight evaluation and eventual incorporation into fleet aircraft such as F/A-18 that currently experience problems, including structural fatigue, due to buffet.

DESCRIPTION: Tactical aircraft maneuvering at high angles of attack induce the formation of unsteady and vortex flows that, in turn, excite the aft aerodynamic surfaces of the aircraft, causing the vibrations known as buffet. Contemporary fighter aircraft such as F-14, F-15, and F-18 have all been subject to destructive vibrations of their twin vertical tails. Control considerations dictate that this type of configuration is likely to remain in favor; that is, the source of the excitations will probably not go away. Therefore, the surfaces will have to be designed to survive in their environment. As an alternative to beefing up the structure to withstand the vibratory stresses, the application of vibration absorber technology is suggested.

Vibration absorbers typically consist of a spring-mass system with a natural frequency that corresponds to the unwanted excitation. In this case, the excitation is broad band, and significant responses are at the natural frequencies of the structure.

Phase I should consist of a study to characterize the potential performance of such a device, including an assessment of its energy absorbing potential and frequency requirements.

Phase II should develop and deliver to the government for testing a prototype model tailored for a particular aircraft application.

N90-078 TITLE: Operational Exploitation of Active and Passive Sensor Information by U.S. Navy Tactical Aircraft Operating in a Multi-Platform Tactical Situation

CATEGORY: Exploratory Development

OBJECTIVE: To design an active and passive sensor information processing and display architecture that enables aircrews to detect and classify targets beyond active sensor range and engage targets at the maximum range of their missile systems. If successful, this system architecture (or components of it) could be integrated into current fighter aircraft and included in the design specifications for future generation fighter aircraft.

DESCRIPTION: Fleet defense and fighter escort operations require aircrews to assimilate a variety of active and passive sensor information, to commit weapons, and to engage prospective enemy targets rapidly. The processing and display of this sensor information (such as information from non-cooperative tactical data links) may provide aircrews with longer detection ranges, longer reaction time intervals, enhanced situational awareness, improved weapon effectiveness, and increased survivability. Phase I should analyze a U.S. Navy fighter aircraft versus a current generation threat using the following approach:

- o Identify a scenario that would include both sides participating in the control of modern fighter/interceptor aircraft, using airborne warning and control system aircraft, or a similar system (E-2C Hawkeye). Each side would also employ state-of-the-art automated control systems.
- o Identify all sensors (existing and proposed) and the types of information provided by each sensor.
- o Analyze the characteristics of the information provided by each sensor.
- o Evaluate alternative information processing and display concepts to optimize fighter weapons systems employment in a real-world operational environment
- o Provide simulations of this architecture and alternative displays on a computer. Specifically, this would include the simulation and display of data from selected sensors, such as non-cooperative data link.

Phase II would expand the processing and display architectural concepts for Engineering Development.

N90-079 TITLE: Automation of Digital Data Review and Verification

CATEGORY: Engineering Development

OBJECTIVE: To take advantage of near-future Computer-Aided Design (CAD) and Engineering Data Management and Information Control System (EDMICS) capability so as to enable on-line verification of aircraft hardware vendor's Technical Data Packages (TDP's) submitted in digital format per Department of Defense (DOD) initiatives. If successful, automated data verification would slash administrative overhead, dramatically increase the accuracy and speed of the Government's verification process, and efficiently focus senior industrial specialists' effort on complex producibility, capability and competitiveness issues.

DESCRIPTION: Government review of vendor TDP's is now a labor-intensive, manual operation requiring direct handling of tens of thousands of paper blueprints or aperture cards for each significant aircraft or component program. The DOD is requiring digital format delivery of TDPs for 1990's new production programs, promising enormous cost savings to vendors, space savings at Government repositories, and vastly broader while better-controlled dissemination to Government engineering drawer users. CAD and EDMICS systems, to be implemented for Engineering Development and repository storage/retrieval operations, respectively, could also automate data verification. However, this potential will not be realized without specialized software and possibly minor peripheral hardware. Order of Magnitude productivity improvements appear feasible by automating database entries, and by

eliminating card-by-card review for completeness and for mat discrepancies. Process automation would also help enforce rigorous statistical sampling, to generate a strong case for Government lawyers should analysts and contracting officers persuasion fail to enforce Government data rights--again, without requiring data review specialists to examine each data element (the labor cost of which review could easily exceed potential benefits to be derived from successful prosecution).

Phase I should consist of a study to determine which data objects may be transferred on-line from either raster vector data representations, and which data review process elements lend themselves to full automation on the projected CAD and EDMICSs systems.

Phase II should develop pilot software (with or without minor hardware add-ons), delivering the resulting package to the Government for testing on CAD and/or EDMICS systems.

N90-080 TITLE: Minimization of Environmental and Health Hazards Through the Use of Innovative Materials and Maintenance Process

CATEGORY: Engineering Development

OBJECTIVE: Provide technology to eliminate or significantly reduce the generation of physical, chemical biological pollutants, generated during naval aviation maintenance, that adversely affect human health or welfare, and to ensure compliance with environmental laws.

DESCRIPTION: The elimination or minimization of hazardous and toxic materials during day to day aircraft maintenance has become one of the Navy's top priorities. Developing EPA compliant maintenance materials and processes will enable the naval aviation community to maintain readiness through realistic and unimpaired operations and to deploy new weapons systems without violation of environmental laws. Because environmental laws are becoming increasingly strict, research is required to identify new maintenance materials and process for both in service and advanced tactical aircraft.

Phase I should evaluate existing technology to determine the Navy's ability to meet EPA laws through the year 2000.

Phase II should identify the maintenance processes that will violate EPA laws through the year 2000 and address research required to develop new processes to meet EPA laws.

N90-081 TITLE: Probability of Flaw Detection for Non-Destructive Inspection of Advanced Materials

CATEGORY: Advanced Development

OBJECTIVE: Develop non-destructive inspection (NDI) techniques and processes to increase the NDI technicians probability of detecting, isolating and assessing flaws in advanced materials.

DESCRIPTION: The probability of detection initiative is to improve the capability of fault detection in aircraft structures and components. It provides technical support of the age exploration statistic based sampling concept. The program will test both flawed and unflawed material specimens to identify confidence levels when detecting crack size and crack growth in advanced metallic structures and critical size and growth of composite delaminations.

Phase I will require identifying and Phase II demonstrating increased fault detection capability through new NDI procedures and development of confidence level factors based on NDI technician techniques and equipment. Knowledge of probability of detecting a crack will increase statistical confidence levels used in sampling inspection programs, thus defining more accurately sample size requirements.

N90-082 TITLE: Ferrite Choke for Cartridge/CAD Application

CATEGORY: Engineering Development

OBJECTIVE: Develop a ferrite choke for cartridge/CAD application that provides broadband nonresonant protection against electromagnetic radiation. Development of this choke will ensure meeting the HERO safety requirements of MIL-STD-1385B and will alleviate hampering restrictions imposed upon cartridge devices in the operational environment. If successful, the technology can be transitioned for use in many of the Navy cartridge/CAD hardware.

DESCRIPTION: A substantial number of electrically initiated cartridges are classified as "HERO SUSCEPTIBLE" and require special procedures in the operational environment. The restrictions imposed by these items on fleet operations are considered substantial and undesirable. The purpose of this project is to develop a ferrite choke that will provide a broadband nonresonant protection against electromagnetic radiation with minimum attenuation of the D.C. firing pulse. The technology developed will be suitable to meet long term requirements, of low cost, and be compatible with high volume cartridge assembly lines. Use of this technology would eliminate special handling procedure for cartridge/CAD systems, and would eliminate shut down of electromagnetic

emitters during susceptible cartridge use. The technology would also provide for replacement of existing cartridges with little increase cost and improved safety margins. An additional advantage of this item would be that it provides attenuation of an EMP signal.

Phase II should consist of development of the ferrite choke with specified physical and electrical parameters and include models and test results of electromagnetic attenuation.

N90-083 TITLE: Automated Integration of Reliability Centered Maintenance (RCM) Analysis with the Logistics Support Analysis Record (LSAR)

CATEGORY: Engineering Development

OBJECTIVE: Develop a computer program to link the data contained in the automated RCM worksheets with the automated LSAR. Cost savings will be attained by automatically and electronically transferring the results of RCM into the LSAR.

DESCRIPTION: NAVAIR currently follows the RCM preventive maintenance (PM) decision logic contained in MIL-STD-2173 (AS) for new procurements and for in-service applications. The MIL-STD-2173 (AS) worksheets have been computer automated to ease RCM documentation requirements. RCM data is also required to be input into the LSA process in accordance with MIL-STD-1388-2A. Currently, during weapons systems acquisitions, RCM is manually entered into RDM worksheets and manually transferred to the LSAR database. This results in duplication of effort and is not cost effective. An automated link between these two databases would reduce costs and make PM analysis more efficient. The resultant RCM/PM data in the LSAR would be used during the acquisition phase to determine initial PM requirements, and throughout the life cycle to identify changes or additional PM tasks as equipment modifications occur.

Phase I would be a concept report and Phase II would be the delivered tested software.

N90-084 TITLE: Automated Integration of Level of Repair Analysis (LORA) with Logistics Support Analysis Record (LSAR)

CATEGORY: Engineering Development

OBJECTIVE: Compare MIL-STD-1388-2A LSAR Data elements with data elements contained in MIL-STD-1390C LORA models, and develop common data element definitions. Develop a computer software link that will allow for the iterative exchange of data between the LSAR and LORA models.

DESCRIPTION: Currently, LORA is performed independently of the LSA process. Data required for input into the LORA is resident in the LSAR and the results of LORA are input back into the LSAR. This is an iterative process that continues as system design matures. The data transfer is accomplished manually and is labor intensive. The automated computer link between LSA and LORA will reduce acquisition program costs and improve the overall quality of weapons system maintenance planning. Automated LORA reports will be extracted from the LSAR database. This will eliminate the need for separate LORA deliverables and further reduce acquisition costs. Phase I would be a concept report and Phase II would be the delivered tested software.

N90-085 TITLE: Aircraft and Engine Preservation Techniques

CATEGORY: Research

OBJECTIVE: To research and analyze aeronautical weapon system preservation techniques.

DESCRIPTION: Prevention of deterioration to aeronautical weapon systems is one of the more important features of the Naval Aircraft Maintenance Program. Current processes call for using spraylat, bags and cans to store operational assets. Proven to be inefficient, the U. S. Army is using a method called "Shrinkwrap" for short term storage or overseas shipment. This process is being applied and studied at Naval Aviation North Island, San Diego. However, application of this relatively new process has not been proven to be cost affective and requires further analysis, particularly for long term storage. Current techniques, policies and procedures are outdated and costly. Some operational assets stored for long duration are frequently degraded beyond economical repair for service use and are consequently scraped.

Phase I should consist of investigating alternative preservation methods. It should develop and deliver a cost effective and efficient aircraft and engine preservation program, focused on identifying equipment requirements, innovative preservation treatment techniques, maintenance requirements and depreservation requirements.

Phase II should emphasize delivering the hardware and procedures identified in Phase I to the Fleet and NAVAVNDEPS for application.

N90-086 TITLE: Automated Technology for Conversion of Existing Paper Technical Manuals into a Form Suitable for Interactive Electronic Display

CATEGORY: Engineering Development

OBJECTIVE: To develop an efficient approach for conversion of existing paper-based technical manuals to a digitally based form capable of interactive electronic presentation. If successful, a system (hardware and software) capable of effectively performing this function would be used for conversion of many millions of current manual pages to render their technical information (TI) commensurate with newly acquired digital TI.

DESCRIPTION: Navy's technical manuals are currently acquired and provided to maintenance technicians as collections of text and graphics on paper pages. Technology for acquisition and distribution of such TI in digital form, and its interactive electronic presentation, is now available; and tests have shown both logistics and maintenance-effectiveness advantages of such approaches. In essentially all new Navy weapon systems, the acquisition of automated technical manual systems is being evaluated. But even with new weapons systems, a vary large fraction of the technical manuals needed for system support is already in existence in paper form (e.g., electronics systems, test equipment) and will require conversion to digital interactive form. However, manual conversion of text and graphic from existing page-oriented paper manuals to a form which could be integrated with the newer approaches would be prohibitively expensive and time-consuming with existing approaches. An organized automated approach toward performance of such conversions is badly needed, involving "intelligent scanning" of existing paper manuals into digital form, and modification of existing page-oriented presentations to the required frame-oriented presentations by auto-recognition and automated accomplished of required changes. Integration of software and hardware technology would be required so that a series of test could be carried out to determined the production effectiveness of such an approach. Phase I would be a study report explaining the approach to accomplish the above. Phase II would be the development of the above.

N90-087 TITLE: Standardized Interactive Electronic Presentation of Weapon-System Troubleshooting

CATEGORY: Engineering Development

OBJECTIVE: To improve maintenance performance and reduce incidence of false component removals in weapon-system maintenance (particularly by inexperienced technicians) through provision of interactive electronically presented troubleshooting technical information. If successful, such an approach would be integrated into the maintenance planning and technical manual design of all new Navy systems of medium and high complexity.

DESCRIPTION: Recent tests in operational maintenance environments have shown that the use of computer-driven interactive presentation of weapon-system troubleshooting procedure can significantly improve performance of minimally trained personnel, and greatly reduce maintenance errors made by both experienced and inexperienced personnel. However, algorithms leading to the most effective logic for fault isolation of a wide variety of systems remains to be developed. Similarly, optimal modes of presentation of test sequences and test procedures, to assure the highest efficiency of information access and greatest comprehensibility, are still unclear. The Navy needs standardized guidelines so that weapon-system contractors can produce high quality interactive troubleshooting technical information in a uniform manner, which may be acquired and tested by many different system acquisition managers, and which may be presented to fleet technicians in a uniform manner, using a single type of fleet delivery device.

Phase I would be a study report explaining the approach to accomplish the above.

Phase II would be the development of the above.

N90-088 TITLE: Automatic Diagnostic Link Between Aircraft and Their Avionics Systems, and Automated Maintenance Aids

CATEGORY: Exploratory Development

OBJECTIVE: To reduce aircraft turnaround times and improve aircraft/avionics maintenance efficiency by automatically linking on-board diagnostic information directly to the technician's maintenance-information presentation system. If successful, such an approach would be incorporated in all future aircraft and avionic systems.

DESCRIPTION: Currently, fault isolation for aircraft and avionics malfunctions require a sequence of processes involving pilot and crew debriefing, fault verification, and the use of technical manuals and prescribed test sequences for identification of the faulty component. Automation of the fault-isolation procedure by use of electronically presented interactive technical information has been shown to greatly reduce technician error and improve performance. The establishment of a direct, automated link between on-board aircraft/avionics diagnostic equipment (e.g. built-in-test equipment) to a portable maintenance aid which may be brought to the aircraft, would significantly streamline the troubleshooting process through elimination of wasted effort, and provision of system-performance data (trouble symptoms) as a direct entry to the fault-isolation system logic of the maintenance aid. Currently, however, the feasibility of such an approach remains to be established in terms of present-day technological potentials as well as in terms of cost-benefit analysis. Both software and hardware needed for a standardized approach require definition to permit

establishment of design approaches, system demonstration and test, and incorporation into aircraft developments where shown to be warranted. Phase I would be a study report explaining the approach to accomplish the above. Phase II would be the development of the above.

N90-089 TITLE: Fretting Damage Detection Device

CATEGORY: Exploratory Development

OBJECTIVE: Develop a device to track and quantify fretting damage. This technology would be used to identify design deficiencies during the Engineering Development of jet engines.

DESCRIPTION: Fretting damage in compressor components is often a precursor to fatigue cracking. Relative motion between the mating surfaces of pinned holes, dovetail attachments and bolted structure produced micro surface damage during normal engine operation. Damage accumulation leads to fatigue crack initiation. There is now an urgent need for a non-destructive inspection device that could assess this fretting damage following finite engine running and predict fatigue crack initiation probability. Such a computer aided engineering tool would permit enlightened decision making by government and engine contracting personnel in assessing needs for anti-fret coatings or cold working the surfaces to avoid reduced service life. Current procedures are trial and error with fretting problems always being discovered in the field well after production has commenced. The proposed device/approach would also be useful for studying new designs and aerodynamic motions relative to fretting potential.

In Phase I specimens would be used to test the principle behind the approach selected; followed by design, development and test of a production prototype model to evaluate engine components from the field in Phase II.

N90-090 TITLE: Wall Thickness Measurement Technique for Turbine Blades and Fuel Nozzles

CATEGORY: Engineering Development

OBJECTIVE: Develop a reliable and accurate method for measuring wall thickness in complex thin-walled cast turbine components. If successful this method would eliminate infant mortality in field components due to inspection errors at the foundry.

DESCRIPTION: Current non-destructive inspection methods are allowing thin-wall acceptance to continue. An applied method that "call-out" thin-walled blades is urgently needed. Furthermore, future engine designs will require thinner, tapered walls with smaller tolerances under the new Integrated High Performance Turbine Engine Test program.

Phase I would demonstrate the feasibility of the principle involved for accurately and repeatedly determining the true thickness geometries of cooled turbine blades.

Phase II would involve reducing the principle to foundry practice e.g. automation, ruggedness, full field capability, low cost per part, adaptability to varying geometries and computer integration for statistical process control. Phase III would involve foundry implementation at the commercial level.

N90-091 TITLE: Digital Imagery Verification System

CATEGORY: Engineering Development

OBJECTIVE: To develop a low cost system which will receive ultra high resolution imagery in a digital format, and display and print the imagery at lower resolution. The system is to verify reconnaissance imagery which has been recorded on tape.

DESCRIPTION: A reconnaissance imagery system is being developed for the fleet. This system will provide digital imagery to a ground exploitation station. It is highly desirable to be able to independently verify the imagery generation and recording system separately from the ground station, and prior to integration of the airborne system with ground station. This can be done by developing a system which can read the imagery tapes and produce imagery output compatible with commercial displays and printers.

Phase I should develop a preliminary design for the system, and begin the detailed design process. The preliminary design should be used to drive the detailed design process directly.

Phase II should continue the detailed design process and produce and deliver to the government a prototype system. The system should include complete information necessary to produce, operate, and maintain the system.

N90-092 TITLE: Interoperability of Navy Range Operations with Air Traffic Control Facilities of the Federal Aviation Administration (FAA)

CATEGORY: Engineering Development

OBJECTIVE: To transfer data automatically between Navy range facilities and FAA Air Traffic Control Facilities which manage the

National Airspace shared between military and civilian users.

DESCRIPTION: Navy Fleet Area Control and Surveillance Facilities, such as at NAS Fallon, manage Navy Special Use Airspace. Controllers at displays of aircraft tracks from surveillance radars, such as the ASR-8, and of secondary radar tracks processed through the TPX-42, monitor the air traffic in the Special Use Airspace. Due to growing congestion of National Airspace, the FAA is considering Dynamic Special Use Airspace Management. This will require the Navy and other services of the Department of Defense to be prepared to justify use of training areas at short notice every day. Required are schemes to exchange real-time information of aircraft flights in Special Use Airspace and information regarding scheduling. Real-time information must not be classified. Scheduling information exchanged may involve compatibility between the Military Airspace Management Systems and the FAA,s Traffic Management System.

Phase I should consist of a study outlining the approach which will be undertaken to pursue the requirements addressed above with sufficient data to demonstrate feasibility.

Phase II should use the approach outlined in Phase I to develop and deliver to the government for testing a prototype model of conversion software and communications links or processors.

N90-093 TITLE: Mini-Air Surveillance Radar Tracker and Identify-Friend-or-Foe System (MASURATI)

CATEGORY: Advanced Development

OBJECTIVE: Design a complete a air search radar and Identify-Friend-or-Foe (IFF) beacon system that can be used as a low cost, air traffic control (ATC) system to fill the gap in existing sensor coverage at an air station.

DESCRIPTION: The need exists for a relocatable low cost ATC system that can be used for non-tactical air surveillance and ground controlled approach at Navy and Marine Corps air stations. As a gap-filling sensor the system should have a range of 15 to 20 nautical miles at altitude down to range zero at sea level. The primary sensor should have a consistently high probability of detection of a non-cooperative, small airframe sized target. It should be highly user selectable and adaptable in terms of tracking performance (helicopters to high speed jets), clutter processing, weather and map display, external data source display and data fusion, on-screen menu presentation and data management, computer generated graphic display, and on-line maintenance monitoring and fault detection and correction. Ease of integration into a region of existing electromagnetic sensor coverage may mean (but does not require) alternate physical principles of operation to the standard L-Band and S-Band ASR radars of the Federal Aviation Administration (FAA) (i.e. millimeter wave, optical, other). The system should be modular in design and compatible with existing external ATC equipment where necessary (i.e. FAA ATC Radar Beacon System), Mode-S, Common Digitizer-2 format etc.).

Phase I consists of a characterization of requirements and operations, a market survey to apply the latest computer and ATC advances, and a preliminary design and interface study with tradeoff analyses culminating in a detailed technical report and decision briefing emphasizing issues of cost, risk, technology, and schedule.

If successful, Phase II will complete the design specifications in preparation for full scale development.

N90-094 TITLE: Microminiature Filter Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To explore High Q filtering methods and techniques that will be compatible with RF and microwave microcircuit technology.

DESCRIPTION: Miniature subsystems for Navy applications are being developed in the tri-service MIMIC program. However, filters continue to be fabricated using older technologies. Virtually every communication system requires filtering for preselection, spur reduction, frequency spectrum reduction and channelization, but unfortunately MMIC's have not adequately met the filtering need, thus subsystem size and weight are determined by filter technology. If a significant improvement in RF and microwave subsystem size is to occur, major advancements in filtering techniques must be achieved.

Phase I should explore new microminiature filtering techniques that will provide high Q bandpass filtering integrated with MIMIC chips. The results of Phase I should show by analysis that one or more feasible techniques could be implemented in Phase II with a good chance of success.

N90-095 TITLE: Automated Feature Extraction and Pattern Recognition Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: To develop algorithm products for the automatic extraction and recognition of natural and man made features from selected aircraft sensor inputs. If successful, this would significantly reduce the cognitive load carried by pilot and weapons officers in

the performance of their respective in-flight tasks. It would enable the real-time update of situation displays, and support automated situation awareness tools as well as provide improved navigation capabilities.

DESCRIPTION: Future avionics systems will rely heavily on digital terrain, threat and target data to perform or improve aircrew functions that include navigation, target acquisition, threat avoidance, and situation assessment. The ability to automatically recognize and extract man-made and natural features from imaging data plays a key role in the generation and maintenance of databases to support these avionics systems. This effort is to develop algorithms for the automated extraction and mensuration of cartographic tactical features from digital imaging data. These algorithms would be used to generate geographic databases from tactical imaging assets and for real-time update from sensors carried on strike aircraft. The imaging sensors to be studied include infrared, visual and radar. Offerors should consider both traditional algorithmic and neural net approaches to feature recognition, multi sensor fusion, and the use of the existing cartographic database to improve recognition accuracy.

Phase I work will involve the identification and collection of advanced algorithms for automated feature extraction and pattern recognition.

Phase II will address the development of a prototype to demonstrate the successful application of the algorithms identified during Phase I.

N90-096 TITLE: Microwave Powered System for High Altitude Long Endurance (HALE) Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: To make a detailed feasibility study and preliminary design of a complete ship-based microwave (MW) power system for a HALE aircraft (ship-based microwave generation and transmission systems, aircraft MW reception, power conversion and electric propulsion systems and backup energy system for times when microwave power is not available).

DESCRIPTION: Previous efforts in this area have focused on MW frequencies below 10 GHz. Recent technology advances appear to make high power MW generation and transmission at much higher frequencies feasible. If true, this may allow a reduction in antenna size to the point that ship-based MW power systems for HALE aircraft are operationally feasible.

Phase I of this effort will consist of two parts. Part 1 is a study to determine if current technologies will theoretically support higher frequency ship-based (destroyer size ship) MW generation transmission, reception and conversion at power levels sufficient to power a HALE aircraft. (Assume cruise altitude is 70 Kft and minimum peak required by the HALE aircraft's system (including energy storage) is 400 KW). If the concept does not appear technologically feasible, part 2 will identify the area(s) where technology is not sufficiently advanced and propose, in the form of a proposal for Phase II, development effort(s) to advance the deficient technology(ies) to the required level. If the concept does appear technologically feasible, part 2 will consist of a description, in the form of a proposal for Phase II, of the methodology planned and issues to be addressed in making a preliminary design of a complete ship compatible HALE aircraft MW power system including a rechargeable backup power system capable of providing power to the aircraft propulsion and mission systems for NLT two continuous hours. When alternative subsystems approaches appear feasible during Phase II, tradeoff studies will be conducted for the two most promising alternatives. Shipboard electromagnetic environment issues will be addressed.

Phase II will consist of one of the two efforts described above, depending on the results of part 1 of Phase I.

N90-097 TITLE: Turbine Engine Response Design Sensitivities

CATEGORY: Engineering Development

OBJECTIVE: Define, analyze, and quantify by sensitivity analysis the effect of key engine internal design characteristics on engine transient power response. Results of this effort can be incorporated in USN aircraft performance assessments to determine, either analytically or by simulating, the adequacy of aircraft system power response characteristics during carrier operation.

DESCRIPTION: Carrier suitability of USN aircraft is an extremely critical requirement in determining system viability for fleet service. A key factor in carrier suitability assessments is aircraft power responses during carrier approach and waveoff. Internal engine design characteristics are a major contributor to this response issue. The purpose of this project is to identify sensitivities in engine design that impact aircraft power response during carrier operation and then to assess the degree of impact of each sensitivity.

Phase I should consist of a study identifying such internal engine design criteria (e.g. turbofan vs turbojet, by pass ratio, locked vs split spool turbine, multi-spool engines/modules, combustor design, etc.) and should include an initial response sensitivity analysis of design, etc.) and should include an initial response sensitivity analysis of design practices within each criterion.

Phase II should expand the Phase I sensitivity analyses by comparing criteria and then develop software models compatible with USN simulators to validate sensitivity analysis results.

N90-098 TITLE: Determination of Critical Parameters in Airborne Early Warning

CATEGORY: Engineering Development

OBJECTIVE: To determine the critical objectives of and parameters affecting the Navy Airborne Early Warning and Battle Management mission.

DESCRIPTION: The E-2C, the current Navy early warning aircraft, is approaching the end of its service life. The definition of a follow-on aircraft, is in process. Many of the perceived requirements identify opposite system requirements. In order to provide a means to quantitatively express the merits of alternatives, it is proposed that the Airborne Earlier Warning and Battle Management mission be defined by a matrix of individual components expressed in the form of a Hierchic Vaulted State Space (HVSS) and normalizing function. This scoring would result in a method of making direct comparisons of candidate configurations and systems to determine the most appropriate course of action to meet the threat; and listings of remaining shortfalls and deficiencies not resolved by competing solutions.

Phase I effort will be a final report outlining the design/structure of the intended approach.

Phase II will be a complete study detailing the scoring, comparisons, and any shortfalls or deficiencies.

N90-099 TITLE: Multiple Chaff Cartridge "SQUIB"

CATEGORY: Advanced Development

OBJECTIVE: Development of a pyrotechnic delay squib for use by the multiple-cartridge chaff. Requires a 40-60 msec sequential delay.

DESCRIPTION: This development program would explore the manufacturing and packaging processes and equipment required to produce a squib which can eject chaff from a compartmentalized chaff container with a 40-60 msec sequential delay.

Phase I - the squib would be tested for repeatable sequential delays.

Phase II - Facilitize and demonstrate the processes and equipment required for quantity "5,000/month" production followed by test and evaluation leading to full production decision.

N90-100 TITLE: Activated Metal Decoy for Low IR Signature Aircraft

CATEGORY: Advanced Development

OBJECTIVE: Development of an activated metal decoy for use by an advanced aircraft with a low IR signature.

DESCRIPTION: This development program would explore the manufacturing and packaging processes and equipment required to produce an activated metal decoy in quantities.

Upon completion of Phase I - The decoy will be tested for IR signature and effectiveness.

Phase II - Facilitize and demonstrate the processes and equipment required for quantity "5,000/month" production followed by test and evaluation leading to full production decision.

N90-101 TITLE: Multispectral Electro-Optical/Infrared Real-Time Sensor

CATEGORY: Advanced Development

OBJECTIVE: A design exercise which would assist in developing a specification for the topic sensor.

DESCRIPTION: Existing reconnaissance sensors provide imagery using either electro-optical (EO) or Infrared (IR) spectral bands. In order to optimize their intelligence value, these images must be brought to a common video screen from separate files and indexed before being compared. EO/IR imagery, if taken with one sensor (with same lens system) would be physically together and indexed when presented in real time for exploitation. Many interpretation questions could be answered on initial screening before the time value of the information is lost. Penetration of many camouflage schemes would be one application of such an EO/IR image capability. A nominal sensor would have a wide field of view (120° - 160°), be capable of operating at 200 ft and 600 kts, and have a digital out put of 130 megabits per second.

Phase I should consist of a study which identifies the technical problems associated with the topic sensor and the various technologies which could be employed in its design.

In Phase II, trade studies should be identified and conducted followed by a design exercise which details potential sensor performance parameters.

N90-102 TITLE: Emission Location System for Cuing of Standoff Electro-Optical Sensor

CATEGORY: Engineering Development

OBJECTIVE: Develop specification parameters and identify interface problems associated with a combined ELS and EO sensor.

DESCRIPTION: Existing Emission Location Systems (ELS) provide an indication of the area in which an emitting object is sited. That indicated location will be in error if the ELS platform Inertial Navigation Systems (INS) has drifted. The indicated area must then be correlated with other intelligence to project the actual site. For time sensitive targets, the process of correlation may preclude effective reaction against that site. However, where an ELS cues a standoff sensor on the same platform, a correlation process is accomplished and the location is accurate relative to the platform. For a multi-mission platform, a reaction effort can be commenced in near real time.

Phase I includes an analysis of threat systems (based on open literature) and a study to define the necessary frequency coverage, estimate the size of such an ELS system, and assess accuracy potential, assuming antennas are a pod of 330 gal size.

Phase II consists of a design exercise which includes functionality of each element of the ELS, interface definition with the existing system (EO-LORPOS) to provide target overlay, and both timeliness and relative accuracy of the output. Data should be adequate for use in a system specification.

N90-103 TITLE: Electronic Soldering Quality Improvement

CATEGORY: Engineering Development

OBJECTIVE: Reduce soldering defects/nonconformances, required visual inspection time, and associated production cost of electronic printed wiring boards (PWB) used in Navy air launched guided weapon systems. Develop automated cost effective factory equipment using the latest statistical process control techniques with wide application to high volume quality manufacture of military and/or commercial electronics.

DESCRIPTION: Develop an approach as part of a Phase I study to enhance flow solder PWB manufacture by automating the quality process with statistical sampling techniques, associated feedback control of production equipment and automated solder inspection in accordance with current Navy WS6536E and/or the DOD MIL-STD 2000 specification requirements. These specifications apply to most Navy air launched guided missiles and associated aircraft avionics. An automated/robotic process is desired to incorporate flow solder process feedback control, reduce current manual inspection time, and increase product quality by minimizing the number of undetected nonconforming solder connections. Proposed factory equipment should take maximum advantage of available commercial equipment and adopted industry standards to insure acceptable investment cost and wide DOD/industry application. Due to the typically high number of solder connections and throughput requirements, automated visual inspection should be investigated to assess soldering quality. Phase II should use the approach outlined in Phase I to develop and deliver to the government for test and evaluation prototype factory test equipment.

N90-104 TITLE: Aircraft Survivability and Mission Analysis Computer Model

CATEGORY: Engineering Development

OBJECTIVE: Develop a high fidelity computer model for survivability and mission effectiveness analysis of a single aircraft flight line mission into a high threat environment. This model can be used for engineering design and systems refinement of candidate concepts for a specific mission.

DESCRIPTION: A mission analysis is needed that properly incorporates vehicle observability, flight path with terrain following, threat sensors, threat vehicle dynamics and guidance, threat system employment and engagement doctrine, and terrain features including clutter. The radar portions of this model should include propagation phenomenon such as multipath, diffraction, and bistatis for both primary receivers and transmitters, and weapon seekers. Terrain following must include vehicle dynamics. Published government threat data would be the input parameters for threat systems.

Phase I of this effort would define overall architecture and identify component models to be used in subroutines.

Phase II would construct and demonstrate the actual survivability and mission effectiveness model. The final model needs to output overall and specific mission effectiveness. This output would include an overall success parameter, relative probability of survival, time in lethal envelopes, threat interceptor engagements, time in ground controlled intercept tracks, miss distances and/or kill by threat weapons. This model could then be used to refine aircraft designs by exercising and comparing relative survivability and mission effectiveness of candidate designs of variations in design.

N90-105 TITLE: Extending Tactical Sensors Through the Use of Signal Enhancement

CATEGORY: Advanced Development

OBJECTIVE: To improve frequency analysis and unfolding algorithms by enhancing sensor quality from 15 to 50%. If successful, sensor fusing performed by existing combat aircraft will be greatly extended. Aircraft produced under the ATA, ATF and LHX programs will also benefit from such signal enhancements.

DESCRIPTION: Active as well as passive sensor fusion is constrained by the quality of received signals. The purpose of this project is to improve the quality of received signals by introducing a digital filter which extracts additional features. The additional features increase the resolution of subsequent analysis. The digital filtering technique is applied to individual sensors before fusion takes place. Under such conditions the differences between two or more sensors detecting the same event (e.g., receiving a Doppler shifted radar wave) assumes great tactical importance. A new level of tactical interpretation is thought to be possible.

Phase I should demonstrate the power of digital filtering to extract additional features from actual data received by tactical sensors.

Phase II extend the techniques developed under Phase I to as many sensors as possible. The initial signals studied under Phase I are Radar Frequencies. Extensions to Infrared should be attempted in Phase II. The cross correlation of infrared frequencies with Radar frequencies should also be attempted in Phase II.

N90-106 TITLE: Marine Attack Helicopter Night Targeting System Training System

CATEGORY: Engineering Development

OBJECTIVE: To develop a training system that will provide Marine AH-1W aircrews and maintenance personnel with the necessary training for effective combat operations utilizing the Night Targeting System (NTS) currently under development.

DESCRIPTION: The U.S. Government and the Government of Israel are currently embarked on a joint program to develop and produce an NTS for U.S. Marine Corps and Israel Air Force attack helicopters. The concept involves modifying the existing daylight sight of the TOW anti-armor missile system with infrared imaging and laser rangefinder/designator. This system is planned to become operational in the 1994 time frame.

Phase I would involve a detailed study of the additional operator and maintenance training requirements generated as a result of incorporation of the NTS in the AH-1W.

Phase II would result in full definition of the training system to include identification of training materials and aids and the creation of design specifications for required operator and maintenance training equipment. This effort would further include definitization of the interfaces and/or modifications required to the AH-1W's existing training system.

N90-107 TITLE: Four-Bladed Main Rotor System for Marine Attack Helicopters

CATEGORY: Engineering Development

OBJECTIVE: To provide increased combat capability for Marine AH-1W attack helicopters through development of a four-bladed main rotor system.

DESCRIPTION: The U.S. Marine Corps, through new procurement and by block upgrade, will achieve an all AH-1W attack helicopter fleet by the early 1990's. This aircraft must be capable of meeting the threat well into the 21st Century. Because of its currently configured semi-rigid, teetering, two-bladed main rotor, the AH-1W has certain maneuvering limitations. The prime contractor has proposed incorporation of a four-bladed system to provide increased lift capability, better maneuvering and reduced noise, to mention but a few of the expected benefits.

Phase I would provide an independent analysis of cost-benefits associated with such a development program.

Phase II would require the development of appropriate computer models to substantiate those performance related estimates derived during Phase I and would define the total impact of such incorporation on the aircraft's structure and overall dynamics system.

N90-108 TITLE: Integrated Strike Planning System Evolutionary Upgrade-General Purpose Explanation Capability for Knowledge-Based Support Systems

CATEGORY: Exploratory Development

OBJECTIVE: Development of a general purpose explanation capability to support the Navy's Integrated Strike Planning System (ISPS). This capability, if demonstrated to be feasible, will be incorporated into the ISPS as an evolutionary upgrade.

DESCRIPTION: The Integrated Strike Planning System, a computer-based man-in-the-loop decision support system, will support the Battle Group Strike Warfare Commander by integrating the strike warfare capabilities of tactical aircraft, major caliber guns, and

cruise missiles to provide strike plans which will maximize the probability of success while minimizing the probability of aircraft attrition. It will be procured via an evolutionary acquisition strategy in which an initial core capability will be developed and fielded in the first quarter of Fiscal Year 1993 and improved thereafter through regularly scheduled evolutionary upgrades. The initial core capability will support the strike planners through target analysis, weapon analysis, and several decision-aid models. It will be a knowledge-based decision support system which will use rule-based, spatial and statistical, and evidential reasoning methodologies to support mission planning.

This effort will support the strike mission planners through the development of a general purpose explanation capability which will enable the planner to critique the analyses and recommendations provided by the ISPS. This capability, which will be developed and demonstrated by the contractor, will provide the planner with a coherent rationale, in a language understandable to the strike planner, for the recommendations obtained via each or a combination of all three of the reasoning methodologies mentioned above.

The contractor will provide the following at the completion of Phase II: a system description of the general purpose explanation capability to include its interfaces with the ISPS; a limited demonstration of this capability in order to provide proof of concept; the software which supports the demonstration; software documentation to the level of DID-MCCR 80012A to support analysis and dissection of the demonstration software by the ISPS prime contractor.

To support this effort, the Government will provide as government furnished information, the ISPS Specification, and limited planning data bases to support the contractor's limited demonstration of the general purpose explanation capability. All software will be coded in ADA.

N90-109 TITLE: Total Quality Management (TQM) Control Criteria Applied to Long Term Test Programs

CATEGORY: Engineering Development

OBJECTIVE: To develop a quantitative methodology which will identify the long term test program process in terms of technical and quality parameters or indicators, and permit trade off analysis of various test alternatives, test approaches, and achievement of systems or process objective. If successful, this methodology would permit the structuring of programs which would improve testing quality, provide for more effective use of resources and increase the test process cost effectiveness.

DESCRIPTION: The Tomahawk Operational Test Launch (OTL) program offers a means of exercising the entire Tomahawk Weapon System under a variety of operational conditions. The high cost associated with each launch requires that a wide variety of tests be considered on each mission and that advanced planning and strict safety criteria be observed. Test requirements are generated from numerous sources including routine inventory sampling, performance envelope verification, planned product improvement validations and flight software performance demonstration. The purpose of this project is to develop a methodology which will permit the quantitative evaluation of the test program process and compare against defined measures of effectiveness.

Phase I should consist of describing the conceptual test process, accommodating requirements generation and priority, sequential events, evaluation or decision points, and feedback to take advantage of historical "lessons learned".

Phase II should use the test process identified in Phase I to develop and deliver a prototype computer model to the government for testing.

N90-110 TITLE: Software Maintenance Cost Estimating

CATEGORY: Exploratory Development

OBJECTIVE: To produce a computer model which will estimate all costs associated with modifying and testing weapon system software.

DESCRIPTION: Tomahawk Weapon System software requires correction of operationally identified deficiencies, upgrades, or substitution of more efficient algorithms through its operational life. While any particular change may only affect a limited number of lines of code, there may be substantial validation and verification to ensure that no adverse impact is produced in other areas of the system software. Furthermore, software modifications which may improve the system performance envelope may require operational testing, including live missile firing tests, under the auspices of the Commander, Operational Test and Evaluation Force.

Phase I should consist of describing the Tomahawk Weapon System software modification process and testing requirements and the methodology of developing cost estimates.

Phase II should consist of developing and testing a prototype computer model for estimating the cost of any Tomahawk Weapon System software modification.

N90-111 TITLE: Self-Protect Weapon Seeker Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: To explore the feasibility of enhancing the capabilities of single-channel self-protect weapon seekers with mechanical scan.

DESCRIPTION: Presently available Self-Protect Weapon (SPW) Anti-Radiation Missile (ARM) weapons use mechanically scanning antennas to develop angular guidance information. These antenna structures, such as employed in the SIDEARM I Missile, have inherent limitations in terms of the frequency band over which their antenna patterns provide useful guidance, the instantaneous field of view within which reliable guidance is available and the rate at which guidance data are generated. Solutions to these problems have been found in complex multiple-channel monopulse systems, which have wide bandwidths, wide fields of view, and the ability to develop angle of arrival information on every pulse. Relative to monopulse systems the mechanically scanning systems have a number of virtues, however, because of the simplicity of their single channel receiver design, and the fact that they are currently in the military inventory because they perform well. Techniques are needed to enhance the capabilities of single channel SPW seekers with mechanical angular scan. The current 1.5:1 frequency band must be extended to 3:1, the field of view in which reliable guidance is developed must be extended by a factor of two and methods must be found so reliable guidance information can be generated on intermittent signals and in signal environments in which more than one signal are within the seeker receiver passband. The antenna enhancement techniques must be capable of implementation as simple modifications to the existing feed and antenna structures and must be mounted on the existing mechanical scan assemblies. The guidance modifications may be implemented in commercially available digital processors suitable for an airborne missile environment, but must be capable of mounting within the physical envelope of the existing SPW guidance circuitry.

Phase I should specify the RF and processing modifications, provide analytical evidence, such as antenna range measurements and guidance simulations, that the proposed techniques will yield the desired performance, and provide a program plan for a Phase II breadboard seeker development and test.

N90-112 TITLE: Measurement of Airborne Surface Search Radar Performance Characteristics

CATEGORY: Exploratory Development

OBJECTIVE: To enhance the operational effectiveness of airborne surface search radars, the operator needs to know the performance characteristics of the system under varying environment and flight conditions. This project will establish a comprehensive standardized test and evaluation methodology and develop a means for correlation of environmental conditions with system operating characteristics for the purpose of performance measurement against operational and contract specification requirements.

DESCRIPTION: The performance of the radar relative to aircraft flight conditions, sea state, atmospheric conditions and the effects of multipath phenomena must be known for the operator to accurately interpret data displayed by the system. Current evaluation methods are neither comprehensive nor standardized.

In Phase I, standard evaluation criteria, critical factors and a system concept incorporating test methodology and correlation of environmental factors will be developed.

During phase II, an Engineering Development model will be provided and evaluated utilizing a AN/APS-140V radar hosted on an RC-12M or a similar configuration. Performance measurement capability should be sufficient to evaluate the capability to detect a standardized one square meter target in sea state three at a range of fifteen nautical miles from an altitude of fifteen hundred feet under any atmospheric condition (all weather).

N90-113 TITLE: Operational Support Aircraft Management Planning System

CATEGORY: Engineering Development

OBJECTIVE: To develop a system of data collection and a model for use in the management and planning of support aircraft utilization and force structure. Based on utilization history and projected demands for both peacetime and wartime, the system will enable planning for more efficient procurement, basing, support and employment of limited operational support aircraft assets.

DESCRIPTION: Effective management of the support aircraft force structure requires an accurate assessment of historic, current and projected cargo and passenger airlift demands for both wartime and peacetime utilization and the ability to evaluate the effectiveness of individual aircraft types in efficiently satisfying the demand requirements.

For Phase I, an aircraft utilization data collection system will be devised and relevant data elements identified for aircraft cost, performance capacity/capability and the critical demand model considerations. Algorithms will then be developed for their evaluation. In Phase II a prototype model will be prepared and the data collection system formalized for trial application. The system designed should be capable of modeling demand profiles on a daily mission basis for periods of up to six months, be capable of factoring out-of-service periods, manpower requirements, basing concepts, aircraft parameters including cost, performance factors and availability and identifying the most efficient aircraft available under either specified or defaulted inventory conditions (i.e. for a given demand profile - what is the best force structure or, given a force composition by type, how many aircraft will be

needed?) The system will be evaluated for data collection efficiency, reliability, sensitivity and transportability (capability to be hosted on a variety of computers-preferably PC's).

N90-114 TITLE: Sensor Fusion for Non-Cooperative Target Recognition (NCTR)

CATEGORY: Research

OBJECTIVE: Identify air targets by fusing sensor information on Navy F-14.

DESCRIPTION: The Navy F-14 fighter currently has a number of onboard sensors which may be used to identify unknown air targets. Among these are the AWG-9 fire control radar, the television camera system (TCS), 1970s radar signal modulation, and various ESM sensors. Currently the data from these systems is presented independently, and any fusion which takes place is done manually by the pilot and weapons officer.

Proposals are sought for a means to fuse some or all of these sensors in order to identify unknown aircraft more reliably and at greater ranges that is now possible. Of particular interest are systems approaches which integrate rule-based architectures, connectionist architectures (parallel, distributed processing or neural networks), and conventional computational methods.

Phase I proposals should include a detailed description of the technique proposed, and an explanation of how realistic data will be simulated in order to test the performance of the proposed technique.

The Government will provide actual real-world data for Phase II demonstration .

N90-115 TITLE: Pulsed Power for Underwater Neutralization

CATEGORY: Exploratory Development

OBJECTIVE: To explore the development of pulsed power sources and how different energy levels react with structural materials immersed in water.

DESCRIPTION: Pulsed power sources at high energy levels have shown capabilities of producing shock wave sufficient to damage underwater equipment. Innovative concepts are sought for neutralization of underwater sea mines.

Phase I should consist of a study to support feasibility of the concept.

Phase II should fabricate a prototype to demonstrate feasibility.

N90-116 TITLE: Underwater Towed System Monitor

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility of a system to interactively monitor the position of underwater towed Airborne Mine Defense systems.

DESCRIPTION: There is a need to monitor the relative position of existing airborne mine defense equipment to determine the depth and offset (distance from the centerline of the towing body) of the equipment. The equipment is a helicopter-towed, minesweeping system that uses sweepwires armed with explosive cutters to sever mine moorings. Four electromechanical otters divert a pair of two-segment sweepwires and control depth of its mid and aft portions. A single electromechanical depressor, located near the sweepwire apex, maintains depth at the forward end of the sweep. The system must be operable without physical connection between the towed underwater body and the towing helicopter.

Phase I should consist of a study showing the feasibility of developing the monitor. The study must consider the deployability of the system with relationship to existing gear.

Phase II should use the Phase I approach to fabricate a prototype system for feasibility testing.

N90-117 TITLE: MV-22/HV-22 Weapons Systems Integration and Armament Control

CATEGORY: Engineering Development

OBJECTIVE: To develop an architecture for integrating defensive weapons with helmet mounted display/sight in the V-22.

DESCRIPTION: There exists an outstanding operational requirement to incorporate defensive armament on the V-22. Currently the projected armament includes the following: turret mounted 50 caliber machine gun; two to four Stinger missiles; two Sidewinder and/or Sidearm missiles in any combination; two to four Sparrow missiles. The weapons should be integrated into the aircraft to maximize the aircraft's capabilities, the weapons capabilities and minimize pilot work load. The aircraft will be equipped with helmet

mounted display/sight, a Forward Looking Infrared (FLIR) and threat warning equipment that must be integrated with the weapons. The weapons control features must be compatible with MIL-1553B. Maneuvering and deviation from preplanned flight path will be minimized while still allowing the pilot to meet the threat. This is particularly important when approaching a landing zone or a strike rescue pickup.

After a successful architecture is defined in Phase I, an Engineering Development model would be built and flight tested on the V-22 in Phase II. After successful flight demonstration, the system could be incorporated in to the aircraft.

N90-118 TITLE: Ribbonized Organized Integrated (ROI) Electrical Wiring Interconnect System for the V-22 Osprey

CATEGORY: Engineering Development

OBJECTIVE: To develop, install and test an ROI wiring system in certain major components of the V-22 OSPREY tiltrotor aircraft to demonstrate the advantages of ROI over conventional electrical wiring. ROI has the potential to significantly increase reliability, improve maintainability, and simplify logistics. It is inherently resistive to electromagnetic interference and readily adaptable to reprogramming for aircraft modifications.

DESCRIPTION: The current conventional aircraft wiring interconnect system has been identified by the Navy as a major contributor to aircraft reliability and maintainability issues, safety of flight issues, and weight issues. The current systems cannot meet the rigorous demands of the NAVY's operational environments. The purpose of this project is to consider converting the present conventional wiring system on selected major components of the V-22 OSPREY tiltrotor aircraft, which is currently in full scale development, to a ROI wire interconnect system. The aircraft wiring under consideration for modification includes that between the fuselage, wing and the rotating wingtip nacelles.

Phase I would consist of engineering study/analysis of the feasibility of installing the ROI wiring and interface components.

Phase II would consist of design, fabrication, installation and test of ROI wiring in a V-22 prototype aircraft at the Naval Air Test Center, Patuxent River, MD as proof of concept. A particularly attractive advantage of the ROI wiring is the potential for weight reduction in the V-22 OSPREY.

NAVAL SEA SYSTEMS COMMAND

N90-119 TITLE: Gateway Processors for Information Systems

CATEGORY: Advanced Development

OBJECTIVE: To provide a data directory service and user request translation among multi-vendor data bases.

DESCRIPTION: Data bases and information systems are by nature highly distributed. Applications are created by individuals and organizations requiring the information in the performance of mission functions in a multiplicity of environments. These environments are affected by the methodologies, architectures, design and specific vendor products used in the development and implementation of a specific system or application. The distribution of data in a highly decentralized organization, such as the Navy, creates significant problems and inefficiencies in management, operations and human resources.

Under this topic, a set gateway product, consisting of hardware and software, which would have as its main function to provide interfaces between users/applications and targeted data bases. In concept, a user should be able to generate an English language type query or command, using decision support/expert system techniques. The gateway would determine the location of the data; the attributes of the target networks, systems and data bases; establish necessary connections and accesses; and provide the necessary translation of the request to the appropriate data base command. Upon receipt of messages from the targeted data base, translation back to the original user/application presentation software would occur, and the session(s) would be terminated.

Software and hardware developed must conform to Federal Information Processing Standards and must be portable among multiple vendor product lines. User access will be via PC based workstations and terminals. Applications and data bases may be resident on personal computers, distributed processors and central corporate processors. Networks will consist of direct connections, local area networks, and local and long distance remote connections.

Phase I would include detail planning with respect to the technical specifications, assumptions and constraints imposed on the design, hardware and software requirements and a plan for follow-on prototype and demonstration.

Phase II will consist of the development of a prototype. Although in its completed stage the gateway should be generic in its application, the prototype will be based on the logistics planning function.

Phase III will be the installation and testing of the prototype in BETA sites.

N90-120 TITLE: Next Generation RADIAC

CATEGORY: Exploratory Development

OBJECTIVE: To determine if it is feasible and cost effective to develop a radiac which can accurately measure radiation at a distance from the source while displaying the location of the source.

DESCRIPTION: High radiation sources have to be localized by using hand held probes on telescope extenders which is difficult and/or a greater hazard to the user. This effort would determine a video display system which would show the area and objects under surveillance with the specific location of the radiation source. A Sonar System found in cameras used to help determine the strength of the source.

Testing in Phase I would be to determine usefulness in the field as well as Cost Benefit Analysis.

Phase II would develop a militarized system.

N90-121 TITLE: Shipboard Communications Systems Network Model

CATEGORY: Engineering Development

OBJECTIVE: To select a ship communications system network model for comparison of different network configurations and architectures.

DESCRIPTION: Phase I consists of a review of candidate models for design and predicting performance of shipboard communications. The issues of performance shall include survivability, reliability, and intelligibility. Interfaces with other shipboard models for survivability and damage control are important.

Phase II will select and evaluate the model(s).

N90-122 TITLE: Submarine Quiet Announcing Systems

CATEGORY: Advanced Development

OBJECTIVE: Determine the means to produce an announcing system that emits no acoustic noise outside of the hull.

DESCRIPTION: Phase I consists of a study which reviews the acoustic performance of submarines and the acoustic performance of various announcing techniques and evaluate them with respect to the requirements for voice recognition and intelligibility of combat communication.

Phase II will build and test selected engineering models for practical application in the operational environment.

N90-123 TITLE: Shipboard Non-Detectable Portable Communications Systems

CATEGORY: Engineering Development

OBJECTIVE: Determine the availability and practicality of a mobile shipboard communication system that is not detectable off the ship.

DESCRIPTION: Phase I consists of a study to identify candidate technologies (e.g. low power r. f., infrared, millimeter waves, and magnetic). Issues will be safety, range and detectability.

Phase II will select and fabricate systems for evaluation.

N90-124 TITLE: Translation of IDS/Protocols into Mathematical (Boolean) Expressions

CATEGORY: Advanced Development

OBJECTIVE: Develop a methodology to be used in the translation of existing IDS/protocols and the formulation of new ones. Use of mathematically expressed (boolean) IDS/protocols would eliminate much of the confusion that now exists when an IDS/protocol is implemented.

DESCRIPTION: Phase I shall consist of developing a cost effective methodology for translating and formulating IDS/protocols in mathematical (boolean) expressions. Preparing documentation and recommending candidate test systems.

Phase II would consist of translating an existing IDS/protocol and then proving the effectiveness by having a third party, not involved in the translation, implement the IDS/protocol. The measure of effectiveness will be the delta between the implementation of a conventional IDS/protocol (English) and the mathematical IDS/protocol (boolean).

N90-125 TITLE: Development of Transducer Coatings with Low Volatile Organic Compound

CATEGORY: Advanced Development

OBJECTIVE: Develop corrosion resistant EPA-approved paint systems for transducers.

DESCRIPTION: Many Navy sonar transducers are coated with paint to inhibit corrosion. Some existing paint systems have a high volatile organic solvent content which do not meet EPA guidelines for volatile organic compounds (VOC's). Potentially more stringent EPA guidelines may be issued which could severely limit available transducer paint systems. Proposals are invited for the development of improved coatings systems for use on Fleet sonar transducer assemblies and other underwater piece-parts that meet current and future environmental regulations controlling volatile industrial solvents. These systems should be identified and directly compared to systems currently in use. Durability in Fleet service conditions is to be determined.

Phase I will review low solvent coating technology and identify formulation with potential as transducer coatings.

Phase II will be a formulation and test period.

Phase III will include successful coatings transitioning to large production formulation and processing specifications.

N90-126 TITLE: Non/Low Magnetic Signature Engines

CATEGORY: Engineering Development

OBJECTIVE: Develop a Non/Low Magnetic Signature Auxiliary Engine to provide electrical power to Minesweeper/Mine Countermeasure ships.

DESCRIPTION: Non/Low magnetic signature auxiliary engines are required for ocean minesweepers (MSO's). Typically these engines are in the 80-150 horse power range. Various approaches have been used to reduce the magnetic signature of the engines; degausing or use of non-magnetic materials for the block and engine components. The Navy is looking for a reliable non magnetic engine capable of providing electrical power to the Minesweeper/Mine countermeasure ships.

Phase I would be the identification of a non magnetic engine/material candidate for Phase II development and testing.

N90-127 TITLE: Acoustic Propagation Path Determination

CATEGORY: Advanced Development

OBJECTIVE: Provide an approach to determine acoustic propagation path (i.e. DP/BB/CZ) using analytical environmental modeling/heuristics. This is needed to support the APP program.

DESCRIPTION: Develop an operational methodology using both analytical modeling and underwater acoustic phenomenon to aid in determining the sound propagation path of acoustic data received by a thin line towed array.

It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates feasibility of technique using synthetic data.

Phase II would provide a computer based system which could be tested at-sea under realistic conditions.

N90-128 TITLE: Azimuthal Noise Variation Effects

CATEGORY: Advanced Development

OBJECTIVE: Investigate new innovative methods to account for real-time changes in azimuthal noise in ASW acoustic sensor employment. These methods are needed to support the APP program.

DESCRIPTION: Several shipboard systems measure ambient noise in a beam which provides a "snapshot" of existing environmental conditions on an azimuthal basis. Attempts to develop high fidelity APP models that account for azimuthally dependent noise measurements are too slow and can provide misleading results since any change in own ship heading or the disposition of adjacent forces renders the noise measurements obsolete. It is necessary to develop an innovative and rapid methodology to account for this noise variation in ASW search planning and sensor employment.

It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates feasibility of the technique.

Phase II would provide a computer based system which could be tested at-sea under realistic conditions.

N90-129 TITLE: MIL-STD-480B Expert System Tool Compound

CATEGORY: Engineering Development

OBJECTIVE: Demonstrate expert system designed to simplify Engineering Change Proposal (ECP) preparation. Use AN/SQQ-89 ASW Combat System as test bed. The proposed end product would be a system supporting ECP preparation and a process for applying the system to Navy projects.

DESCRIPTION: MIL-STD-480B is a complicated process used to control changes to Navy equipments and software. Often, project managers tailor away the control that 480B attempts to impart to the change process in order to simplify and minimize impact on their day-to-day operation.

Rather than simplifying the task by a redefinition of the ECP requirements, the Navy should provide tools that allow easy compliance with all 480B requirements.

The proposed research would prototype a system that would provide on line help for identifying the requirements for each ECP block. Additionally, an Expert System would be developed based on knowledge about the project under control, and would provide logical alternatives for information to be included in each ECP block. Ultimately the intent would be to tie the ECP CASE TOOL to the CM data base(s) and a "function matrix" in an attempt to predict change impact through all documentation.

For the first phase, plan to demonstrate interactive production of ECP forms, select a MAC II with 2 page monochrome display, mouse and laser printer as the basic engine. The system would be designed within the HYPERCARD paradigm (using SuperCard or its predecessors). A help file would be generated and a "help" interface developed for the interactive ECP forms.

Certain critical blocks within the ECP would be singled out to demonstrate the functioning of a simple expert system for Phase II. Rules and relationships would need to be identified and incorporated within the HYPERCARD context. Alternatives would be presented in windows adjacent to the on-line ECP form and selection of an alternative would be via the mouse point-n-click capability. The Expert System would be focused on identifying logical alternatives for the selected ECP block based on previously entered information and the knowledge of the AN/SQQ-89 (or other) system. The system would be able to learn new alternatives through a common usage algorithm.

The proposed expert system should be considered in the context of an assistant or a mentor. It will not even come close to displacing an engineer from the ECP process.

Follow on work would look at linking the ECP CASE Tool to non-destructive editors, spread sheets, electronic mail, and database systems to further expand the engineers ability to produce complete, correct, and well defined Engineering Change Proposals. Red-lined change pages, cost estimates, and automatic logging, tracking, distribution, and recording in the CM database are future possibilities for inclusion in such an expert system.

N90-130 TITLE: Shipboard Medical Waste Treatment System

CATEGORY: Advanced Development

OBJECTIVE: Develop a shipboard treatment system that disposes medical waste in an environmentally acceptable fashion.

DESCRIPTION: Ships routinely generate small amounts of medical waste. The volume of waste is a function of crew size. The Navy is searching for a concept and system to dispose of this waste in an environmentally acceptable manner. This system must be suitable for use in a shipboard environment, it must sterilize and destroy the waste. Destruction through incineration is preferred.

Phase I should address design and Phase II should include development of a prototype for land based evaluation.

N90-131 TITLE: Non-Vapor Compression AC System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype non-vapor compression AC plant for potential shipboard use.

DESCRIPTION: Concepts may use Stirling cycle, Brayton cycle, thermal electric, etc. Target size is 200 tons cooling. Prototypes should be in the 3 to 10 ton range. Seawater at 88 degrees F is the heat rejection reservoir. Innovative approaches are invited. Size, weight, power consumption, reliability, and safety are critical parameters.

N90-132 TITLE: Integrated On-Line R&M Design Program

CATEGORY: Engineering Development

OBJECTIVE: Integrated family of Navy TIGER R&M computer programs in workstation oriented ship design and overhaul process.

DESCRIPTION: The Navy is focusing increased attention on reliability, maintainability, quality, and logistics due to extended service lives and scheduled depot availability. This effort extends to both design and overhaul. Modified ship designs are continually being developed and increasingly complex ship overhauls will occur in the near future due to presently scheduled cycles and deferred maintenance. Concepts for integration of Reliability and Maintainability (R&M) as an on-line part of workstation oriented computer aided engineering are required to provide significant improvements in weapons systems effectiveness and decreased life cycle costs. Integration of an enhanced Navy TIGER R&M computer program in the ship design product model and adoption of the evolving Computer-Aided Acquisition and Logistic Support (CALS) data interface standards are needed.

N90-133 TITLE: Rotational Propulsor Concepts for Surface Ships
CATEGORY: Exploratory Development

OBJECTIVE: Improve acoustic and powering performance of surface ships using advanced propulsor concepts. Phase III transition into revolution at sea and advanced machinery efforts.

DESCRIPTION: In the near to mid-term (1990's-2010) the Surface Ship Navy will require increased stealth and propulsion efficiency to maintain and/or improve our current threat advantage. This will require the development of advanced rotational propulsor concepts. Proposals are requested which address alternative advanced rotational propulsor concepts.

Phase I: Develop advanced rotational propulsor concepts and quantify improvement relative to establish baseline. Provide supporting sketches, drawings, design calculations and performance calculations of alternative concepts.

Phase II: Provide detailed designs of propulsor concepts for specific applications and validate with model experiments.

N90-134 TITLE: Ship Design Tools - Measures of Effectiveness

CATEGORY: Advanced Development

OBJECTIVE: To provide an expert system to recommend naval surface combatant systems which can meet a given set of mission and operational requirements and identify measures of effectiveness (MOE) for the systems and the combatant.

DESCRIPTION: It would be quite useful if the naval surface combatant ship designer could input top level ship, mission and operational requirements (AAW, ASW, range, speed, etc.) into a computer and have an expert system/optimization program apply rules from a knowledge base to determine what kind of ship HM&E and combat systems provide the required capabilities. The designer would confirm or modify the equipment list and the program would access the knowledge base to find the resulting characteristic performance attributes for the selected systems. These attributes would be automatically categorized into seven mission drivers (battlespace, firepower, battle management, sustainability, survivability, mobility and readiness) which have known impacts on the force warfighting capabilities. Using further rules from the knowledge base and optimization algorithms, like attributes would be combined in each driver category and converted to total ship MOE's. Results would then be compared with current ships in the knowledge base having similar mission profiles. Significant benefits would result in quantifying this information in expert systems containing hypermedia capabilities. Knowledge engineering concepts and tailored prototypes of commercial grade computer programs for ship design are required for non-programmer, ship designers who need to continually update the knowledge base and develop freely distributable knowledge based systems on micro computers.

Phase I would develop a prototype expert system and Phase II would produce the operational program.

N90-135 TITLE: High-Efficiency Thermoelectric Material

CATEGORY: Exploratory Development

OBJECTIVE: To develop material for use in thermoelectric cooling modules.

DESCRIPTION: Develop semiconductor material for use in thermoelectric cooling modules that yields a higher coefficient of performance than the currently available doped bismuth telluride (i.e., produces more cooling for a given amount of input power at a fixed set of temperature conditions). The goal for the material developed under this task is to demonstrate consistently a figure of merit greater than 3.5 x 10-3 K-1.

N90-136 TITLE: Fiber Optic Current and/or Voltage Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Development of a model fiber optic voltage sensor and/or a laboratory demonstration of a fiber optic current sensor.

DESCRIPTION: The National Bureau of Standards and the Navy have developed fiber optic technology for current and voltage sensors. The current sensor technology uses the Faraday effect with bulk glass fibers and the voltage sensor technology uses polarization rotation, Pockels effect, and standard Navy fiber optic components. Proposals are requested for development of current and/or voltage sensors for Naval shipboard monitoring, control, electrical distribution, and propulsion systems based on the fiber optic technology.

Phase I proposals should include sensor design and laboratory test and evaluation plans; followed by laboratory hardware evaluations to determine suitability for shipboard evaluation.

N90-137 TITLE: Composite Flexible Pipe Coupling for Surface Ships

CATEGORY: Exploratory Development

OBJECTIVE: Develop a flexible pipe connector constructed of composite (Fiber Reinforced Resin) Material

DESCRIPTION: Develop a flexible pipe connection, similar to the currently used rubber insert sound isolation coupling, from fiber reinforced resin materials. Coupling of this type are found on surface ships in the controllable pitch propeller hydraulic piping and Prairie Masker piping. The newly developed coupling should closely match the form fit and function of the metal couplings in use. Flexibility within the coupling can be achieved by use of elastomeric materials similar to current practice. Coupling design may be either repairable or nonrepairable in nature and conform to the function and fit of current couplings.

N90-138 TITLE: Cavitation Suppression Technologies for Surface Ship Propulsors

CATEGORY: Exploratory Development

OBJECTIVE: Reduce surface ship acoustic signature through suppression of propeller cavitation. Phase III transition into revolution at sea and advanced machinery efforts.

DESCRIPTION: Propeller cavitation broadband radiated noise is a major, and often dominant, contributor to the total noise signature of surface ships. The Navy needs to reduce or eliminate propeller cavitation. Proposals are requested which address advanced cavitation suppression technologies applicable to surface ship propellers.

Phase I: Develop propeller cavitation suppression technologies and quantify expected improvements relative to established baseline. Provide supporting sketches, drawing, design calculations and performance calculations for technology assessment.

Phase II: Provide detailed designs of technology improvements for specific applications and validate with model experiments.

N90-139 TITLE: Novel Materials for Shipboard Fire Barrier Applications

CATEGORY: Advanced Development

OBJECTIVE: The purpose of this effort is to develop a lightweight composite fire barrier material with the capability of significantly improving the protection of vital ship spaces for extended periods following weapon impact. Materials emerging from this effort that satisfy established fire exposure criteria for shipboard use may be transitioned to the Advanced Shipboard Materials effort under the Passive Fire Protection Materials NAPDD (PE 63514, Project S1565, Damage Control).

DESCRIPTION: The Naval Sea Systems Command has identified the development of lightweight composite fire barrier materials as a key technology for future ships. It is highly desirable that the materials selected be capable of surviving initial weapon impact effects and secondary fire effects, thus providing sufficient protection to vital ship spaces to insure "fight-hurt" capability.

The objective of the Phase I effort is to identify novel approaches to fire protection which offer the potential for order-of-magnitude performance improvement compared with current materials, and to assess their potential in shipboard applications from the standpoint of cost, development risk, weight, volume and performance.

Phase II will consist of fabricating samples representative of the most promising materials which emerge from the Phase I trade study for testing in a simulated post-hit environment.

N90-140 TITLE: Realizing the Potential of Total Platform Sensor Data Fusion

CATEGORY: Exploratory Development

OBJECTIVE: Investigate innovative approaches that will lead to Total Combat System Integration/Automation of shipboard sensors with the goal of increasing shipboard reaction time to the threat environment.

DESCRIPTION: Sensor data fusion can be viewed as a method for combining similar/dissimilar sensor data from multiple shipboard sensors to provide local and area air defense against anti-ship missile and aircraft threats. It attempts to overcome existing shipboard sensor system limitations and ever increasing 1990's threats characterized by:

a. Low observable technology which is sharply decreasing radar cross sections.
b. Decreasing threat infrared (IR) signatures.
c. Decreasing attack altitudes of low flyers and terrain/sea skimming missiles.
d. Threat speeds escalating to MACH 3.0 and beyond.
e. Increasing threat maneuverability with higher "G" terminal maneuvers.
f. Increasingly sophisticated threat countermeasures and effective jamming in support of incoming raids.

While current sensor integration has demonstrated the potential for some automation of the combat system, considerably more needs to be done to effectively exploit the potential of sensor data fusion. Innovative ideas are sought to demonstrate the potential gains that could be achieved by multi-sensor fusion of the entire spectrum of visual, infrared, radio, laser, acoustic, and ESM sensors. Shipboard sensor data fusion architecture which exploits the diversity of frequency and characteristics of each sensor to provide a complete, timely, and accurate picture of the tactical situation in the post 1990 threat environment under adverse conditions including clutter, ECM/ECCM, and multipath environments is the goal of this effort. Technologies that can help sensor data fusion architecture reach their full potential is sought.

A survey of the capabilities of existing and planned tactical sensors must be conducted with computer models of sensor performance generated during Phase I.

During Phase II candidate multi-sensor data fusion architectures must be hypothesized. Each of these candidate architectures must address scene registration/sensor alignment problems, track initiation decisions, and track correlation concepts. Concepts for triangulating passive data from both ownership and remote platforms must be evaluated. Measures of effectiveness must also be developed to assist in determining the most promising sensor fusion architecture.

N90-141 TITLE: Shipboard High Speed Optical Data Transport Network (HSODTN)-Compartment Area Network (CAN)

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate cost effective trade-off CANs.

DESCRIPTION: The CAN is the only part of the HSODTN to which the agent(s) has direct access. Thus it is of particular importance to achieve a good cost/performance trade-off for the CAN. Considerations of broadband services from the CAN in a few years, with risks of independent implementation of products, could lead to less difficult interconnections in the future HSODTN. Furthermore, the CAN requirements for combat or critical systems are different from logistics or non-critical systems, so well conceived CANs studies are justified in this specific area.
The tasks are to:

1. Define the CAN requirements and then establish an architecture which can act as a frame work for satisfying these requirements across the range of diverse applications and varying traffic capacities and speeds.
2. Ensure that proper technologies are available to achieve the required costs and performance for the CAN.
3. Implement subsystems of the overall predefined CAN architecture to validate technologies and system choices (compatible with HSODTN interfaces).
4. Integrate subsystems into a laboratory prototype to validate the feasibility of the model.

An effective interwork with the HSODTN functional requirements is necessary, so that implementations can take into account the functional specifications defined and the results of the technology validation can be made in a timely manner.

N90-142 TITLE: Ice Phobic Coatings for Ship Antenna Applications

CATEGORY: Advanced Development

OBJECTIVE: The goal of the proposed program is to develop a low cost material to inhibit ice accretion on antenna systems during cold weather operations. Current systems are expensive and exhibit limited stability in the marine operational environment. Successful development of coatings with improved behavior will result in large scale testing as part of Phase III.

DESCRIPTION: Ice accretion on surface ships operating in the arctic regions and North Atlantic can have a severe effect on the operational capability of top side systems including antennas for radar and communications. Degradation of these systems can reduce the warfighting capability of the vessel thus limiting its ability to meet mission objectives. Coatings currently in use are

expensive, abrade easily, and can be difficult to apply. New coatings are sought which demonstrate improved environmental stability, can be easily applied to a wide variety of surfaces at minimum cost, and exhibit electrical properties compatible with the operating parameters of the antenna system.

Phase I will address performance requirements and goals in addition to initial formulation, sample fabrication, and proof-of-concept testing.

Phase II will expand on the Phase I effort generating sufficient data to assess feasibility of large scale application.

N90-143 TITLE: Non-Corrosive Composites for EMI Shielding Applications

CATEGORY: Advanced Development

OBJECTIVE: The purpose of this effort is to develop conductive, lightweight composite materials for topside hardware EMI shielding applications which are stable in the marine environment. Materials satisfying established performance goals at the end of Phase II will be transitioned to Phase III for large scale testing.

DESCRIPTION: The Naval Sea Systems Command has identified the need for new EMI shielding materials as a key technology for future systems. Highly conductive, non-corrosive materials are of great interest for these applications. Candidate materials systems under consideration must be easily fabricated into complex shapes, low cost, and highly reliable. Signal reductions in excess of 60 dB across a broad frequency range represent the performance goal for this program.

Phase I will involve identification of candidate materials, fabrication of samples, and preliminary testing.

Phase II will optimize the best candidates emerging from the Phase I study and thoroughly characterize their properties in terms of environmental stability and electrical behavior.

N90-144 TITLE: Equipment Readiness Status Monitor and Recorder (RSMR)

CATEGORY: Exploratory Development

OBJECTIVE: Naval Combat system equipment must be monitored for operating time in its various modes of operation and for non-ready status due to marginal states, reduced capability, critical failures, preventive and corrective maintenance, etc., to access its operational availability in the fleet environment. Current procedure is to monitor by fleet technicians who manually record these operating status changes as part of his assigned tasks.

DESCRIPTION: An automated microprocessor based monitoring and recording capability requiring minimal or no technician entry is needed to collect accurate consistent data while detecting operational status changes at the source. The output would be a daily/weekly operating log report for each unique equipment that can be electronically transferred off ship to a centralized computerized data base for analysis. The RSMR production cost must not exceed $500 per unit and either installed new as part of the existing equipment architecture or backfitted to existing equipment.

PHASE I:

1) Survey industry for monitoring and recording capability and propose existing or new research to design to requirement.
2) Conduct life cycle cost analysis of cost to design, procure and operate.
3) Conduct cost benefit analysis for having accurate data to optimize maintenance philosophy and equipment availability.

PHASE II:

1) Select a design to meet requirement.
2) Build a prototype RSMR.
3) Conduct test and evaluation to verify and demonstrate operational suitability.
4) Conduct production cost analysis to meet design-to-cost criteria.
5) Produce acquisition specifications and planning documentation for production decision.

N90-145 TITLE: Microwave Monolithic Transmitter/Receiver Designs for Naval Electronic Warfare

CATEGORY: Exploratory Development

OBJECTIVE: Develop phased array designs and modular architecture employing MIMIC transmit/receive modules adaptable to several Naval platforms.

DESCRIPTION: The DOD Microwave Monolithic Integrated Circuit (MIMIC) program is developing transmit/receive modules for employment in phased arrays that may serve the needs of EW and radars in the future. Octave band phased array design architectures are required to use the basic modules in moderate power decoy designs and to build toward higher power designs for

aircraft, helicopters and small ships. Nanosecond beam steering techniques, multiple signal capability, high transmit/receive isolation, polarization control and extension to higher frequency bands are basic goals for this design architecture.

N90-146 TITLE: Versatile Signal Recognizer

CATEGORY: Engineering Development

OBJECTIVE: To develop a signal recognizer that is small, versatile, easily interfaced with any receiver and capable of rapidly adapting to the changing threat.

DESCRIPTION: Since the development of Radar Warning Receivers (RWR), there has been specific signal recognizers that set off alarms to give warning of imminent danger. These recognizers are relatively signal specific and are built around hardware and firmware in a module. The number of signals of interest (SOI) and the number of modules are normally one for one. These recognizers also suffer from variations in signal parameters so that a new SOI requires a redesign of the original module. It is therefore desirable to have a module that can recognize multiple SOI's at the same time, be readily programmable in the field with available assets and maintain all the desirable characteristics such as a high probability of intercept/detection, low false alarm rate, rapid recognition and have good sensitivity. The module should be able to interface with a variety of receivers and permit integration of modern devices as the technology changes. The device should also be capable of operating on multiple types of modulations such as FMCW, plus stagger etc. and be able to accept both analog and/or digital inputs.

N90-147 TITLE: Deinterleaving Pulse Trains in Severe Multipath Environments

CATEGORY: Exploratory Development

OBJECTIVE: Development of an algorithm that can sort radar pulse trains in the presence of strong multipath by using angle of arrival information.

DESCRIPTION: Radar pulse sorting by submarine ESM systems is complicated by multipath in that near sea surface environment. When a monopulse capability is present, pulses may each be tagged by direction-of-arrival (DOA). Design a deinterleaving algorithm for pulse trains in a dense signal and multipath environment, that takes advantage of DOA tagging and takes into account DOA measurement tolerances. The only other parameters the algorithm can make use of are frequency and time of arrival.

N90-148 TITLE: High Power, Short Pulse Jammers

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate feasibility of electromagnetic pulse radiator for disrupting airborne missile guidance systems.

DESCRIPTION: There is an increasing need for more generic means of jamming communications and electro-magnetically guided weaponry in all services and the U. S. Navy has unique needs to disrupt anti-ship missile guidance systems. The effects of electromagnetic pulses (EMP) on sensors, electronics and servos is documented in the open literature and provides the impetus for research to provide practicable shipboard jammers of this type. Photoconductive switching, using silicon or gallium arsenide diodes can switch large powers (gigawatts) with nanosecond risetimes. A laser can be used to trigger the photoconductive switches that discharge high voltage capacitors into a waveguide horn array. This array jammer could also be possibly used in a dual mode as a radar to detect low observable missiles and aircraft. Trade-offs on alternate practicable and affordable EMP mechanisms must be presented with effects of projected electric field intensity on the target at ranges from two to fifteen miles. A plan for testing the demonstration transmitter should be addressed.

N90-149 TITLE: Radiometric Detection of Targets at Sea

CATEGORY: Exploratory Development

OBJECTIVE: To develop passive detection system for targets at sea.

DESCRIPTION: Passive detection of targets from on-board Navy surface ships is needed in order to maintain radar silence and to detect low observable targets through fog and rain. Microwave and millimeter wave radiometry have demonstrated potentials for detecting and even imaging ships and aircraft at sea. The target may have reduced infrared signature and the radiometer will measure "radio temperature" difference between the target and its background. A four foot parabolic antenna disk and cryonic cooling will be acceptable for demonstration, but diode arrays should be explored for more compact and higher sensitivity designs.

Signal processing, displays and data recording shall be addressed with a plan for demonstration with U. S. Naval facilities.

N90-150 TITLE: Tailoring Tool for Assuring Effective R/M/QA Clauses in Acquisition Documents

CATEGORY: Engineering Development

OBJECTIVE: To provide EW System Managers with Cost Effective Options for Specifying R/M/QA Requirements that meet Navy Policy.

DESCRIPTION: To develop an IBM PC compatible program (on floppy disk) expediting preparation of "tailored", cost effective Reliability (R), Maintainability (M), Quality Assurance (QA), requirements, mission profile, Availability and R/M/QA tests for Acquisition Plans and Packages (SOW and SPEC). This program would be designed for Program Manager/Acquisition Engineer use in selecting clauses that comply with OASN/NAVSEA requirements policy but categorized for selection by contract type, environment, EW requirements and cost alternatives (minimum requirements). Development of program will include user friendly display and development of some clauses. Results will be more intelligent and less costly requirements imposed in new RFPs designed to program needs.

N90-151 TITLE: Testing of Shipboard EW Equipments

CATEGORY: Advanced Engineering Development

OBJECTIVE: Develop test set to verify operation of Shipboard EMC & ESM operation.

DESCRIPTION: Current equipment used to test shipboard EW system for correct operation prior to deployment is outmoded and is not able to fully test modern EW systems. A set of test equipment is needed to stimulate active systems externally and measure ECM performance parametrics such as effective radiated power, transmit beam pattern, J/S ratio, and jammer set on accuracy. Approaches to fixed site and portable equipments are desired as well as automated measurement techniques.

N90-152 TITLE: Passive Ranging with Limited Data

CATEGORY: Advanced Development

OBJECTIVE: Exploiting characteristics of electromagnetic signals emitted at great distances in ways that allow passive ranging by submarines in relatively short periods of time.

DESCRIPTION: Submarines usually need to support Over-The-Horizon (OTH) targeting by locating distant signal emitters by purely passive means. Classical methods such as triangulation have been generalized into powerful techniques but almost always require large times and distances of travel to collect the necessary data to determine the location of very distant emitters.

Develop an algorithm that may exploit any and all characteristics of received signal such as phase, amplitude, polarization, etc., to determine the position of distant emitters without traveling large distances or making numerous maneuvers.

N90-153 TITLE: The Use of Artificial Intelligence for Torpedo Detection

CATEGORY: Exploratory Development

OBJECTIVE: Detect and classify torpedos using artificial intelligence.

DESCRIPTION: The Navy has a requirement for a system that can rapidly and reliably classify torpedoes while maintaining a low false alarm rate. The use of Artificial Intelligence (AI) in digital processors for human speech recognition is an example of present capabilities in this technology. A natural extension would be the use of AI to discriminate between the acoustic radiation of a torpedo from non-torpedo noise. The input to the system would be acoustic data provided by the Navy. The offeror should have an understanding of underwater acoustics and torpedo radiated noise characteristics in addition to AI technology.

During Phase I, the contractor will demonstrate detection in a laboratory environment with acoustic data provided by the Navy.

Continuation into Phase II, the contractor will be provided a larger acoustic data set and demonstrate a low false alarm rate along with reliable demonstration in a Navy ship. The contractor should include in the proposal: (1) a description of how the system requirements will be met, (2) an analysis to support how the requirements will be satisfied, and (3) any real data to substantiate the analysis. The qualifications of the principal investigator(s) should be provided. The company must also hold or be able to obtain a facility clearance for the storage of classified data.

N90-154 TITLE: Neural Networks for Torpedo Detection

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system capable of detecting torpedos using neural networks.

DESCRIPTION: The Navy has a requirement for a system that can rapidly and reliably classify torpedoes while maintaining a low false alarm rate. Recent advances in neural network technology have the potential to satisfy this requirement. The input to the system would be acoustic data from existing onboard sensors. The offeror should have an understanding of underwater acoustics and torpedo radiated noise characteristics in addition to neural network technology.

During Phase I, the contractor will demonstrate detection and classification in a laboratory environment with acoustic data provided by the Navy.

Continuation into Phase II will be based upon successful per-formance in Phase I. During Phase II, the contractor will be provided a larger acoustic data set and demonstrate a low false alarm rate along with reliable detection and classification. This will be followed by an at-sea demonstration in a Navy ship. The contractor should include in the proposal: (1) a description of how the system requirements will be met, (2) an analysis to support how the requirements will be satisfied, and (3) any real data to substantiate the analysis. The qualifications of the principal investigator(s) should be provided.

N90-155 TITLE: Preset Capability for Expendable Countermeasure (CM) Devices

CATEGORY: Exploratory Development

OBJECTIVE: To identify a new concept for presetting countermeasure devices after loading.

DESCRIPTION: This task involves the investigation and selection of the most feasible, new, innovative concepts for presetting CM devices after they have been loaded in water-tight CM launch tubes. Currently such devices have presets (such as hover depth, noise mode, run duration, etc.) selected before loading in the CM launcher located inside the submarine.

For external CM launchers these presets are made using a small electrical umbilical cable and a 64-bit digital word. Ideally these presets should be made without physically attaching a link to the CM device. An acoustic, optical or magnetic link would be acceptable if the transmission of data is reliable.

Phase I will consist of engineering analysis sufficient to determine concept feasibility. During Phase II, a breadboard model will be fabricated and undergo test and evaluation.

N90-156 TITLE: Automatic Radar Scan Recognizer

CATEGORY: Exploratory Development

OBJECTIVE: Development of an automatic radar scan recognizer for complex scan patterns in a multi-signal environment.

DESCRIPTION: The Navy requires an automatic scan recognizer to enhance radar signal identification. Current Navy submarine EW systems reply on the three basic radar signal parameters (radio frequency, pulse repetition interval, and pulse width) to perform automated signal identification. Additional radar signal parameters are required to resolve ambiguities when multiple candidate solutions are present after identification attempts using the three basic parameters. The best candidate additional parameters in the submarine environment are scan type and scan rate/period.

Current automated scan measurement systems deployed on submarines are effective only when the most ideal signal to noise ratios are present, and normally are limited to simple scan types such as circular. The Navy's requirement includes automated recognition and measurement of radar signal scans in multi-signal environments, when signal side lobes are present and on all scan types including complex scans such as conical and lobe switching.

N90-157 TITLE: High-Efficiency Low-Noise Hovering Systems for Underwater Devices

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the development of high-efficiency low noise hovering systems for underwater devices.

DESCRIPTION: Several types of submarine-deployed expendable devices are required to remain at pre-determined depths for periods of time up to one hour. These devices range in size from 3" diameter by 40" length to 6.25" diameter by 106" length, and have wet weights from a few ounces to several pounds. Hovering systems which are small in volume, quiet, reliable, and energy efficient are of great value to the success of device development programs.

Phase I will consist of engineering analysis sufficient to determine concept feasibility.
During Phase II, a breadboard model will be fabricated and undergo test and evaluation.

N90-158 TITLE: Low-Noise Microwave Receiver Using High Temperature Superconductors

CATEGORY: Research

OBJECTIVE: The application of the new, high-temperature, superconductors to develop ultra low-noise receivers using only liquid nitrogen refrigeration.

DESCRIPTION: Receivers with some cryogenic and superconducting elements have been used in radio telescopes in the millimeter and submillimeter ranges for more than 7 years. The noise figure for such receivers are much lower than those for comparable receivers operating at room temperature. The very low temperature used in these receivers are usually obtained with liquid helium refrigeration units. The recent discovery of superconductors with transition temperatures in the 90 degree K range, and above, make possible such receivers cooled by liquid nitrogen refrigeration units.

Develop a very low noise microwave receiver, cooled only by liquid nitrogen, using one of the new high temperature superconductors.

N90-159 TITLE: Advanced Machinery Monitoring Sensors

CATEGORY: Engineering Development

OBJECTIVE: The key to automating ship and machinery control functions is durable, reliable sensors which need little or no care. Existing sensors are electrical and either contact closure type or continuous type. They generate low level signals and are prone to EMI, shorts and grounds. They require recalibration (annual basis) and in many cases there is no way to distinguish between a failed sensor and an actual alarm condition.

DESCRIPTION: Existing electrical type sensors will be examined for approaches to provide automatic recalibration and loss of sensor detection. Various transducer types will be compared on the bases of cost, accuracy, availability, reliability, operating temperature range and compatibility with computer based monitoring and control systems. Fiber optic sensors will be developed for areas in which no electrical sensor can meet the requirement and as a replacement for existing sensors for improved reliability, survivability, lower cost, broader environmental operating range, and/or elimination of EMI, shorts and grounding problems. Integration of fiber optic sensors into the advanced monitoring and control systems for maximum utilization of potential benefits will also be addressed.

PAYOFF:

WEIGHT: If properly integrated into the system the fiber optic sensors will be lighter and have lighter cabling.
VOLUME: Fiber optic sensors are smaller as are the connecting cables.
MAINTENANCE: Self calibration, increased reliability and redundancy of critical sensors will essentially eliminate sensor maintenance.
OPERATING ENVELOPE: Fiber optic sensors will operate in more extreme environmental conditions and are more survivable.
MANNING: Reduced maintenance burden.
RELIABILITY: Sensor reliability vastly improved.
COST: Fiber optic sensors cabling have potential for substantially reduced costs.

N90-160 TITLE: Undersea Fiber Optic Communications Network

CATEGORY: Exploratory Development

OBJECTIVE: To develop a fiber optic communications network for underwater use.

DESCRIPTION: The Navy has a requirement for a high data rate underwater Fiber Optics Communications Network which is robust, self healing, and automatic reconfiguring. The network must be randomly accessible at multiple points by means of an attachable/detachable fiber optic coupling device. Recent advances in neural technology have the potential to satisfy the network requirements. Innovative research will be required to design and access the required access coupling.

During Phase I, the contract will provide the initial engineering analysis necessary to develop the network architecture and the access coupling.

Phase II will be based on successful performance in Phase I. During Phase II the contractor will demonstrate the fiber optic neural network and access coupling in a laboratory environment. This will be followed by a prototype installation for

testing in the undersea environment. The contractor should include in the proposal: (1) a description of how system requirements will be met, (2) an analysis to support how system requirements will be satisfied, and (3) the qualifications of the principal investigators.

N90-161 TITLE: Pressure Compensation Systems for Moving Coil Projectors

CATEGORY: Exploratory Development

OBJECTIVE: To improve reliability of moving coil projectors.

DESCRIPTION: The Navy has the need to improve the reliability of moving coil projectors. To this end, approaches to either ruggedize existing designs or develop novel concepts to minimize the pressure compensation requirements need to be developed. Hydrostatic pressure requirements are in the range of 0-100 psig.

During Phase I, the contractor will submit a paper analysis with a breadboard of the proposed pressure compensation system.

Phase II will require the contractor to make a prototype pressure compensation system, attach this system to a moving coil transducer, and conduct a laboratory test.

Phase III would produce from scratch a compact moving transducer Advanced Development Model (ADM) with an improved pressure compensation system. Finally, this ADM would be subjected to an at sea test. The contractor should include in the proposal: (1) a description of how the system requirements will be met, (2) analysis to support how the requirements will be satisfied, and (3) any real data to substantiate the analysis. The qualifications of the principal investigator(s) should be provided.

N90-162 TITLE: High Order Spectrum Applied to Time Delay Estimation

CATEGORY: Exploratory Development

OBJECTIVE: To develop a method of estimating signal propagation times

DESCRIPTION: The Navy has an interest in developing improved methods of estimating signal propagation times and time differences. This technology has direct application in active and passive sonars to support bearing and range estimation. The contractor shall develop a signal processing technique based on high order spectrum estimation to measure time delay differences between different sonar signals.

The contractor shall describe the signal processing algorithm used and how it will meet the requirement to measure time delay. The contractor shall describe how this signal processing can be demonstrated and tested using simulated data and report the performance achieved. Testing shall include a sample of data recorded during at-sea exercises. The contractor shall describe the qualifications of the principal investigator for this task.

N90-163 TITLE: Automated Groundwave Recognition for HF Communication

CATEGORY: Advanced Development

OBJECTIVE: Development of an algorithm which can discriminate between ground wave and sky wave signals in the HF band when antennas are used which are electrically very small.

DESCRIPTION: The HF signals of interest to Submarine ESM system operators are usually the groundwave. However, often HF skywave signals are intercepted. Sometimes skywave and groundwave signals are intercepted together.

Develop an algorithm which will recognize HF groundwave from skywave signals when received by an AN/BRD-7 antenna array in close proximity to the surface of the ocean. The algorithm must detect when an intercepted groundwave signal is contaminated with a skywave.

N90-164 TITLE: High-Frequency, High-Power Transparent Transducer

CATEGORY: Exploratory Development

OBJECTIVE: Hardware demonstration of high power, broadband transducer.

DESCRIPTION: A requirement exists for a high power, broadband, acoustically transparent, high frequency transducer. A broad operating band (one octave) is required.

The Phase I requirement is a design and hardware delivery of a projector(s) suitable for test and evaluation for initial demonstration of the feasibility of the concept.

Phase II will be a full array hardware demonstration of the total concept.

N90-165 TITLE: Electronic Precision Focusing for the Type 18 Periscope

CATEGORY: Engineering Development

OBJECTIVE: To develop an electro-optic sensor that determines the optimum focus of an optical system from its real scene image within the limitations and restrictions of packaging, cost and vehicle environment and improve intelligence, reconnaissance, sensor contrast and atmosphere contrast with regard to image acquisition.

DESCRIPTION: A study performed by EK and sponsored by OP-924 in the early 1980's showed that lack of resolution of intelligence imagery shot through the Type 18 periscope was due to poor focusing of the IMCCS. Accuracy of focusing relies on the operators eyeballs without any electronic assistance. Results by the end user of the imagery show about a 7% return of usable film negatives, however not necessarily at resolution levels designed into the Type 18 periscope. The proposed task is to analyze the Type 18 focusing shortcomings, evaluate current state-of-the-art automatic electronic focusing systems and incorporate it into the Type 18 periscope. The addition of precision focus capability should greatly enhance intelligence gathering missions, reconnaissance scenarios, and provide the photo interpreters with more usable imagery during image acquisition missions.

N90-166 TITLE: Pulse Power Supply for Submarine Electromagnetic Launch

CATEGORY: Exploratory Development

OBJECTIVE: An appropriate power source for submarine electromagnetic launch system capable of supplying 15,000 amperes at 250 volts DC for a period of 1 second with an approximate rate of 8 shots per minute for a total of 40 shots does not exist, and much of the technology required for such development is deficient.

DESCRIPTION: Develop a power source for the electromagnetic launch system based on advanced fuel cell technology. The fuels and oxidants will be generated electrolytically and stored onboard with no requirements for shoreside replenishment.

PAYOFF:

ENVELOPE: Allows development of an electrolytic weapons launch system requiring no additional support systems, independent of the ship's battery system.
SIGNATURE: Decreases noise signature 90% over conventional power sources utilizing heat-engine technology. Reduced weight 50% over conventional battery systems.
SYNERGISTICS: It is possible for this fuel cell power system to share or be combined with a fuel cell system used as emergency power generation. In this case, development of the reactant systems would converge, and the electrolytic oxygen generator used in life-support, could be eliminated.
MAINTENANCE: Fewer moving parts yield 50% improvement in the mean-time-to-repair compared to engine generators and battery maintenance.
RELIABILITY: 50% increase over heat-engine technology.
MANNING: No change except that a higher level of training is required.

N90-167 TITLE: Directional Hydrophone for Acoustic Towed Arrays

CATEGORY: Advanced Development

OBJECTIVE: To develop a directional hydrophone for towed arrays.

DESCRIPTION: The Navy has a requirement for a directional hydrophone for acoustic towed arrays. Current towed arrays have a left/right ambiguity because they are constructed with omnidirectional hydrophones. If the omnidirectional hydrophones were replaced with hydrophones that discriminate between left and right, this ambiguity would be removed. Additionally, the hydrophone must have the sensitivity, frequency response, and low acceleration response comparable to current hydrophones, must physically fit within a 2.5-inch I.D. hose (and preferably within a .75-inch I.D. hose), and must maintain left/right discrimination as the towed array rotates.

During Phase I the contractor will design, fabricate, and test a hydrophone in a laboratory environment. A decision to proceed into Phase II will be based upon actual test results.

During Phase II, the contractor will fabricate and support calibration and at-sea tests on a Navy test ship. The contractor's proposal should address how he will satisfy the requirements and provide analysis and any test data available to support performance predictions. The proposal should include the predicted level of left/right discrimination and sensitivity as a function of frequency.

N90-168 TITLE: Non-Electronic Shipboard Systems Diagnostic Concepts

CATEGORY: Engineering Development

OBJECTIVE: To develop portable, diagnostic systems and concepts for non-electronic shipboard system or equipment.

DESCRIPTION: The Navy requires portable diagnostic systems and equipments which can be used to: (1) diagnose non-electronic equipment and (2) assist repair technicians during the repair and post-repair check out process. Three categories of equipment are of interest: (1) rotating machinery, (2) reciprocating machinery, and (3) high current handling electrical equipment (>400 amps) such as circuit breakers and switchboards. The Navy is particularly interested in a concept for using the same system on more than one type of equipment and throughout the diagnostic, repair, and checkout process. These processes may migrate through all three levels of maintenance, organizational, intermediate, and depot.

Phase I of the project should provide the concepts or products to be used and the rationale for selecting the shipboard systems for diagnosis. It should also include a description of the range of applicability and a description of the Phase II effort.

Phase II should demonstrate the use of an actual system in a Navy ship and repair activity, and should lead to actual fleet-wide introduction. The contractor will be expected to deliver the required procurement specifications and contract CDRL requirements for inclusion in the system procurement solicitation for Phase III.

N90-169 TITLE: Wave Characterization System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system for use on Amphibious ships capable of supporting Landing Craft, Air Cushion (LCAC) operations to reliably characterize the sea conditions immediately prior to and during LCAC operations.

DESCRIPTION: The ability of the LCAC to effectively conduct its mission to carry personnel and equipment to and from shore including interfacing with well deck ships is significantly effected by sea conditions. Optimal LCAC cargo loading, fueling, craft speed and heading can only be determined based upon a relatively accurate characterization of ambient sea conditions. Means currently available to the Task Force Commander for assessing these conditions in order to determine resultant effect on LCAC performance are limited. A system that would reliably measure, and provide a real time display of sea-state data including wave height, wave length and period of maximum energy would prove to be a valuable tool for use in the planning and conduct of LCAC operations.

The Phase I program involves further definition of requirements, development and comparison of alternatives and demonstration/validation of concept(s).

Phase II would involve full scale prototype test and evaluation, and further development of the preferred configuration.

N90-170 TITLE: Inflatable Craft Design Developments and Improvements

CATEGORY: Advanced Development

OBJECTIVE: To improve current Combat Rubber Raiding Craft for future procurements through development of:

a) Low detectability
b) A means of suppressing wake and spray
c) A more producible design
d) New/better construction techniques
e) New materials for overall construction
f) A personnel cover
g) Strengthened transom for higher horsepower engines

DESCRIPTION: Combat Rubber Raiding Craft are used by Naval Special Warfare (SEAL) Teams for many types of operations. A primary method of reducing threat in this arena is by decreasing detectability. A low detectable craft will improve the survivability of SEALs in the combat arena.

In the past, the Navy has purchased many of these craft off GSA contracts which decay efforts of configuration management and Navy Logistics support. The design development and improvements stated above would further Navy development of Combat Rubber Raiding Craft Specifications.

Phase I should include feasibility studies and preliminary design sketches for those items listed above.

Phase II development of feasible products and techniques culminating in production drawings and the production and testing of a prototype craft.

Phase III, after incorporation of concepts developed in Phases I and II into the specifications for CRRC, a firm

fixed price production contract may be awarded based on either a RFP or an IFB.

NAVAL SURFACE WEAPONS CENTER/WHITE OAK

N90-171 TITLE: System Design Methodology for Massively Interconnected Models

CATEGORY: Exploratory Development

OBJECTIVE: Develop methodologies, techniques and tools to reduce insertion time of massively interconnected models into hardware for Navy Systems.

DESCRIPTION: Numerous massively interconnected models with simple computational nodes (such as artificial neural networks) have been shown to have great promises for Navy applications. However, these models have only been used as part of software simulations on their proposed applications. To have any real value to embedded, real-time systems, they must be implemented to a large extent in hardware.

A huge bottleneck to such implementations is the complexity of the communication interconnection required by these computational models. The Navy seeks a performance based (response time, volume, area, etc.) methodology and associated techniques and tools to systematically reduce such interconnection complexity for hardware implementation without disturbing the value of the underlying algorithm. These techniques and tools must allow the analyst to tradeoff feasible designs for area, time, fault tolerance and system performance.

N90-172 TITLE: Statistical Testing of Model Hypothesis in Binomial Regression

CATEGORY: Research

OBJECTIVE: Improve and develop the properties of a statistical test for model goodness-of-fit in binomial regression problems involving a complicated regressor function.

DESCRIPTION: Numerous militarily significant problems, such as the evaluation of weapons system effectiveness, the sensitivity and reliability of explosives, and the vulnerability of complex structures to severe loading conditions, often involve the regression of a binomial proportion (number of successes/number of trials) on some loading functions or quantity that is assumed to characterize the severity of the trial environment. The probability of success estimated in this manner (mean of the binomial proportion) as well as further inference, is dependent upon the assumed model hypothesis, i.e., the loading function (or class of functions) employed and the class of distributions used to relate probability of success to loading level. The credibility of any prediction model developed in this manner depends on a statistical test of the model hypothesis and the power of the test against alternative model hypotheses.

The Phase I effort would develop the properties of an existing chi-squared test, perhaps by numerical situation, and explore the possibility of developing a test with improved small sample properties.

The Phase II effort would continue the development of the improved test. An important focus during both phases would be the power of the tests as a function of sample size. The broader impact of this work would be to provide the Navy with a means of discriminating between effective and weak prediction models and for determining the data requirements for significant comparisons.

N90-173 TITLE: Improved Methods for the Manufacture of Pentafluorosulfanyl Components

CATEGORY: Exploratory Development

OBJECTIVE: Develop chemical reactions, methods, or processes which will permit the economical synthesis of key pentafluorosulfanyl intermediates such as SF_5CF_2COOH, SF_5CH_2COOH, $SF_5C_6H_4R(m)$ (R=halogen, COOH, OCH_3), $HOC(0)CF(SF_5)CF\text{-}(SF_5)C(O)OH$, $(SF_5NCO)_3$

DESCRIPTION: Pentafluorosulfanyl (SF_5) compounds exhibit reduced sensitivity and relatively high energy content. These properties would allow the formulation of improved explosives for insensitive and high-yield underwater munitions, and of fast-burning pyrotechnic compositions. However, practical use of SF_5 compounds is restricted by their high cost.

The Phase I effort would identify and evaluate, on a laboratory scale, novel approaches to the economical synthesis of SF_5 compounds such as those listed above, as well as other SF_5 compounds which can be made economically and have appropriate functionality for further chemical reactions.

Under the Phase II effort, the synthesis of selected SF_5 compounds would be scaled up using economical processes developed during Phase I. Significant quantities ($\geq$ 10 lbs) of selected compounds would be produced as precursors for

explosive and pyrotechnic ingredients. Such ingredients would be prepared and evaluated in follow-on efforts supported by appropriate 6.2 programs.

N90-174 TITLE: Discontinuously Reinforced Magnesium for Missile Components

CATEGORY: Exploratory Development

OBJECTIVE: To develop an improved discontinuously reinforced magnesium matrix composite material.

DESCRIPTION: Magnesium is a lightweight structural material that has relevance to missile applications. A magnesium matrix composite which exhibits significantly improved thermal conductivity or dimensional stability versus the baseline metal would be useful for components such as heat sinks, mirrors, or stable platforms. This composite should be isotropic in thermomechanical behavior. Proposals are sought with a demonstrated capability to fabricate high conductivity or high stability magnesium matrix composites.

The Phase I deliverable is test data sufficient to indicate the quality of the composite.

Phase II efforts will consist of defining an application and making components that manifest the improved material properties. The deliverable will be small or reduced scale components for evaluation by the Navy.

N90-175 TITLE: Phased Array Antenna

CATEGORY: Advanced Development

OBJECTIVE: The Navy is interested in monopulse phased array antenna technology that would enable the construction of a low cost, back-to-back, rotating phased array.

DESCRIPTION: The antenna should possess the following characteristics:

Aperture - 2m vert by lm horiz or larger
Frequency - x-band or higher
Bandwidth - 10% minimum, 30% desired
El Scan - +70 deg to -20 deg
Az Scan - 0 to 20 deg
Scan rate - 120 rpm minimum
Sidelobes - -23 dB maximum, -35 dB desired
Peak power - 100 Kw

Designs should minimize the number of phase shifters. Space and reciprocal feed designs are encouraged. Wide bandwidth, low weight and low sidelobes are desirable. Azimuth scan is not necessary but could result from squinting over the operating band. Beam spoiling in either azimuth or elevation will also be considered desirable.

The first phase of the contract would be to produce a detailed design of the proposed antenna. The design would include predictions of far-field antenna patterns.

The second phase of the development would be the construction of a full-scale or sub-scale model of the antenna and the measurement of far-field antenna patterns over the operating frequency band and over all scan angles.

N90-176 TITLE: Detection of Hidden Corrosion Under Aircraft Skin

CATEGORY: Research

OBJECTIVE: Research to discover new ways of detecting corrosion under aluminum aircraft skins.

DESCRIPTION: The Navy presently expends considerable effort in assessing the extent of hidden corrosion in its aircraft. The current method involves the expensive and time-consuming process of removing the outer aluminum skin so that a visual inspection can be conducted. A means of assessing hidden corrosion without skin removal could result in significant cost savings. Such an approach would require the development of a technology suitable for ultimate transition to a typical aircraft maintenance environment. Despite prior research in this area using neutron radiography, the development of a practical inspection tool has been elusive.

Either totally new technologies or significant advances in the practicality of implementing neutron based methods are sought in Phase I. Salient features of any instrumentation associated with the technique would include portability, ease of operation, and capability to adapt to the wide range of geometries encountered in a typical aircraft structure.

Phase II of this effort should use approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

N90-177 TITLE: Nonlinear Transforms for Optical Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate optical systems or devices capable of real-time nonlinear transformations.

DESCRIPTION: Optical systems provide true parallelism and thus great speed advantages over electronic systems in a large number of signal processing applications. Linear operations such as correlation, convolution and Fast Fourier Transformations are relatively easy to implement. Many signal processing techniques for radar and sonar applications utilize nonlinear transforms such as the log function.

New concepts and techniques for nonlinear optical processing are sought in Phase I.

Phase II of this effort should use approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

N90-178 TITLE: Embedded Training Capability for Afloat Cryptologic Systems

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop an approach for implementing an embedded training capability in cryptologic systems in surface combatants. Such a capability would significantly reduce the manpower and funding required to provide formal operator training in a class room environment.

DESCRIPTION: A priority Navy requirement exists for the development of an approach for defining and implementing an embedded operator training capability in cryptologic systems installed in surface combatants. This capability must be structured enough to allow for stand alone, individual system operator training, while being flexible enough to provide afloat cryptologic systems operators the capability to participate in own ship Combat Information Center (CIC) simulated training exercises and scenarios. This task is to develop and evaluate candidate approaches for implementing such an embedded operator training capability in afloat cryptologic systems.

N90-179 TITLE: Cryptologic Expert System Man-Machine Interfaces (MMIs)

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this task is to perform appropriate analysis and engineering studies to define Man-Machine Interface refinements and improvements to the multi-faceted internal operations of a cryptologic expert system to enhance the system's combat effectiveness, while reducing operator workload.

DESCRIPTION: The use of expert systems in cryptologic systems operations is a relatively new concept. Few scientific studies, if any, have been conducted to address the Man-Machine Interface requirements of such a concept on a global scale encompassing Navy wide cryptologic operations. The concept is valid, and essential, however, the implementation may not be so straightforward. This effort is to apply analytical tools/methodology, tables, lists, charts, statistical and other data and methods to develop a cost effective Navy wide implementation approach.

N90-180 TITLE: Distributed Operating System Design Assistant

CATEGORY: Exploratory Development

OBJECTIVE. To develop a methodology and tool for tailoring of distributed and parallel processing operating systems for real-time systems.

DESCRIPTION: The research will evaluate and develop a methodology and tool to facilitate optimized distributed and parallel processing operating systems for real-time systems. The methodology will be implemented to allow an automated way for real-time system developers to tailor a distributed/ parallel operating system to their applications needs while minimizing the requirements for knowledge of low level operating system details. The tool should handle characteristics such as fault tolerance (detection, localization, and recovery); memory management (local and global), resource allocation, I/O management, interrupt handling, data synchronization, critical deadlines, and error monitoring. Similarities between existing operating systems should be examined to determine key design requirements for a highly efficient and generic operating system development tool The methodology should handle a wide range of software architectures as well as isolate and manage identification of device dependent partitions of the operating system to accommodate a wide variety of hardware architectures. The result of the research will be a methodology and a

tool to optimize the design and implementation of distributed/parallel processing operating systems to meet the requirements of the complex and computational intensive real-time applications.

N90-181 TITLE: Modeling of the Human Decision Maker in Support of C^3I

CATEGORY: Exploratory Development

OBJECTIVE: Develop candidate model structures in Phase I in order to develop various implementations of future C^3I Assessments.

DESCRIPTION: Present C^3I modeling techniques are based on traffic analysis and/or various object-oriented techniques that will additionally capture queuing/contention type issues. In these approaches, some aggregate effective delays for the human decision making process that supports the command of warfare assets. Of considerable importance is the development of better detailed representations of the decision process and the associated delays and non-linearities introduced in the overall system performance.

During Phase I various detailed techniques and structures would be developed in preparation for integration with other C^3I assessments.

N90-182 TITLE: Optical Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate an advanced optical neural network system to support a wide range of military real-time pattern recognition applications.

DESCRIPTION: Neural networks provide high speed and fault tolerant associative memory, classification and data extraction from partially obscured information. Neural network implementations require a highly interconnected and parallel architecture. Optical neural network implementations can exceed many, if not all, of the present capabilities of the electronic implementations. Using optics it is potentially possible to obtain up to 1 Giga associations per second, 1 Giga interconnections per cubic cm of optical materials using holographic interconnects and 10 to the 18th (Exa) interconnects per second. Such a system could be used for spread spectrum communications which cannot be implemented at this time due to the speed limitations of digital pattern recognition systems. Innovative neural network systems concepts using new optically implemented paradigms, or novel architectures, and/or advanced device/materials applications are sought.

N90-183 TITLE: Advanced System Architecture for Target Tracking and Recognition

CATEGORY: Exploratory Development

OBJECTIVE: Develop new and improved neural network architectures for real-time target tracking and recognition.

DESCRIPTION: Automatic targeting for imaging systems is becoming a requirement in development of a smart weapon system. The promise of employment of emerging technology of artificial neural networks provides novel opportunities in achieving full autonomy and realization of smart weapons that reduce load on the personnel.

Concepts are being sought that represent new and/or modified neural network architectures with one or more of the following features: invariant detection of patterns, reduced learning cycle, dynamic and adaptive system, robustness to noisy data, and real-time processing using IR or radar sensory data.

N90-184 TITLE: High Energy Melt-Castable Explosive

CATEGORY: Exploratory Development

OBJECTIVE: Develop a melt-castable explosive in which the matrix is an inorganic oxidizer.

DESCRIPTION: Hydroxylammonium perchlorate (HAP) is a compound that is related to ammonium perchlorate (AP), an ingredient in many explosives and propellants. Calculations indicate that there could be advantages to using HAP as an ingredient in an explosive formulation for underwater applications, particularly if it could be used as the matrix in a melt-cast system. The melting point of HAP is lower than that of AP, and if a eutectic were formed between the two, the melting point would be even lower. Proposals are solicited for investigating the use of HAP as a melt-cast matrix for an aluminized explosive with bubble energy superior to PBXN-103.

Phase I should include a study of the phase diagram of HAP and AP, and of HAP and other potential oxidizers. The questions of hygroscopicity and sensitivity of the materials should also be addressed.

Phase II should include the development of a melt-cast explosive formulation using HAP has a melt-cast matrix. It should include: small scale impact, electrostatic discharge and friction sensitivity tests; thermal stability tests; determination of failure diameter and detonation velocity; underwater performance test; and cylinder test.

N90-185 TITLE: Acousto-Optic Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate systems and devices based on acousto-optic principles for high speed radar signal processing.

DESCRIPTION: To defeat the high performance air targets of the future, signal processing systems must be capable of instantaneously processing target information and providing missile guidance commands in a hypersonic engagement. New concepts, techniques and improved acousto-optic devices for optical signal processing systems are required to perform real-time processing and interpretation of radar and other sensory information at extremely high data rates. Specific applications include range and doppler processing of pulse radar and noncooperative target recognition. These require high time-bandwidth products for the system and wide time apertures, low signal attenuation and high diffraction efficiency in the acousto-optic cells.

N90-186 TITLE: Advanced Damage Model Development

CATEGORY: Exploratory Development

OBJECTIVE: To develop/improve/validate models describing damage to targets from warheads.

DESCRIPTION: A need exists for the development of advanced models for predicting the damage inflicted on targets by underwater weapons. The task requires that finite element codes and models be upgraded to treat the following topics: large dynamic plastic deformation; perforation; erosion of penetrators; spalling; crack growth; fluid-structure interaction; and propagation of strong shock and detonation waves through several media, and long-duration subsonic shock waves. Not only are new capabilities added to the codes, but basic improvements in the codes themselves are made. These include modular architecture; numerically stable interfacing between the modules; efficient integration; and "user friendly" pre- and post-processing. Supporting experimental efforts to validate the models are planned in detail and executed, if possible.

Phase I deliverables: Refine methodology and apply to specific Navy problems. Develop small-scale tests to assess the validity of the methodology. Using the results of these tests, design new large-scale tests to validate and further refine the methodology.

Phase II deliverables: Refine the methodology developed in Phase I and apply it to specific Navy problems. Develop small-scale tests to assess the validity of the methodology. Using the results of these tests, design new large-scale tests to validate and further refine the methodology.

N90-187 TITLE: Design Guidelines for Touch-Sensitive Screens

CATEGORY: Exploratory Development

OBJECTIVE: To develop design guidelines for Touch-Sensitive Screens which can be incorporated into MIL-STD-1472 (and applied to future systems).

DESCRIPTION: Due to the advent of the Touch-Sensitive Screen, MIL-STD-1472C requirements have become insufficient for keyfields (i.e., dimensions, separation, resistance, etc.). The forthcoming version D of MIL-STD-1472C is also deficient in this area. As a result, current separations and dimensions are being specified by individual system designers without the benefit of detailed research and documented studies. While this information has DOD-wide applications, specific needs exist for this information relative to the Navy (e.g. sea state and shipboard-vibration).

Questions have arisen whether the limited amount of screen display area has been efficiently utilized by the designers of systems for the Navy. The operator of a Touch-Sensitive Screen should have a screen which compensates for these conditions. In addition, when the keyfield dimensions and keyfield separations are too large, the overall screen design is inefficient and underutilized. If the keyfield dimensions and keyfield separations are too small, an incorrect entry or inadvertent action may be made. An incorrect entry may cause severe problems, especially if the operator is controlling a fire control system. Currently, without formalized design guidelines, recommendations, or standards for utilization by system designers, the overall design is configured without consistency. A good user-system interface makes the program not only easy to learn but also easier and more efficient to operate. Conversely, a bad user interface may make things so difficult for the operator that the program is inefficient and unusable.

N90-188 TITLE: High-Speed Photodetector Switching to Avoid Backscatter

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, design and demonstrate performance of techniques to gate optical detectors so as to avoid saturation effects during laser transmission (especially in high backscatter environments under water).

DESCRIPTION: Short range laser ranging systems are often limited by the detector turn on and settling time. Laser ranging systems are composed of a short pulse laser, high speed counter, and photo detector. The photo detector is disabled and the laser is pulsed. During the laser pulse a high speed counter is started. The photodetector is turned on and the reflected pulse stops the counter. The range is calculated from the counter.

Phase I would investigate methods to switch photodetector (Discrete Dynode PMT and Micro-channel PMT) on and resulting settling times to achieve full gain or time variable gain. A method would be selected and circuits would be proposed that would supply the high voltage to the detectors and perform the gating or switching function.

Phase II would involve the construction of three breadboards systems and evaluating their performance. Physical packaging, high voltage components, high voltage converters, high speed switching (< 10 nanoseconds) would be studied.

N90-189 TITLE: Crack Detection in Explosives and Rocket Motor Propellant

CATEGORY: Exploratory Development

OBJECTIVE: Develop a system for detecting very small cracks in solid rocket motor propellants and warhead explosives.

DESCRIPTION: A system is required which is capable of examining loaded solid rocket motors and warheads, and detecting very small cracks and voids anywhere at the surface or in the interior of the motor propellant or warhead explosive. These motors and warheads will of course have steel outer cases. The warheads could contain performed fragments or other irregularities in the case design. Center burning rocket motors may contain large irregular voids at the center of the solid propellant. The warheads may contain tubes of metallic or nonmetallic design in the center of the warhead. This system should have a void or crack detection resolution which exceeds the resolution of standard x-ray techniques. The system should produce a visual image and printout of the cracks or voids which are detected.

Phase I will propose a method of achieving the desired capability. It will define the degree of superior resolution and should contain a preliminary design to build a system. It will also address safety issues with using the system in conjunction with loaded warheads and rocket motors.

Phase II will be to design, construct, demonstrate, and deliver an operational prototype system.

N90-190 TITLE: Time-Resolved Radiation Diagnostics for 0.6-1.3 Mev Peak Bremsstrahlung (X-Ray) Generators

CATEGORY: Advanced Development

OBJECTIVE: To develop the time-resolved dose rate (silicon) and/or spectral diagnostic measurements of 0.6 - 1.3 Mev peak 5 1000 KA Bremsstrahlung (X-Ray) Generators.

DESCRIPTION: Methods to measure time-resolved dose rate (with direc or calibrated dose (silicon)/second) and time-resolved spectra are needed for 0.6 - 1.3 Mev peak, 5 - 1000 kA Bremsstrahlung (X-Ray) generators. These diagnostics will have to operate in a 1E6 to 1E10 rads (Si)/sec field (3ns to 80 ns pulse width). The region, conditions, and dose rate levels where the measurements will be made vary from generator to generator and from experiment to experiment on a given generator. Therefore, it is important that the diagnostics have as flexible a range and operating characteristics as possible.

These diagnostics have to be made in a real-time environment with data analysis taking less than 15 minutes after each shot. The data acquisition and analysis should be done on the same data acquisition system used by the generator facility (Macintosh, IBM PC, or minicomputer).

Phase I: Prove feasibility and develop a prototype detector. Demonstrate feasibility on x-ray generators having the same characteristics as NSWC's nuclear weapons effects (NWE) generators. Provide documentation including 1) test results 2) detector principle of operation and calibration 3) detector design drawings 4) feasibility study considerations 5) detector size, weight, speed 6) detector operating conditions 7) data acquisition and analysis requirements and times. If a prototype can not be developed in Phase I, then the documentation should include additional information to delineate the feasibility, limitations and operating conditions of the proposed detector.

Phase II: Produce finalized detectors with all associated hardware, software, and calibration procedure and apparatus. Demonstrate operation on NSWC's NWE X-ray generators. Provide documentation including 1) rest results 2) detector principle of operation and calibration 3) detector and associated hardware design drawings 4) analysis considerations, assumptions. limitations, and results, 5) operations, calibration and maintenance manual, and 6) software listings and documentation.

N90-191 TITLE: Stable Silver Oxide (AgO) Battery Electrode

CATEGORY: Advanced Development

OBJECTIVE: Develop, manufacture and demonstrate prototype electrochemical cells employing silver oxide (AgO) cathodes that have extremely low thermal decomposition rates during storage and that are suitable for use in high-capacity, high-rate primary batteries.

DESCRIPTION: Deterioration of discharge performance during storage seriously limits the storage life and reliability of silver oxide/zinc batteries used in such applications as torpedo propulsion and missile guidance and control. Decomposition of the silver oxide (AgO) cathode material during storage is recognized as a major cause of this problem.

The invention of a new high-temperature method for the preparation of highly-stable silver oxide cathodes on a laboratory scale is disclosed in NSWC TR 89-66, "Thermal Instability of AgO Cathode Material: Causes and Solutions". Further development of stable silver oxide cathodes is sought, based on the new high-temperature method, and leading to commercialization in Phase III.

The Phase I goals are to identify and define, and to verify by experiment the methods, conditions, and design requirements of production-scale equipment for manufacturing stable, high-purity AgO cathodes. This should include preparation of sample cathodes, testing for purity and stability, and discharges to verify high-rate performance capability.

The Phase II efforts should include: (1) fabrication of manufacturing equipment and pilot-scale production of several small lots of stable, high-purity AgO cathodes, (2) development of quality control methods, (3) fabrication of small prototype high-rate primary silver oxide-zinc cells employing stable, high-purity AgO cathodes, (4) accelerated storage and discharge testing of prototype cells to demonstrate successful achievement of the objective, and (5) delivery of cathode samples and prototype cells for Government tests.

N90-192 TITLE: Active Mine Batteries with Long Shelf-Life

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate improved technology to enable prolonged storage of active lithium-thionyl chloride cells without significant loss of capacity.

DESCRIPTION: Unfortunately, much of the high energy advantage of lithium battery technology is lost during storage of active cells. Recent tests of various manufacturer's C-size cells stored for about one month at 54° C and 70° C indicated a 15% to 70% loss of capacity. Innovative concepts to mitigate this loss during storage are needed. One promising approach is an overlayer of thin polymeric ion-conducting film on the anode to serve as a barrier to corrosion during storage. Other possible approaches are encouraged.

During Phase I, potential concepts would be evaluated in terms of practicality, safety, reliability, cost, and complexity. A design would be proposed, and a hardware prototype, if possible, would be fabricated and tested. An estimate of performance after storage for various periods at various temperatures would be prepared. Requirements of the concept include storage at temperatures up to 70° C for five years or more with minimal impact upon the cell's tendency to vent under abuse conditions such as short-circuit, forced discharge, and charging.

During Phase II, hardware would be fabricated, tested, and evaluated, and a practical design would be proposed. Performance in terms of reliability, safety, producibility, and the environmental conditions of transportation, storage, and underwater use would be determined.

N90-193 TITLE: 1750A Microprocessor Optimized for Low Power Digital Signal (DSP) Processing

CATEGORY: Engineering Development

OBJECTIVE: Optimize a 1750A architecture chip for signal processing by use of special onchip hardware and microcode, analyze its performance as a replacement for other general purpose microprocessor architectures.

DESCRIPTION: Present 1750A microprocessors offer the advantage of a MIL-STD language and state-of-the-art design and process. However the 1750A architecture is general purpose and could be greatly improved for the math intensive algorithms needed for signal processing. The latest die shrink will allow for extra microcode and improved onchip hardware to greatly enhance the DSP capability and therefore result in lower power consumption per function.

Phase I should be a study would detail the areas of greatest possible improvement, i.e. the Arithmetic and Logic Unit (ALU) section on the chip and the operations that need to be put in the microcode. Computer simulation would detail the computational improvements offered and quantify the power reduction. The study would investigate which manufacturing processes

offer better power efficiency and project power reductions vs. die feature dimensions for advanced and future manufacturing processes.

In Phase II, Phase I data would be used to optimize a 1750A microprocessor to offer a low power DSP. The chip would be augmented with enhanced math capabilities and special DSP macros in microcode. Microcode would implement high level DSP operations as high efficiency macros, minimizing power consumption and program memory. The most efficient manufacturing processes would be used to deliver a small number of test dies to be used as advanced technology demonstration. A study would follow detailing the performance capabilities of the optimized 1750A microprocessor. A contrast and comparison will be drawn between this optimized 1750A microprocessor and other existing general purpose microprocessors. Examples of other general purpose microprocessors are: Motorola 68020 and 68030, Intel 80286 and 80386.

N90-194 TITLE: Development of High-Energy Density, Pressure Tolerant Batteries

CATEGORY: Advanced Development

OBJECTIVE: This project will develop and evaluate high energy density (greater than 100 Watt hours per pound) batteries which are able to tolerate pressures of several thousand pounds per square inch, as might be experienced in deep water, without the use of an additional case.

DESCRIPTION: The batteries in much Navy equipment, including sonobuoys, mines, transponders, surveillance systems, vehicles, etc., must operate under water. In most currently available equipment the batteries are isolated from the external water pressure by some form of protective hull or container. These containers are often bulky and heavy and therefore reduce the effective specific energy (Watt hours per unit volume) and energy density (Watt hours per unit weight) of the battery. The reduction in battery effectiveness are often directly reflected in reductions in equipment performance.

This project will develop a pressure tolerant battery with an energy density of at least 100 Watt hours per pound. The ideal battery will have good shelf life, a high degree of safety and reliability, a wide range of operating temperatures, and will operate in all environments (including out of water).

During Phase I, an electrochemical system and cell design will be chosen and built as prototype cells. These cells will be tested to demonstrate that they can tolerate external pressure during discharge.

During Phase II, practical cells will be built and tested at a variety of applied pressures. The cells' performance and safety will be assessed. Progress during Phase II should allow the cell design to be ready for production and use in batteries during Phase III.

N90-195 TITLE: UAV Compatible Sensor, Processing, and Communication Systems

CATEGORY: Exploratory Development

OBJECTIVE: In-depth study of low cost, off-the-shelf, infrared sensing technology for wide area surveillance and battle damage assessment.

DESCRIPTION: Naval surface and subsurface elements need an organic capability for wide area surveillance and battle damage assessment. Unmanned aerial vehicles (UAV's) are currently under development, and there is a need to fit the UAV's with the appropriate sensor, processing, and communication systems. The intent of this study is to examine and evaluate the availability and suitability of existing, inexpensive off-the-shelf technology to meet systems requirements. The sensing package may operate at altitudes between 10,000 to 25,000 feet at speeds ranging from 80-120 knots for periods of time ranging from 24-94 hours.

The specific goal of Phase I is to examine the capability of the uncooled pyricon thermal television tube in a real-time processing environment to eliminate clutter and locate and track ships. The system must have the ability to save important data and imagery for transmission to the launch platform at appropriate intervals. The study must address costs/benefit trade-offs involved in lens selection, spectral bandwidths, resolution and area coverage, probability of false alarms and missed detections, and system reliability.

Phase II should produce a prototype.

N90-196 TITLE: Electronic Cooling System Electrolytic Corrosion

CATEGORY: Research

OBJECTIVE: Quantitatively describe cooling system destructive electrolytic corrosion and find substitute materials.

DESCRIPTION: Many electronic system designs result in voltage gradients being applied across a low conductivity cooling path. For example, a high voltage tube anode may be cooled via low conductivity demineralized water channeled in an insulated hose. Often electrolytic corrosion will cause the metal associated with the hose fittings to dissolve. In practice this results in a high

maintenance expense. Various metals including high purity steels and Titanium have been used as hose fittings with limited success. This corrosion mechanism in not well understood.

Proposals are sought that develop a quantitative theory of this phenomena which can be developed and verified by experiments. The theory and supporting experiments should as a minimum describe corrosion rate behavior as a function of applied voltage, current, water conductivity, and metal type. Alternate hose fittings types should be proposed and evaluated.

N90-197 TITLE: Development of Test Methods for Graphite Fibers

CATEGORY: Exploratory Development

OBJECTIVE: To develop test methods for the characterization of graphite fibers.

DESCRIPTION: Graphite fibers are now being produced with higher moduli, strengths, and thermal conductivities than ever. Innovative techniques are desired for the characterization of these fibers. Procedures are needed for both individual filaments and tows with greatly different numbers of filaments. The methods should encompass the ability to test for modulus (possibly including obtaining stress-strain curves), strength, thermal conductivity, electrical conductivity, etc.

Phase II would encompass validation of the procedures by testing a number of lots of production material (to be furnished) and extending the test techniques to continuous on-line examination of the fiber during production.

N90-198 TITLE: Electronic Safe and Arming Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop components required to design electronic safe and arming devices for naval ordnance. Electronic safe and arming devices might improve system reliability and on-target effectiveness.

DESCRIPTION: In order to build electronic safe and arming devices whose cost would be acceptable for use in a conventional warhead, advances are needed in high voltage power supplies, high power switches, safing electronics, slapper detonators, and sensors. The power supply converts weapon voltage to DC potentials needed to function slapper detonators. Switches are needed to couple energy stored in capacitors to the slapper detonator. Safing electronics will assure that energy does not unintentionally accumulate so as to erroneously initiate the slapper detonator. Slapper detonators might be incorporated into the safe and arm to permit the explosive train to be in-line with the main explosive charge. Sensors are needed to monitor launch, safe separation from the launch platform, water impact, target proximity, and ideal firing time.

N90-199 TITLE: Infrared Background/Clutter/Target Signature Model

CATEGORY: Exploratory Development

OBJECTIVE: To develop PC-based signature model.

DESCRIPTION: An infrared background/clutter/target model is needed to characterize the scenarios most often encountered in naval surface warfare. This model will be used in conjunction with both existing and future target signature data, to specify the required operational environments for Automatic Video Trackers (AVTs) and Automatic Target Recognizers (ATRs) to be developed for shipboard use. In addition, the model will form the basis for synthetically generating realistic infrared scenes to test AVTs and ATRs. The model must accommodate the wide variety of backgrounds encountered in naval warfare (i.e., land, sea, sky) and capture the contrast and spatial attributes of backgrounds which have the greatest impact on AVT and ATR performance.

It is anticipated that Phase I of this effort will encompass the analysis of existing infrared background imagery to develop a preliminary mathematical background signature model.

Phase II would then encompass extensive background signature collection, model refinement, computer implementation and model validation.

N90-200 TITLE: Advanced Automatic Target Recognition (ATR) Techniques for IRST Systems

CATEGORY: Exploratory Development

OBJECTIVE: Innovative utilization of state-of-the-art automatic target recognition techniques to enhance target vs. clutter discrimination in shipboard IRST systems.

DESCRIPTION: A typical scanning shipboard IR Search and Track (IRST) system generates several millions of data samples per second. These raw video samples undergo signal processing by means of different types of filters; threshold are exceeded or

detection data are thus created. The detection data, which may contain targets, but are mostly due to clutter or other noise, are then subjected to additional target vs. clutter discrimination algorithms. An innovative approach is needed to exploit advanced automatic target recognition (ATR) techniques in order to enhance the target vs. clutter discrimination process. Such ATR techniques may be applied to optimally selected windows in the raw video, prior to or after the threshold exceedances. The result of this effort should be optimum ATR algorithms with the demonstratable capability to increase the probability of target detection, while decreasing the probability of false alarm. This capability may be demonstrated by means of the ATR techniques acting independently or in conjunction with the other algorithms mentioned above. Due consideration must be given to the extraordinarily high number of data samples to be processed very effectively so as to achieve timely target declarations.

Phase I should demonstrate a high probability of success for the proposed concept.

Phase II should produce a complete prototype set of highly effective target vs. clutter algorithms for a generic scanning shipboard IRST sensor, with particular emphasis of ATR algorithms.

N90-201 TITLE: Synthesis, Chemistry and Reactions of Energetic Phosphazenes

CATEGORY: Exploratory Development

OBJECTIVE: Research and development of synthesis pathways to energetic (azido, difluoroamino, trinitromethyl) substituted phosphazene compounds.

DESCRIPTION: Future high energy-density explosive and propellant systems will require advanced binder, plasticizer and oxidizer ingredients to meet the demands of increased performance while substantially reducing weapon vulnerability. One potential major class of compounds designed to meet this objective are the phosphazene telomers (cyclic or linear). Although standard synthesis methodology exists for the preparation of a variety of phosphazenes and their derivatives, the introduction of energetic moieties, such as, difluoroamino, trifluromethyl, fluorodintrioethoxy, etc. have not appeared in the literature. The conception of basic synthesis methodologies and the development of preliminary process and scale-up techniques to prepare reasonably cost-effective energetic alternatives like those described above will enhance the development of these critical new ingredients for ordnance applications.

The basic research addressed in Phase I of this opportunity should be directed towards the development of synthesis routes for the formulation of cyclic and linear energetically substituted phosphazenes. Development of synthesis routes to difluoroamino, azido, trinitromethyl phosphazenes should be demonstrated to prove feasibility of chemistry. Theoretical energetic compositions resulting from the new materials synthesized by the contractor will be performed by NSWC after receiving small samples of new phosphazene compounds along with standard technical information such as, densities melting points, NMR, IR, elemental analysis and stability data (DSC, TGA).

The Phase II plans of the research and development effort should address the large scale preparation of selected cyclic and linear energetically substituted phosphazenes prepared and characterized in Phase I. Additional basic research and development work will be required to maximize synthetic efficiency for selected target compounds. Focus should be on the cost factors related to the control (process) and scale-up of selected new materials. Sufficient material should be synthesized and forwarded to NSWC to determine experimental heats of formation and for preliminary formulation studies for energetic performance evaluations.

N90-202 TITLE: High-Speed Launcher for Fragment Simulator

CATEGORY: Exploratory Development

OBJECTIVE: Develop a launcher capable of projecting parallelepipeds weighing from 30 to 250 grains at speeds to 15000 ft/s.

DESCRIPTION: Modern air to air weapon - target encounters are producing fragment impacts at speeds of 15000 ft/s and more. A system needs to be developed that is capable of duplicating these conditions which can be used in fragment impact research. The system must be capable of firing at least two shots per day. The system must launch the metallic simulators in a controlled orientation. Emphasis is placed on delivering the simulator to the target in a predefined orientation. The weight of 250 grains is the minimum top weight, weights up to 500 grains should be addressed. The minimum speed range is 5000 ft/s to 15000 ft/s. Speeds to 20000 ft/s should be addressed. Overall size and power requirements should be minimized. The target will be sufficiently distant from the muzzle to allow for flash x-ray and other instrumentation.

The Phase I effort will be a feasibility study reporting on the ability to produce a launcher capable of meeting the stated specifications.

The Phase II effort would design and construct an operational prototype of the desired launcher.

N90-203 TITLE: Procedures for the Design of Software Controlling Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop a procedure for efficiently translating system requirements and design into software requirements and design with regard to equipment, interface and user requirements.

DESCRIPTION: Department of Defense procedures suggest a sequence of activities for developing software. Developers are to analyze overall system requirements, analyze design and construct software modules, and finally, progressively test software components as well as the integrated system it may serve. There is a need for studying the interrelationship of the development phases and determining the underlying structure to permit consolidation of the phases for more efficient software specifications.

Experience has shown that many software problems are due to a delayed recognition of system requirements or the faulty translation of system requirements and design into software structures. Thus, solving the translation problem may require improved concepts for representing and translating system requirements and design into software requirements and design.

A procedure is requested for tracking and controlling the various project objectives and system requirements for which software is required. This procedure should include program and data structures, data flow, and program control such as data abstractions, information hiding and minimizing processing interfaces.

Phase I should define the procedures and propose a method for guiding software development.

Phase II should develop the method into a useful tool.

N90-204 TITLE: Ruggedized Fiber Optic Switch

CATEGORY: Exploratory Development

OBJECTIVE: Develop and build a ruggedized fiber optic switch for use in Navy standard fiber optic local area networks and other applications.

DESCRIPTION: We propose that ruggedized fiber optic switches be built. The switches should have low loss (less than 1 dB) with minimal transients and crossovers. The switching time, which includes the bounce time, must be less than or equal to 30 millisec. The switches must be applicable for either 62.5/125 micron multimode and/or x/125 micron single mode fiber at 1300 nm. Electrical or optical signals should be needed to activate the switches. The proposals should indicate the feasibility of converting the multimode design to a single mode design or vice versa. The fiber optic switches should be able to operate under environmental stresses which exist aboard surface ships. The fiber optic switches should be able to perform during temperature-humidity, shock, vibration, and thermal shock environments.

Proposals for Phase I should contain multiple switch designs.

For Phase II, prototypes would be built and subjected to in-house testing. From these tests, we would evaluate and make suggestions for improvements. Phase II would result in several ruggedized fiber optic switches applicable for the naval shipboard environments.

N90-205 TITLE: High-Power Fiber Optic Sources

CATEGORY: Exploratory Development

OBJECTIVE: Design and produce prototype high power fiber optic LED sources for use in naval communications and sensor systems.

DESCRIPTION: It is proposed that high power fiber optic LED sources be built. The sources should operate at 1300 nanometers and should launch greater than -12 dBm into standard single mode fiber. The sources should have a greater than -5 dBm into 62.5/125 multimode fiber. The LED's should have a temperature dependence of less than 8 dB over an operational temperature range between -28 and +85 degrees celsius.

Proposals for Phase I should include more than one LED design as well as background information and data indicating the feasibility of the designs.

For Phase II, prototypes would be built and evaluated for base performance, temperature dependence and reliability. Phase II would result in Engineering Development models that could be utilized in Navy fiber optic systems.

N90-206 TITLE: Laser Initiation of Secondary Explosives

]CATEGORY: Exploratory Development

OBJECTIVE: Develop a method of initiating secondary explosives with a laser whose size is small enough to be compatible with warhead design constraints.

DESCRIPTION: Ability to directly initiate secondary explosives with a laser might eliminate the need to use sensitive primary explosives in warhead explosive initiation trains. Laser initiation of secondary explosives is limited by the efficiency of transforming

laser energy into mechanical, thermal or other forms of energy capable of causing detonation in secondary explosives. The goal of this research would be to elucidate waves of using a laser to initiate detonation of secondary explosives and package them in sizes small enough to be practical for conventional weapons.

N90-207 TITLE: Theoretical Study of "Cold Fusion" Using Quantum and Statistical Mechanics

CATEGORY: Research

OBJECTIVE: To develop a novel theory for estimating the rates of nuclear reaction of deuterium and lithium nuclei in crystal lattices.

DESCRIPTION: The recent claim by Martin Fleischmann and Stanley Pons that nuclear fusion may be achieved at room temperature by electrochemical means has puzzled and startled physicists and chemists throughout the world. Conventional nuclear theory indicates that fusion is possible only at very high temperatures, and that neutron production should be much higher than is observed. On the other hand, the observed heat output appears to be too large to arise from known chemical reactions at room temperature. Measurements of neutrons by different researchers continue to indicate that nuclear processes may be occurring in the palladium crystal lattice. That nuclear processes may not be ruled out on the basis of "conventional wisdom" finds historical precedence in earlier predictions that muon-catalyzed fusion (MCF) of two deuterium nuclei would be improbable, and the MCF would be of little interest. Recent studies continue to show, however, that much higher rates occur for MCF of deuterium and tritium. In the same way, new nuclear reactions involving lithium may be important in the crystal lattice. It is interesting to note in this regard that Fleischmann and Pons have stressed the importance of using electrolytes containing lithium and of employing carefully molded cathodes with the proper crystal structure.

The Phase I effort would involve the development of a quantum statistical mechanical theory of nuclear fusion among lithium and deuterium nuclei inside the palladium lattice. Since experiments show saturation of the electrode by deuterium to be essential, the theory would need to show the importance of coupling of the reaction of the nuclei to the entire lattice.

The Phase II effort would involve calculations of rates as functions of electrochemical potential in order to demonstrate the feasibility of fusion of deuterium and lithium as a source of propulsion in torpedoes.

N90-208 TITLE: Development of High Power Microsecond Two-Stage Free Electron Laser (FEL) Source

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this research is to provide and demonstrate a highly efficient two-stage FEL wiggler on an existing long pulse accelerator.

DESCRIPTION: A long-pulse generator and an electron beam diode have been acquired by NSWC. This generator is capable of producing a microsecond long, 3 Mev, 1 kA electron beam. The objective of this work is Free Electron Laser (FEL) source development for anti-missile defense, both "soft" electronics kill, and hard kill applications. In addition, long range radar applications are of interest. The successful offeror will justify the selection of FEL parameters based on one of the applications mentioned above and clearly show its benefit to the Navy. There are many physics issues to be addressed in the production of this longer microsecond pulse which should also be addressed.

In Phase I of this work, a set of FEL wiggler parameters for this accelerator should be determined according to a well defined Navy application mentioned above. Computer simulations should be performed showing the feasibility and successful operation of this wiggler. Finally, a set of drawings from which the wiggler can be produced and a description of appropriate diagnostics for determining the FEL output pulse width, frequency, and power as functions of time should be produced.

In Phase II of this work, these parameters then should be used to manufacture, test, and optimize the wiggler on the Long-Pulse Accelerator in cooperation with Navy scientists. This work also requires assistance in the analysis and design of the electron source to prepare the proper electron beam parameters required for input to the FEL wiggler, as well as the assembly of the diagnostics package to adequately measure the output parameters of the FEL. The contractor would have to develop an experimental task plan and coordinate the FEL work at NSWC with Navy scientists.

N90-209 TITLE: Programmable Linear Digital Beamformer

CATEGORY: Exploratory Development

OBJECTIVE: Produce prototype hardware capable of linear beamforming acoustic data received from a variety of experimental arrays.

DESCRIPTION: Many of the acoustic sensor investigations being conducted involve the collection and analysis of data from multiple hydrophones configured as an array. As part of the analysis process it is necessary to beamform the acoustic data at

appropriate steering angles. In the past this beamforming task has been performed with dedicated hardware uniquely tailored to the array under test and with the minimum capabilities required to support the desired analysis. This approach has led to the repeated design and fabrication of array specific beamformers. What is needed is the design and fabrication of a programmable beamformer that can be applied to a wide variety of array configurations.

The Phase I effort would review current beamform technology determine the optimum approach for the class of arrays under investigation and produce the design plans.

Phase II would be the fabrication and testing of prototype hardware based on the design proposed in Phase I. Potential sponsor is NAVSEA.

N90-210 TITLE: Thin-Wafer Components for Thermal Battery Cells

CATEGORY: Exploratory Development

OBJECTIVE: Develop technology for the manufacture of thin (0.1 to 0.3 mm thickness) wafers of inorganic mixtures suitable for use in thermal battery cells.

DESCRIPTION: Thermal batteries employ electrochemical cells with molten salt electrolyte. The cell components are usually in the form of thin, circular wafers, 1.0 to 10 cm in diameter. Future needs for very high-power thermal batteries will require thinner cell component wafers than can be manufactured at present.

The Phase I effort will explore novel approaches to the fabrication of thin wafers for anode (lithium alloy), anolyte (LiCl-KCl (MgO)), catholyte (LiCl-KCl, FeS_2) and pyrotechnic heat source (Fe-$KClO_4$) cell components, prepare samples, and submit them to the Government for testing.

The Phase II effort will further develop methods for the manufacture of wafers in sizes suitable for use in thermal batteries, and will perform a demonstration test program through a subcontract with a thermal battery manufacturer.

N90-211 TITLE: Non-acoustic Underwater Influence Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To develop new sensors for underwater mines that can detect the non-acoustic influence fields of surface ships and submarines.

DESCRIPTION: Underwater mines detect targets at a distance using sensors that respond to influence fields generated by the target's equipment or by its presence or movements in seawater. There is a growing need to complement existing acoustic and DC magnetic field sensors with devices able to detect other influences. Such other influences include, but are not limited to: water pressure, water current, gravity, electric field, AC magnetic field, total magnetic field, temperature, and nuclear radiation.

During Phase I, the potential influence or influences would be evaluated in terms of magnitude, frequency, and consistency of generation by submarines and ships; and candidate sensors would be evaluated in terms of sensitivity, self-noise, linearity, power requirements, size, reliability, cost and complexity. A design would be proposed, and a hardware prototype, if possible, would be fabricated and tested. An estimate of performance against typical targets would be prepared.

During Phase II, hardware would be fabricated, tested, and evaluated, and a practical design would be proposed. Requirements for compatibility with mines include: size less than approximately 25 cubic inches; power requirements less than approximately 25 milliwatts; shelf life greater than approximately 5 years; storage temperature -65 degrees to 125 degrees C; operating ambient temperature -10 degrees to 50 degrees C; and the shocks involved with parachute-retarded delivery and water entry.

NAVAL WEAPONS SUPPORT CENTER (CRANE)

N90-212 TITLE: Radiation Hardened Robot Positioner for Test Samples in Proton Experiments

CATEGORY: Engineering Development

OBJECTIVE: Develop a robot system for replacement and positioning of devices under test in a proton LINAC.

DESCRIPTION: The rate at which testing can be performed at proton LINAC facilities is limited by the activation of the test fixture and device under test. The test engineer must wait for the test cell to "cool" before he can enter and replace test samples. Much more of the proton facility time could be devoted to testing if the device under test could be replaced without human entry into the cell. The proposed system shall include a device test card and connector suitable for insertion by the robot positioner. The robot electronics shall be hardened sufficiently to withstand 1000 hours of operation in the test cell. The robot will not be located in

the line of sight of the radiation. However, it will be subjected to the secondary irradiation resulting from the cell and fixture activation. Provisions shall be made in the design for the robot to "fail safe" to ensure that no damage will be incurred by either the proton facility or the test fixtures if a robot failure occurs. All electronics shall be modularized for ease of replacement. Self-test capabilities shall be designed into the robot. Complete design documentation and directed diagnostic procedures shall be included in the user manual delivered with the robot. A complete set of spare electronic modules shall be included with the deliverables. The robot shall be designed to be compatible with the physical environment in the proton LINAC test cell at Brookhaven National Laboratories.

N90-213 TITLE: Instrumentation for Logic Upset Detection in Transient Environments

CATEGORY: Engineering Development

OBJECTIVE: Develop instrumentation which will detect and report upset for the most general class of state machine operating in a transient radiation environment.

DESCRIPTION: The detection of logic upset in VHSIC/VLSI microcircuits is co...plicated by: (1) the large number of output terminals, (2) high operating frequencies, (3) the complex relationships among input conditions, previous internal states, and outputs. Test engineers are often uncertain about which output to monitor, when to expect an upset, and how to recognize an upset. These problems are particularly severe in testing class 4 state machines (conditional state output/conditional state transition) such as microprocessors. Phenomena such as single event upset, due to localized ionization in the track of a heavy ion, are especially difficult to detect because the location of the strike is unknown and the state of the microcircuit at the time of the strike is unknown. Radiation environments shall include: (1) ionizing dose rate, (2) proton beam, (3) heavy ion beam, and (4) high power microwave. The developed instrumentation shall be capable of detecting upset at the operating speeds associated with VHSIC class CMOS and bipolar technologies. The upset reports shall include terminal location, I/O vectors, and the time of upset relative to a known reference. The instrumentation shall be sufficiently portable to permit transport to irradiation facilities.

NAVAL WEAPONS CENTER/CHINA LAKE

N90-214 TITLE: Optical Component Measurement for Multispectrum Guidance

CATEGORY: Engineering Development

OBJECTIVE: Develop equipment and techniques to perform an optical acceptance testing capability.

DESCRIPTION: Multispectrum guidance systems are being developed which contain extremely small, non-spherical optical components for long wavelength IR seekers. These parts are fabricated using numerically controlled machines. The parts are then coated with anti-reflection coatings for assembly into the final optical system. These parts need to be tested for conformance to specifications prior to being assembled into the system. This must be done without contact to the parts which would cause damage to the optics. The optical equations, surface quality, coating performance, transmissibility, and other optical parameters need to be measured without damaging the parts. The parts for the Multispectrum Guidance IR Seeker can be used to evaluate the ability of the measurement system to perform and to verify the optical parts at the same time.

Phase I should provide the testing concept and Phase II should provide a demonstration of the equipment and testing techniques.

N90-215 TITLE: High Temperature Radome Adhesives

CATEGORY: Engineering Development

OBJECTIVE: Develop and test an adhesive for high temperature radome application.

DESCRIPTION: Missile systems are being developed which fly at very high speeds. These missiles have domes which cover the target seekers. Dome fabrication and assembly is becoming more complicated and includes the assembly of dome parts with adhesives. A low cost, easily applied adhesive which can withstand the high temperatures and stresses when mounted in the front of high speed missile is needed. Current adhesives fail in this environment or involve costly processing to apply.

Phase I should recommend solutions and propose a Phase II development and test of the recommended adhesive.

N90-216 TITLE: Optimized Antennas for Multispectrum Guidance

CATEGORY: Engineering Development

OBJECTIVE: Develop and test an optimized RF antenna for multispectrum guidance.

DESCRIPTION: Multispectrum seeker systems are being developed which include a coaxial IR system mounted in the radome of an RF seeker. Presently these seeker systems are developed independently and then integrated into a single system. The RF antenna patterns are degraded by the presence of the IR seeker in front of the RF antenna. Total system performance could be improved by designing the RF antenna for optimum performance in the presence of the IR seeker blockage.

Phase I should recommend solutions and propose a Phase II development and test of the recommended RF antenna for multispectrum guidance.

N90-217 TITLE: IR Background Modeling and Analysis

CATEGORY: Engineering Development

OBJECTIVE: Develop the classes of IR background models and incorporate them into analysis programs to calculate background IR signals for seeker performance analysis of actual target signals.

DESCRIPTION: The analysis of the performance of IR detectors/seekers in background is a difficult task. Some computer analysis programs have been developed which analyze target signals in presence of uniform background. These need to be extended to the analysis of categories of structured backgrounds (sea, various land models, urban, etc.) which can bound the performance of the IR detectors/seekers in this variety of backgrounds.

Phase I should propose an approach to the Phase II modeling and analysis.

N90-218 TITLE: Spectral Analysis of Stray Light

CATEGORY: Engineering Development

OBJECTIVE: Develop and test the capability to perform computer analysis of stray light in the frequency domain.

DESCRIPTION: Free gyro IR seekers are being developed for the Multispectrum Guidance Project that operate in the long wavelength IR spectrum. These systems are susceptible to degradation due to stray reflected and emitted light from internal and external sources. Currently, specialized computer programs exist for the analysis of stray light in static conditions. This analysis is done in the time domain. In order to evaluate the performance of the Long Wavelength Infrared seeker, it is highly desired to perform the stray light analysis in the frequency domain. This would produce frequency spectrums for the rotating free gyro seeker.

Phase I should propose an approach to the Phase II development and testing of this stray light analysis capability.

N90-219 TITLE: Multispectrum Guidance Target Generators

CATEGORY: Engineering Development

OBJECTIVE: Develop and test a target generator for use on multispectrum guidance.

DESCRIPTION: Multispectrum guidance seekers are being developed which use the RF spectrum and long and medium wavelength IR spectrums. Target generators are needed which provide both point source and extended source target signals in each of these spectrums which are coincident. Target generators are needed for laboratory, field, and hardware-in-the-loop testing. These target generators must present signals to the seeker in the frequency bands which are representative of the signals actually emitted from a target source under a variety of conditions. The complexity of the target generators may vary from simple to very complex which more accurately model the targets. Verification of the target representation is needed. The Multispectrum Guidance Project seekers would be used to test the capability of these target generators.

Phase I should propose an approach to the Phase II development and testing of the target generator.

N90-220 TITLE: Passive Fuel Vapor Detector Device

CATEGORY: Exploratory Development

OBJECTIVE: To explore the feasibility of developing a passive device that can identify the presence (or absence) of carbon based fuel vapor within a closed container without opening, or disturbing the seal on the container. The product of this research would be used by fleet personnel to determine by viewing an indicator device from the outside of sealed container, if the pre-fueled contents such as a missile, has developed a leak.

DESCRIPTION: Several modern air launch missiles (HARPOON, TOMAHAWK, TACIT RAINBOW) use turbo-jet engines with an associated liquid fuel (JP-10) fuel bladder or tank. These weapons are delivered to the government pre-fueled in reusable transportation/storage containers. Part of the periodic and pre-use integrity inspection is to ensure there is no fuel leak by opening the container for visual inspection. In the case of TACIT RAINBOW, part of the warranty for missile integrity is to maintain the container sealed until intent for deployment. To allow an electrical integrity test of TACIT RAINBOW without opening the container, the containerized weapon has an electrical cable connected to the missile umbilical, with the other end of the cable attached to an external connector on the container. This allows running an electrical built-in-test of the weapon without opening the storage container. For safety purposes, the present planning for TACIT RAINBOW is to perform a vapor "sniff" test through the container desiccant port prior to running the electrical test. The candidate device to be used is the BACHARACH, Inc. model 502 battery operated Portable Combustible Gas & Oxygen Deficiency Indicator (National Stock Number 6665-01-153-8474). This unit is very sophisticated, cumbersome to use, time consuming, and maintenance intensive for the intended fleet operations application. Recommended exploratory research to develop a passive JP-10 vapor detector that can be mounted or affixed within a container sight glass. Something similar to the commonly used passive humidity indicators that change color in the presence of moisture would be ideal. A reliable device such as this will find immediate application with TACIT RAINBOW and likely other DoD carbon fuel based weapons systems.

Phase I should identify a practical passive medium for fuel vapor detection.

Phase II should establish the vapor content types and density, or ratio of air to vapor detected and include application planning for the device package or packaging.

N90-221 TITLE: Measurement of Explosive Outputs Electronically

CATEGORY: Advanced Development

OBJECTIVE: Develop methods to electronically collect data during explosive detonations which will allow quantitative and qualitative analysis of the output of various devices. Electronic data collection techniques should allow development of an instrument which should give a direct comparison of an explosive output with the required input of another device.

DESCRIPTION: Presently, the output of an explosive device cannot be directly related to the known inputs necessary for the reliable initiation of the next device in an explosive train. The small scale gap test (devised in 1960) is currently used to measure the shock sensitivity of an explosive. The sensitivity is specified in units of Decibangs, a unit of measure convenient to the method of testing. Outputs of devices, on the other hand, are measured in terms of dents on steel block. This too, is a unit of measure convenient to the method of testing. No direct method of comparing decibangs to dents exists. Hence, the reliability of an interface is estimated by sing a third explosive to indirectly determine how the output of one device relates to the need input of the next in line. From this relationship, a reliability "estimate" is made. Varicomp explosives currently available have not been produced since the early 60's. Some mixes are low in quantity and funding to produce more is unlikely. Measurement of such things as energy out, rate of energy out, and output calibrated to decibangs, is possible. This will permit more efficient design of explosive trains and the possible elimination varicomp explosives. The time savings could potentially be enormous.

Phase I - develop methods to electronically collect data during explosive detonations which will allow quantitative and qualitative analysis of the output of various devices.

Phase II - develop/demonstrate method.

N90-222 TITLE: Safe-Arm Indicator for In-Line Fuzes

CATEGORY: Advanced Development

OBJECTIVE: Design, fabricate, and test a visual safe-arm indicator for in-line safety-arming devices

DESCRIPTION: Paragraph 4.5 of MIL-STD-1316 requires either a feature that a) "assures a positive means of determining the safe condition at the time of fuze installation into the munition, for example by visual observation", or b) "a feature which prevents installation of an armed, assembled fuze into the munition;, or c) "a feature which prevents assembling the fuze in the armed or partially armed position." Since modern electronic In-Line fuzes are armed when the firing capacitor is charged, it is desirable to have a visual indication of the charged condition. The indicator should be of a cylindrical configuration of not more than 0.5" diameter by 0.350" long. The device should cost less than $20, require less than 1 microampere to operate and shall indicate a change from the "safe" to the "armed" condition which the firing capacitor voltage is between 400 Vdc and 600 Vdc. The device must be "fail-safe" so that if failure occurs, it would indicate the device was in the "armed" condition.

Phase I should document the intended approach to continue into the Phase II objective to design, fabricate, and test a visual safe-arm indicator for in-line safety-arming devices

N90-223 TITLE: Electronic Retard Sensor for Bomb Fuzes

CATEGORY: Advanced Development

OBJECTIVE: Design, fabricate, and test an electronic retard sensor for advanced bomb fuzes.

DESCRIPTION: Mechanical spring-mass retard sensors currently in use in bomb fuzes are prone to failure due to imperfections in machined surfaces, contamination and tolerance stack-up. Imperfections during manufacture have resulted in "sticky" operation and non-repeatability during acceptance testing. It is desired to develop new concepts, preferably electronic, that will eliminate sliding components and contacts. Specific requirements for Phase I design and Phase II fabrication and test are as follows:

Electrical: a) Contact Resistance: 500 ohm Max @ .03 mA
b) Max Contact Current: 2 A @ 28 Vdc, 5 sec pulse
c) Max Supply Current: .1 mA Max for 5 sec max

Functional: a) Sensor contacts shall not close at accelerations below 1.9 G
b) Sensor contacts shall be closed at accelerations above 2.3 G

Size/cost: The device shall be housed with a 0/5" diameter TO-8 can or a 20 pin leadless chip carrier and shall cost less that $20.

N90-224 TITLE: Long Wave Infrared Non-mechanical Electronic Scan

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate the capability to nonmechanically slew the line of sight of an 8 to 10 micron optical system through an arc of at least plus and minus 10 degrees.

DESCRIPTION: It is desired to be able to smoothly move the field of regard of 8-10 micron optical systems by a least $\pm$ 10 degrees at rates up to 60 degrees per second without the use of mechanical positioning equipment as is presently done. The electro-mechanical scanning systems now used have several disadvantages: primarily cost, complexity, and inertia. Acousto-optical devices used in commercially available laser printers permit 0.633 micron laser energy to be moved by at least 6 degrees with no mechanical involvement. Perhaps a technology exists that can nonmechanically scan, bend, or refract 8010 micron energy rapidly and over an angle of at lest 20 degrees. The device that achieves this capability must be able to be packaged within existing military tactical missile optical systems/night vision systems or added to them in no more space than is now taken by their mechanical scanning systems.

Phase I should document the approach to Phase II, demonstrate the capability to nonmechanically slew the line of sight of an 8 to 10 micron optical system through an arc of at least plus and minus 10 degrees.

N90-225 TITLE: Solid FAE Detonation Mechanism Model

CATEGORY: Advanced Development

OBJECTIVE: Develop a mechanistic model of the detonation zone for fuel-air explosives (FAE) that use fuels in the solid state.

DESCRIPTION: Current fuel-air explosive warheads use a fuel in the liquid state. This results in handling and storage hazards associated with the liquids and also results in large warhead volumes since the liquids have a low density. The use of solid fuels in these warheads would greatly reduce the hazards and also significantly increase the energy density of the warheads. In order to realize these advantages, methods for ensuring the detonatability of solid fuels dispersed in air over a wide range of conditions need to be developed. A mechanistic model that includes the significant factors governing both initiation and propagation of a detonation is needed to provide direction for the development of reliable and efficient fuels. As a minimum, the model needs to capable of prediction the effect of these initial input conditions, temperature, particle size and shape, particle spacing, coatings, and radiation factors. The model shall be compatible with machines no larger than a VAX.

Phase II should use design approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

N90-226 TITLE: Compaction and Rapid Dispersion of Powdered Fuels

CATEGORY: Advanced Development

OBJECTIVE: Develop techniques for compacting powdered fuels to high bulk densities and then disperse them rapidly to form clouds in air that are detonable.

DESCRIPTION: Current fuel-air explosive warheads use a fuel in the liquid state. This results in handling and storage hazards

associated with the liquids and also results in large warhead volumes since the liquids have a low density. The use of solid fuels in these warheads would greatly reduce the hazards and also significantly increase the energy density of the warheads. In order to realize these advantages, techniques are needed that will take the powdered fuel and pack it to a relatively high density in the warhead, and then, upon warhead function, disperse it into a nominally uniform cloud of very fine particles in the atmosphere. This dispersion process must occur in a very short time (<20 millisec), explosive charges are used to disperse the liquid fuels. Also, the final particle size needs to be on the order of microns (<10) with little or no agglomeration. Some of the fuel candidates have coatings which may contribute to agglomeration under compaction or the shock loading conditions of explosive dispersion. The cloud that is formed must be in a concentration range that is detonable.

The deliverables shall be a Phase I design concept and a Phase II feasibility hardware demonstration.

N90-227 TITLE: Replication of Aircraft Structure for Ballistic Vulnerability Testing

CATEGORY: Advanced development

OBJECTIVE: Design cost-effective methods of replicating mechanical behavior of full scale aircraft structures (metal and composites) in ballistic test samples.

DESCRIPTION: For many years the survivability/vulnerability community has performed ballistic testing on small panels (one to ten square feet) because of the high cost and limited availability of actual aircraft structures. This is especially true for investigation of "hydraulic ram" - induced failure mechanisms. (Hydraulic ram is a very destructive high-pressure shock which propagates through fuel when tankage is impacted by bullets or warhead fragments). However, such samples, even though faithful to the full-scale structures in most ways, often behave differently from the replicated structures and each other. This is largely the result of boundary or "edge" conditions required to mount the sample in a test fixture. The fixture and its mounting mechanisms exhibit strengths, stiffness, mass, and natural frequencies much different from the aircraft structure surrounding the local area being replicated by the sample.

Phase I studies are solicited to determine different (but cost effective) test approaches or fixture designs or panel designs necessary to obtain reasonable comparable ballistic behavior between the sample and actual aircraft structure. Emphasis is on fuel tank structures under hydraulic ram loading and other stressed-skin structures.

N90-228 TITLE: Inertial System Expert System

CATEGORY: Advanced Development

OBJECTIVE: Develop an expert system to assist weapon system planners and missile system designers to elect candidate inertial sensors/systems for particular applications

DESCRIPTION: Early in the planning phase for every new missile system or missile system upgrade, trade-off studies are performed to determine what subsystems or combinations of subsystems will enable the missile to meet its performance requirements and cost goals. To be certain that the studies are complete, the system planner or the system designer must rely on specialists in each subsystem. Fortunately, the nature of these studies is such that the needed inertial system's expertise can be codified and incorporated into an expert system.

For Phase I design, the expert system must run under VAX/VMS, and the data base or the rules set must be simple to modify in order to keep it up-to-date and to allow for growth. The system must be interactive with tutorial or help utilities which will guide any scientist, engineer, or technical manager through a session. The system must respond to queries involving sensor technologies (e.g., ring laser gyros, tuned rotor gyros, floated gyros, various accelerometer technologies, etc.), system technologies, (e.g., gimballed, strapdown), system implementations (e.g., space stabilized, local level, north slaved, wander azimuth, etc.), aiding systems (e.g., doppler radar, GPS, etc.), performance or error characteristics, service life, recertification intervals, and cost. Ideally, the expert system will include provisions for automatically generating the files necessary to run our covariance analysis program for the particular system configurations the user specifies so that accurate performance predictions can be generated. (Implementing this feature can be deferred, but the system must be designed to allow this feature to be added later).

Phase II should develop, demonstrate and deliver software designed in Phase I.

N90-229 TITLE: Determine the Aggregate Heat Transfer Coefficient into Objects within an Expanding Supersonic Rocket Plume

CATEGORY: Exploratory Development

OBJECTIVE: Develop a simple technique to determine the aggregate heat transfer coefficient into selected elements within the flow of rocket motor exhaust. Examples of applications for these techniques are rocket nozzle improvement, jet vane thrust vector control development, heating of turbine blades or elements within a ramjet or rocket exhaust, ionized-flow aerodynamic heating, etc.

The typical application flow field may be opaque due to the presence of aluminum in the flow. Simple and innovative methods are sought to improve the state-of-the-art in this measurement technology.

DESCRIPTION: Approaches envisioned for this research may be unique new technology or substantial developmental improvements on existing processes such as: scanned (IR) thermographic video techniques, computational fluid dynamic modeling if verifiable by test measurements, empirical or semi-empirical process modeling showing analytical and experimental methods to accomplish repeatable results,development of very high temperature heat flux gauging methods, laser induced fluorescence, spectrographic analysis of flow field showing correlation with heat transfer processes, optical pyrometry suited to very high temperature flow conditions, etc. The nominal flow field conditions are: Mach 3.4, Gamma 1.2, and Stagnation Temperature 5800°F. Generally, the flow is short duration (3-10 sec), unsteady, and nonuniform.

Major considerations for measurement work will be tailoring the method to address the unique severe conditions of this application including short duration testing, thermal interference, high temperature measurements, and optical path contamination. If considered, computational modeling must consider exhaust effluent gas-dynamic properties including particulate phases, and radiation influences on film coefficient behavior as well as supersonic compressive flow. These must be verifiable by test measurement to prove predictive capabilities of the model.

N90-230 TITLE: Laser Brazing Ceramics to Metals

CATEGORY: Advanced Development

OBJECTIVE: Develop a laser brazing process capable of joining a wide variety of ceramic materials to metals.

DESCRIPTION: Current ceramic materials used in missile applications have been selected primarily for their unique IR or RF properties(ZnS, yttria, Pyrocedram, Rayceram, etc.). The use of these materials necessitates significant constraints in design and production techniques due to significant thermal mechanical differences between the ceramic and other structural components of the missile. Current methods of joining such materials to the structural components of the missile system (aluminum, titanium, and steel alloys) rely on adhesive or polymeric joining techniques. There is a need for unique joining/bonding processes that can directly join ceramic IR and RF dome components, 2 inches to 13 inches in diameter, to cylindrical metal surfaces. Performance requirements dictate that the joining process should produce hermetic joints which can withstand an environment of 550°+C for a minute or more and up to 150 cycles from -40°C to 200°C. Exposure to the high temperatures associated with conventional brazing processes can degrade the optical merit of materials like ZnS and promote chemical reaction between the braze material and the ceramic throughout the entire heat affected zone. Still higher temperatures which required to facilitate wetting of RF materials by a braze which would promote further chemical reaction. It is therefore desirable to utilize a highly localized heat source for the joining effort. Laser brazing is a promising joining technique which is capable of providing the heat necessary for a metallurgical bond. The heat provided by the laser is localized, thus limiting thermal degradation to regions adjacent to the joint. Residual stresses due to thermal expansion of the entire component during assembly are also avoided. Process development for a ceramic to metal joining method which takes advantage of the highly localized heating offered by a laser source would be most desirable.

NAVAL AIR DEVELOPMENT CENTER

N90-231 TITLE: Applications of Anti-Jam (AJ) Direct Sequence Spread Spectrum (DSSS) Waveforms to High Frequency (HF) Communications

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to exploit current advances in modulation and coding theory to provide a demonstrated improvement in the jam resistance and reduction in intercept/exploitation probability of High Frequency (HF) communication signals.

DESCRIPTION: The Navy uses the HF to support over the horizon and extended line of sight communication requirements. In general, these links are both easy to exploit and easy to jam. Application of spread spectrum techniques are the classical method of providing AJ protection and lowering the probability of exploitation. Historically frequency hopping has been used to provide some AJ or LPI protection. Direct Sequence techniques have not been applied in the past due to the non-coherence of the HF channel.

This effort should concentrate on the application of modern spectrum spreading techniques coupled with state of the art signal processing techniques to overcome the traditional limitations of the HF band. Techniques that may be applicable include:

- Use of an efficient modulation scheme to maximize data rate.
- Concatenation of multiple channels to increase processing gains and data rate.
- Bandwidth independent communications with a reasonable compromise for performance.
- Fast acquisition schemes.

- Techniques that minimize computational complexity.

Phase I of this effort should concentrate on providing the theoretical basis and a solid proposed approach. Phase II should carry that approach through design and into a feasibility demonstration model.

N90-232 TITLE: Multi-Tadil Task Force Connectivity/Communication Systems Capacity Processor

CATEGORY: Exploratory Development

OBJECTIVE: Develop a dynamic/adaptive processor to allocate tactical communications system and data link resources (e.g., transmit slots of opportunities) to optimize multi-link throughput/functional efficiency based upon available task force disposition and relative position information.

DESCRIPTION: Phase I effort will be an expanded concept definition, development of system measures of effectiveness, and specification of relative position based algorithms of increasing levels of sophistication.

Phase II will involve development and operation of simulations and modules evaluating proposed algorithm performance for communication systems such as JTIDS, MILES, and other data links with resource sharing protocols.

N90-233 TITLE: New Techniques to Enhance AJ in Spread Spectrum Communications

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop advanced techniques in spread spectrum system technology that will augment pseudo-noise spreading as a means of providing anti-jam (AJ) protection. These techniques will be applied to spread spectrum AJ techniques currently being considered for use with Navy expendable sensor systems.

DESCRIPTION: The Phase I effort should include the performance of engineering studies and simulation efforts that will provide a recommended AJ protection technique that is applicable to expendable sensors such as sonobuoys. The recommended system must be simple to implement at the transmitter such that recurring cost can be kept quite low. Techniques applicable to digital implementation at the receiver are preferred.

Phase II of the effort would result in the completion of the system design and the construction of engineering prototypes. A demonstration should be performed that shows the increase in AJ protection.

N90-234 TITLE: Constraints and System Primitives in Designing Operating Systems for Real-Time Distributed Warfare Systems

CATEGORY: Exploratory Development

OBJECTIVE: To identify constraints placed upon operating systems in real-time distributed Navy warfare systems and the operating system primitives necessary for successful performance.

DESCRIPTION: Navy warfare systems function in very demanding distributed real-time environments. An operating system provides system resource control to support software applications in critical areas such as memory management, scheduling, and input/output. The operating system must guarantee predictable and timely services to application software. Application software currently must often circumvent the operating system to achieve the stringent performance levels necessary to meet Navy warfare system requirements. There is a need to identify operating system primitives which can provide the functionality required for successful performance of real time distributed Navy warfare systems. A study is required to identify constraints placed upon operating systems in Navy warfare systems. The study should also identify operating system primitives necessary for successful performance in light of the identified constraints.

N90-235 TITLE: GPS System Specification for Shipboard TACAN Replacement

CATEGORY: Advanced Development

OBJECTIVE: Generate systems specification to ensure that GPS can be properly implemented as an eventual replacement for shipboard TACAN.

DESCRIPTION: Current implementations make use of GPS as a mission sensor only and this is not adequate for TACAN replacement. Concepts are sought which will enhance carrier operations at sea using a differential or pseudo-lite system mode. The contractor will address control/display issues, flight instrument interface, and flight safety issues. The work will specify a minimum level of integration required to satisfy shipboard TACAN replacement objectives.

N90-236 TITLE: Machinability of AF1410 High Strength Steel

CATEGORY: Advanced Development

OBJECTIVE: To determine quantitative machinability data for use in establishing optimum tool life in machining of AF1410 steel. The resulting data would facilitate the use of this improved property material and would reduce the cost of its machining at the Naval Aviation Depots.

DESCRIPTION: Ultra-high strength steels currently used for applications such as aircraft landing gears are flaw sensitive and subject to hydrogen embrittlement and stress corrosion cracking. AF1410 steel has been shown to offer improved fracture toughness and stress corrosion cracking resistance, but its machinability parameters are not well established. Unknown factors in machining contribute to increased cost and discourage the application of this otherwise beneficial high strength steel. The lack of established machining procedures must be resolved in order to achieve high-production machining at the lowest possible cost and to facilitate the use of this improved flaw resistant steel in naval aircraft.

Phase I should consist of a study outlining an approach for establishing optimum tool life in machining AF1410 steel.

Phase II should use the approach outlined in Phase I to determine the speeds, feeds and other parameters associated with boring, drilling, grinding, milling, reaming, thread grinding and turning of aircraft components (such as landing gear) and present the parameters in handbook form.

N90-237 TITLE: Cognitive Workload Measurement Device

CATEGORY: Exploratory Development

OBJECTIVE: Design of a non-intrusive hardware/software system capable of measuring and predicting cognitive workload of the human operator is needed. This system will reduce the uncertainty and maintain maximum return of investment of many funded new system development. It will also enable Navy contract monitors to measure the performance effectiveness of system design without the expense of simulation and the critical risk of field operation. Application must extend to new system design technologies involving interactive computer operation, expert systems and artificially intelligent/predictive systems.

DESCRIPTION: Current methods of determining and developing designs and system aides often lead to ineffective efforts that do not solve problems and that frequently create new and more complex cognitive workloads. Current and near term new technologies will be applied to help design a system and method of measuring cognitive load. Resulting application will provide output, give direction to design and guarantee performance gains of state-of-the-art systems. Expenditure of large sums of monies, hardware, and technical personnel to support new requirements of techniques involving complex computer simulation will be avoided. Measurement/prediction system must be universal and modular in application. System must also be generic and capable of direct measurement of human performance in state-of-the-art applications. Newly developed technologies capable of mapping and measuring cerebral processing are to applied to the design of this non-intrusive cognitive workload measurement device.

N90-238 TITLE: Thermographic Non-Destructive Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: Develop thermographic techniques for nondestructive inspection and defect evaluation of fracture critical advanced aircraft materials.

DESCRIPTION: An experimental study is required to determine the capabilities of using the adiabatic thermoelastic effect to assess the criticality of flaws in advanced aerospace materials such as the high temperature high strength engine materials used in the hot stage of a turbine engine. Advanced composite materials in which stress concentrations are difficult to analyze either theoretically or experimentally might also be profitably studied using this technique. Both laboratory studies and theoretical considerations indicate that this approach when used with synchronous detection of temperature changes can produce images of stress concentrations in damaged materials under cyclic loading.

Phase I should apply this technique to the detection of defects and determination of defect severity for one or more of the advanced aerospace materials currently in use or planned for use on US Navy aircraft and propose the development of the technique for Phase II demonstration. The materials might include ceramics, ceramic or metal matrix composites, high temperature alloys, protective coatings for propulsion materials or advanced structural composites. Critical issues which should be addressed would include the sizes of defects which the technique can detect and its capability for detecting subsurface flaws. Also, simple and innovative techniques for applying loads to real components would be important in the implementation of the techniques.

N90-239 TITLE: Drag Reduction on an Ejection Seat During High Speed Ejection

CATEGORY: Exploratory Development

OBJECTIVE: Conduct aerodynamic analysis on a typical ejection seat shape using appropriate computational fluid dynamics models. Define novel methods and select an optimum design that can reduce the overall drag on the seat, especially behind it, thus reducing the acceleration forces imposed on the occupant during high speed ejections.

DESCRIPTION: Future aircraft missions dictate high speed, low level scenarios, thus requiring an expansion in the ejection seat envelope up to 725 KEAS. Ejections at 700+ KEAS in current state of the art seats can cause g x acceleration levels on the occupant beyond his physiological tolerance levels. The g x acceleration forces executed on the occupant are mostly due to the drag forces. Therefore, a thorough aerodynamic analysis using the latest CFD models will be conducted on the seat in order to understand the flow behavior. First, an appropriate model for this application will be chosen. Then analysis will be conducted on a typical shape. Novel concepts and methods will be investigated to reduce the drag on the seat within the geometrical constraints of the aircraft installation.

In Phase II, conduct wind tunnel tests on scaled down models including the new designs to verify the CFD findings and optimize the designs.

N90-240 TITLE: Design for Pre-Tensioning Restraint Straps for Crash Protection

CATEGORY: Exploratory Development

OBJECTIVE: Design pre-tensioning restraint straps for crash protection.

DESCRIPTION: It is known that helicopter occupants are better protected during a crash if their restraint straps are tightly adjusted. However, during normal flight routines they normally adjust their restraint loosely to gain mobility and comfort. The inertia reel, which attaches from the seat back to the crewmember's restraint does not serve the purpose of pre-tensioning the restraint at the onset of a crash.

A design which interfaces with conventional type seat restraints used in military fixed wing and helicopter aircraft (non-ejection seat) and which upon sensing a crash, pre-tensions the occupant's restraint is required for Phase I. The design should consider its interface with a crashworthy seat that is capable of moving downward during the crash event. Bucket downward displacement of 12 inches should be accommodated.

A prototype development will be required for Phase II.

N90-241 TITLE: Elastomeric Pitch Link Bearings for Helicopter Rotor Heads

CATEGORY: Advanced Development

OBJECTIVE: Design and fabrication of elastomeric pitch link bearing for helicopter rotor heads.

DESCRIPTION: Bearings which carry rotor blade pitch control loads and motions are needed which have long life (1500 flight hours minimum), are maintenance free, are highly reliable, can operate in the full operational temperature range of the helicopter, and can be retrofitted into existing helicopters without major modification of mating hardware.

Phase I would provide for design and fabrication of experimental bearings for a specific rotor head application for either the SH-60B, CH-53E, or AH-1W tail rotor pitch link bearings.

Phase II would provide for bench testing of the bearings. Bench tests to accurately simulate the load/motion regime of the application will be required. Successful completion of bench tests would demonstrate that the bearings are safe-for-flight.

N90-242 TITLE: Airborne Low Frequency Sonar Cable

CATEGORY: Engineering Development

OBJECTIVE: Develop a small diameter high strength cable which is not subject to distortion (stretching) when run under load at high speed. Must retain flexibility at $\pm$ 40°C temperatures.

DESCRIPTION: The Airborne Low Frequency Sonar requires the use of approximately 1500 - 2500 ft. of cable to transport and provide an electrical cabling conduit to a sonar device which will weigh between 250-1600 lbs. The sonar must be raised at approximately 22 fps. Previous cable designs have experienced distortion (stretching) which cause difficulty in depth control as well as safety problems in the proximity of the aircraft. (The sonar is dropped from a hovering helicopter.)

Phase I should recommend/develop a prototype cable to interface with the prototype sonar device for Phase II

follow-on.

NAVAL UNDERWATER SYSTEMS CENTER

N90-243 TITLE: Periscope Laser Eye Protection

CATEGORY: Engineering Development

OBJECTIVE: Demonstration of a device to protect the eyes of a submarine periscope operator from damage due to laser radiation. Successful demonstration will lead to development of a field change kit.

DESCRIPTION: Submarine periscope operators are vulnerable to eye damage or dazzle due to hostile use of laser radiation. Protection is required against this threat. Passive devices that do not severely reduce overall light transmission are required. Such a device may take the form of a filter or a possible optical switch. Different implementations are required for two basic periscope optical designs. Phase I should result in a detailed conceptual design that can be built and tested in Phase II.

N90-244 TITLE: Single-Sided Flextensional Transducer

CATEGORY: Exploratory Development

OBJECTIVE: Hardware demonstration of a flextensional transducer capable of both omnidirectional and unidirectional radiation.

DESCRIPTION: A high power, low frequency Class IV flextensional transducer is needed that has the ability to radiate both in its normal omnidirectional radiation mode and in a single-sided directional radiation mode. The required transducer shall exhibit a primary mechanical resonance in the frequency band from 500 Hz to 8 kHz and be capable of an acoustic output of at least 2000 watts. The transducer shall be capable of highly efficient operation in its omnidirectional mode with an in-water mechanical Q less than six. The directional mode shall generate a radiation pattern with a front-to-back ratio of at least 15 dB.

Phase I deliverables shall include a scaled prototype transducer capable of demonstrating the concept.

N90-245 TITLE: Single-Sided Electrodynamic High Power, Underwater Projector

CATEGORY: Exploratory Development

OBJECTIVE: Hardware demonstration of a partial array of electrodynamic transducers exhibiting a bandwidth of one octave.

DESCRIPTION: A requirement exists for the development of a single-sided electrodynamic projector for use in a planar array at low frequency and high power. The mechanical Q(Qm) of the array shall be less than one with the frequency band of interest being in the 500 to 1500 Hz band.

The Phase I hardware demonstration shall be a prototype transducer.

The Phase II partial array demonstration may consist of transducers resonant at a scaled frequency (due to cost constraints) but must be completely tractable with the full-size transducer.

N90-246 TITLE: Turbulent Boundary Layer Drag Reduction

CATEGORY: Exploratory Development

OBJECTIVE: Develop a novel and/or revolutionary technique to reduce drag and noise on a turbulent boundary layer on an undersea vehicle.

DESCRIPTION: Novel techniques are required to reduce the turbulent boundary layer drag and noise on underwater vehicles. The technique should not require large amounts of volume or weight and should be energy efficient. Total levels of drag reduction greater than 30% and turbulent boundary layer pressure fluctuation reductions greater than 5 dB are desired. The length of time over which the technique must work is on the order of one hour. The techniques will be required to work at high Reynolds numbers.

The objective of Phase I will be to perform a proof of concept of the proposed drag/noise reduction technique. It is anticipated that this will be a feasibility experiment.

In Phase II the technique would be demonstrated at full scale.

N90-247 TITLE: Live Plankton Characterization in Fluid Flow

CATEGORY: Exploratory Development

OBJECTIVE: Develop experimental techniques to determine the mass density, drag coefficient and particle alignment/tumbling ratio in a boundary layer for living marine plankton.

DESCRIPTION: Small particles (marine plankton), which range in size from 50 to 1000 microns, can enter an underwater vehicle's boundary layer and produce substantial local disruptions. In order to understand this disruption process, characteristics of the small particulates must be known. The parameters that are critical are the mass density, drag coefficient and alignment to the flow of the living organism as it traverses a boundary layer. The living characteristics are required because upon death, the particles rapidly deteriorate (protoplasm leaks out) and the resulting characterization becomes meaningless. The experimental characterization data will be used as input to a particle trajectory simulation computer code that tracks a particle's trajectory as it moves past an undersea vehicle. With this information we will be able to predict particle trajectories for naturally occurring particulates for the first time.

Particles of interest include both zooplankton and phytoplankton. Species of interest include (but are not limited to) the copepod Acartia hudsonica, the diatom Rhizosolenia and rotifers. It is expected that there will be a distribution of plankton characteristics for a given species according to particle size, health and other environmental factors. The density measurement technique should have an accuracy greater than $\pm$ 5%. The drag coefficient measurement technique should be accurate to $\pm$ 10%. Particle Reynolds numbers of interest range from the Stokes range to 1000 and it is expected that the density of these particles is close to that of seawater. These particles are highly nonspherical and may exhibit tumbling motions in particle specific Reynolds number egimes or in certain regions in the boundary layer. The alignment/tumbling measurement technique should work for the entire range of Reynolds numbers of interest. Currently there are no measured mass density measurements or drag coefficient measurements as a function of Reynolds number for live plankton. Particle alignment in sheer flows is also an unknown.

Phase I of the effort should culminate a proof-of-concept characterization demonstration for a single species of marine plankton. In Phase II the technique would be improved so that routine plankton characterization measurements could be made. If more than one area is addressed in the proposal the effort may be priced accordingly.

N90-248 TITLE: Multi-Line Array Retrieval and Stowage System

CATEGORY: Exploratory Development

OBJECTIVE: The intent of this effort is to establish a method to retrieve a multi-line array in a manner which will make it possible to reliably separate and store the arrays without inducing damage. It would be necessary to verify the proposed drive principle during Phase I via a low cost test mockup and to critically test the accepted drive principle under load and speed during Phase II. The deliverables for Phase II would be a functional test model, critical test results, and a system level drawing package.

DESCRIPTION: Submarine handling of multi-line towed arrays presents unique problems. The methods for retrieval and storage of these arrays have not been determined. It is necessary to investigate drive principles which have the potential of inhauling multi-line arrays separately without causing undue stress on any one array, then to reduce the tow tension to a low level for array stowage. The equipment must be capable of operation on a surface ship or submarine. Because of submarine requirements, the system weight, size and noise levels must be minimized with maximum reliability. The minimum bend radii of the arrays is ten feet, and the arrays will be entering the submarine at twenty to thirty degrees from its direction of travel. It is required to verify feasibility of the drive with a simple mockup. It will then be required to verify functionality through critical tests. Because of minimum bend radii requirements of the array and space limitations of a submarine, conventional capstan methods may not be applicable.

N90-249 TITLE: Prelaunch Electric/Acoustic/Optic Communications

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to replace the prelaunch umbilical cable with a reliable, close range communication system for operation in a full flooded torpedo tube environment. Innovative electrical, acoustic or optic concepts should be applied to the communication system. Weapon fire/refire time is to be minimized.

DESCRIPTION: Research into replacing the existing submarine-to-torpedo prelaunch system with an improved system which applies innovative electrical, acoustic or optic concepts is desired. Current submarine launch weapons rely upon umbilical cables that are connected during the weapon loading cycle to provide prelaunch communication and warm power. The umbilical has a large 65-pin connector that is attached to the torpedo tube breech door and a smaller connector that is attached to the torpedo with shear screws. Each weapon has its own unique cable variation that has been developed or adapted to suit specific operational demands. All variations have displayed low reliability, high cost, lengthy time-to-make-ready, and procedural complexity. The major problem facing all designs is that salt deposits and moisture cannot be effectively isolated from the active elements because they are continually mated and unmated at sea. The components cannot tolerate such contamination.

The desired features of an electrical, acoustic or optic prelaunch communication system include: high reliability, versatility, reusable, free flooding, solidly encased, simplified set-up procedures, and minimal fire-refire time.

N90-250 TITLE: Development of Miniature High Temperature, High Pressure Steam Throttle Valve

CATEGORY: Advanced Development

OBJECTIVE: Develop a miniature valve to throttle the flow of high pressure superheated steam from a boiler to an expander. If testing of initial prototype hardware is successful, this device may be further refined and incorporated into a propulsion system speed control loop.

DESCRIPTION: A valve is desired which can throttle the flow of 1600 degrees F steam from 1.8 lbm/sec required to .25 lbm/sec. Over this throttle range, the valve must be designed to operate without producing audible whistles or roars. The valve should not exceed 10 pounds in weight and 40 cubic inches in volume. The valve should have a full stroke response time of less than 100 milliseconds.

The control signal will most likely be a pulse width modulated Direct Current (DC) voltage source. The maximum electrical power required shall not exceed 100 watts and the maximum voltage shall be limited to 33 volts. The actuating force may be electrical or power may be provided from external supplies of 1500 pounds per square inch (psi) hydraulic fluid (MIL-H-5606) or high pressure water ($\leq$ 1300 psi) at $\leq$ 200 degrees F. The steam inlet and outlet ports shall conform to MS 16142. The design life for the valve shall be 20 cycles of 1 hour operations.

Phase I shall result in a layout of a design concept supported by stress and thermal analysis. Particular attention must be paid to differential thermal expansion and selection of materials for corrosion and thermal stability.

Phase II effort will consist of refining the design based on comments resulting from the review of the Phase I product. After another design review and design intercepts two prototype valves shall be fabricated and submitted for testing in Navy facilities.

N90-251 TITLE: Automated Sound Velocity Profiler

CATEGORY: Exploratory Development

OBJECTIVE: To develop an acoustic array system which can determine the sound velocity profiles of a body of water, such as an acoustic tracking range.

DESCRIPTION: The sound velocity profile on a tracking range is currently obtained by a series of measurements of water temperature and salinity performed from a surface craft. These measurements are then processed using an empirically derived algorithm which provides an estimate of the sound velocity profiles. This approach is limited by the empirical model used, and by the small number of samples which can be cost-effectively obtained.

In recent years, CAT SCAN x-ray examinations have allowed the determination of the internal structure of an object via external transmitters and receivers. The basis of reconstruction from this data is the Radon Transform. Measurements are taken at various positions to determine variations of the internal structure of the object (e.g. intensity of the received x-rays depends on the density of the tissue). Profiles through the structure from any selected angle can then be recreated by post-processing of the raw data. Using a similar approach, the new sound velocity measurement system will employ several sets of hydrophone arrays at the boundaries of a range, with processing through a derivation of the Radon Transform, to determine the internal structure of the range (i.e. sound velocity profile).

Phase I, offerors shall: 1) Perform a literature search and determine what work has been done in this area; 2) Modify the Radon (or suitable) Transform for application with acoustic signals, 3) Propose a practical acoustic array geometry and a discrete computer algorithm based on item 2, 4) Show theoretical and simulated proof that the approach will work as described and 5) Provide a description of restrictions or special requirements for use.

In Phase II, experimental hardware will be developed to verify the approach through an actual range test.

NAVAL AIR ENGINEERING CENTER

N90-252 TITLE: Optical Correlator for Aircraft Recognition

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the capability of optical signal processors to determine aircraft parameters during terminal phase of guidance on aircraft carriers. If successful, this system would replace video trackers and provide aircraft identification and feature recognitions for LSO display and automated setting of recovery equipment.

DESCRIPTION: Identifying aircraft during terminal phase of landing on aircraft carriers requires recognizing aircraft type and various features such as hook down, wheels down and configurations as well as its dynamic performance about glide slope.

Phase I is to investigate the capability of optical signal processors working on a direct image or an image from a video sensor such as FLIR to recognize aircraft type, various features and its potential for determining dynamic track data.

Analytic methods as well as proof of concept model should be demonstrated in Phase II. Aircraft type should be determined by two nautical miles and hook down/wheels down should be identified by one nautical mile from the ship. Tracking data would be required from one and one quarter nautical miles. Cost estimates and all required interfaces should be described that are required for a shipboard installation.

N90-253 TITLE: Radar Cross Section (RCS) Validation

CATEGORY: Exploratory Development

OBJECTIVE: Perform a rapid analysis of aircraft RCS prior to mission deployment.

DESCRIPTION: Navy and Marine Corps aircraft will be designed and retrofitted to minimize the RCS of the airframe. It will be imperative to verify and maintain this low observable (stealth) status. Innovative instrumentation/techniques are being developed to verify the multi-band RCS integrity of the aircraft. Advances in sensor and signal processing technologies will enable high resolution/dynamic RCS measurements in the operating environment.

Example: After launch of the aircraft, an array (e.g. deployed on the carrier, an AEGIS cruiser, another aircraft etc.) would scan the aircraft at various aspect angles and frequencies and then process this data utilizing the latest generation of parallel computing architectures and support tools to perform a real-time one-, two-, or three-dimensional RCS analysis of the target. A modification of this process would also enable the detection and identification of hostile aircraft/missiles. A dual-mode millimeter wave/infrared version (narrow beam width for sea clutter reduction, good resolution of target, and at certain frequencies - convert propagation/detection) can provide additional data for a shipboard point defense system.

Phase I: Requirements evaluation/development of algorithms and software for multi-octave, real-time analysis of targets utilizing innovative computer architectures.

Phase II: Array, software, computer and networking development/integration for demonstration of advance development model.

N90-254 TITLE: Derivation of Functional Testing Requirements from Weapon System Mission Requirements

CATEGORY: Exploratory Development

OBJECTIVE: Reduce weapons replaceable assembly testing time and test program complexity by testing for mission capability rather than full parametric performance standards.

DESCRIPTION: Functional testing is being hailed as a breakthrough in avionics testing by reducing test program set complexity and test run times. The assumption is that only mission requirements tests are to be performed rather than full-scale parametric testing for ready for issue.

Phase I would develop a rationale for comparing the effectiveness of functional testing and parametric testing based on weapon system performance and mission requirements.

Phase II would consist of a pilot effort comparing the effectiveness of functional testing approach to more traditional parametric testing for selected test program sets currently in use.

PACIFIC MISSILE TEST CENTER

N90-255 TITLE: New Emitter Sorting Techniques

CATEGORY: Engineering Development

OBJECTIVE: Develop new emitter sorting techniques which are fast, accurate and provide high resolution of signal parameters necessary for optimum signal sorting and cataloging.

DESCRIPTION: Modern radar systems use complex intrapulse coding techniques to enhance radar performance and ECCM capabilities. Radar warning receivers (RWRs) and Deception Electronic Warfare (DECM) systems must detect, sort and identify these advanced radar systems in an extremely dense electromagnetic environment containing numerous similar emitters. To adequately sort specific emitters from this environment, catalogue the complex signal modulations and identify by comparison with

stored emitter data, new sorting techniques must be developed. These techniques must be fast, have high accuracy and resolution of signal parameters such as phase, frequency, modulation linearity, phase coding bit rates, etc. that are necessary for optimum signal sorting and cataloging. They may also allow emitter and/or platform fingerprinting based on measuring unique characteristics of received signals. It would be desirable if the techniques allow the stored and catalogued data to be used for regeneration of the received signal at a later time for jamming purposes.

Phase I would identify potential sorting techniques for these advanced emitters, analyze each for capability/applicability to meet the requirements stated above, investigate hardware and software implications of each technique, and describe findings in techniques report including a plan for Phase II.

Phase II would generate specification for optimum techniques as directed by the Navy, fabricate brassboard prototype to demonstrate performance predicted in Phase I, prove feasibility of incorporation into present RWRs and DECM suites, and generate a final report on technique performance.

N90-256 TITLE: New Electronic Support Measure (ESM) Classification and ID Techniques

CATEGORY: Engineering Development

OBJECTIVE: Develop a new classification and ID processor to handle LPI radar signals.

DESCRIPTION: The classification of LPI radar signals is important for advanced ESM systems. Technical developments should include basic classification approach, new and novel signal processing algorithms for feature extraction and classifier, software implementation, and actual classification analysis of simulated LPI radar signals ESM classifier performance should be estimated. Feature uniqueness and stability constraints should be developed and S/N requirements should be quantified. New classification techniques should be compared to existing ESM classification approaches. A new ESM classification processor should be designed.

Phase I will develop new signal processing techniques for classification and ID, determine measures of effectiveness in simulated environments, and report on findings with comparisons to existing techniques.

Phase II developments will demonstrate critical technical elements associated with the new processor and quantify expected performance in operational systems.

N90-257 TITLE: Airborne Imaging Spectrometer for Measurement of Low-Observable Aircraft Infrared Signatures

CATEGORY: Advanced Development

OBJECTIVE: Develop a capability which is crucial to missile performance evaluation, built from a flight test and hardware-in-the-loop laboratory aspect.

DESCRIPTION: Current infrared imaging systems and spectrometers or interferometers operating in the 1 to 12 micrometer wavelength range are unable to obtain accurate measurements of low signature aircraft and missiles. Imaging systems measure spatial distribution of infrared radiation and are able to distinguish aircraft from natural backgrounds, but are unable to obtain high-resolution spectral data. Spectrometers obtain spectral data, but are unable to measure spatial distribution of radiation or to perform measurements under conditions of low contrast against background. Accurate measurement of low-observable aircraft signatures in flight requires a combined imaging spectrometer capable of simultaneously obtaining both spatial and spectral data. No instrument of this kind currently exists.

In Phase I perform the conceptual design and develop purchase specifications for a compact airborne imaging spectrometer and data acquisition system capable of obtaining simultaneous spectral and spatial infrared signature measurements of low-observable-aircraft.

Phase II would be the development of such an instrument.

N90-258 TITLE: Radar Reflectivity Polarization Matrix Measurement Instrumentation

CATEGORY: Engineering Development

OBJECTIVE: Design and develop radar reflectivity polarization matrix measurement instrumentation.

DESCRIPTION: Radar reflectivity measurements made in anechoic chambers are required to obtain the polarization scattering matrix. This is implemented by sequentially transmitting two orthogonal linearly polarized signals and receiving the co- and cross-polarized scattered signals. The desired outputs are the phase and amplitude of each received component relative to each of the transmitted components. The microwave assembly required to perform these measurements must consist of two wide-band antennas capable of operating at two orthogonal polarizations and the microwave switching system capable of performing the multiplexing between the various channels. The entire assembly must be equalized to provide relatively constant phase and amplitude between the various channels.

General specification for Phase I design and Phase II development is:

Frequency Coverage:	6-18 GHz
Polarization:	HH,VV,VH,HV
Switching Time:	< 1 ms
Phase Equalization:	Better than 5 Degrees
Amplitude Equalization:	Better than 1 dB
3-dB Beamwidth:	20-25 Degrees across the frequency band

N90-259 TITLE: Multi-Spectral Target Presentation for Missile Test and Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: This project will develop prototype multi-spectral environment generation hardware and software to be used for anti-air missile system test and evaluation.

DESCRIPTION: At present, anti-air missiles employ guidance systems which use either microwave or infrared sensors. The next generation of anti-air guided missiles will employ dual-mode sensors. In order to adequately test and evaluate these systems, hardware-in-the-loop test laboratories must be able to provide simultaneous real-time simulation of each sensor. This will require real-time calculation of both microwave and infrared signatures, clutter and countermeasures and generation and presentation of the data to the respective sensors. Phase I should investigate alternative methods of performing real-time, hardware-in-the-loop evaluation of multi-mode anti-air missile systems.

Phase II should develop prototype multi-spectral environment generation hardware and software to be used for anti-air missile system test and evaluation.

N90-260 TITLE: Microwave Target Presentation for Missile Test and Evaluation

CATEGORY: Engineering Development

OBJECTIVE: Develop prototype hardware for RF environment presentation in hardware-in-the-loop missile system evaluation laboratories

DESCRIPTION: At present, RF guided missiles are tested in hardware-in-the-loop (HIL) laboratories using one of two techniques for the presentation of target signatures, jamming sources and environmental effects. The less expensive of the two techniques generates appropriate angles and angular rates using microwave horns servo-positioned in one or two exes. Advantages of the servo-positioned horn approach include moderate cost and the capability to handle power levels required for simulation of threat representative jamming sources. Disadvantages of the servo-positioned horn technique include inability to represent target glint and restriction to scenarios including one or two sources. The second technique employs an array of horns driven by a complex network of microwave devices. Advantages of the horn array include the ability to represent many targets and to simulate complex target signature phenomena. Disadvantages include cost and the inability to handle the relative and absolute power levels required for tests in some jamming environments.

Phase I is to investigate alternative methods of simulating RF target, jamming and environmental sources in a HIL laboratory; phase II will develop prototype hardware.

NAVAL TRAINING SYSTEMS CENTER

N90-261 TITLE: Real-time Photographic Based Terrain Image Generator with Capabilities for 3-D Objects

CATEGORY: Exploratory Development

OBJECTIVE: To produce a low cost visual system capable of receiving photographic terrain information and in conjunction with Defense Mapping Agency elevation data produce a three dimensional real-time image for flight simulation and mission practice applications. The system should also be capable of integrating 3-D moving models, target and ground queuing objects into the scene.

DESCRIPTION: Photo-based image generators have been utilized by using digitized 2-dimensional photographs and attempting to warp them to produce 3-dimensional perspectives. This has proven to be adequate for some areas of visual training, where low level flight of high detail terrain queuing are not required. Traditional polygon based image generators lack the fidelity to produce a realistic terrain scene, but have been used extensively for visual training because true 3-D perspective can be accomplished. Today's hardware and software technologies have developed to a point where it is feasible to design a low cost and efficient visual system

which could produce a 3-D true perspective terrain scene from 2-D photographs and elevation data. This system would be capable of displaying a wide geographical area at a real-time (30 Hz) update rate. The inclusion of 3-D polygons with texture capability onto a photographic based terrain scene would provide enhanced fidelity as well as realistic true perspective scenes. The system should use the latest methods of photographic retrieval and database standards to include rapid reconfigurability and mission practice application.

Phase I would be a study report explaining the approach to accomplish the above.
Phase II would be the development of the above.

N90-262 TITLE: Low Cost Reconfigurable Cockpit for Deployable Aircrew Team Trainers

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a low cost, modular, reconfigurable cockpit that can be transported to any site and easily reconfigured to simulate a variety of aircraft cockpits to be used with other out the window display and simulation computers in deployable aircrew team trainers.

DESCRIPTION: A low cost, deployable cockpit that can be easily reconfigured to simulate a variety of aircraft is desired. The cockpit instrumentation and controls would be modular in that they could be rearranged inside the cockpit to simulate different configurations. Display such as the head-up displays, weapon status, electronic countermeasures, etc. would be reconfigurable to simulate different aircraft formats. All aircraft functions need not be represented but if in a modular design, function could easily be added. This cockpit would then be connected, via a proper interface network, to a low cost, deployable simulator system for use in team training.

Phase I should be the preliminary design of the cockpit and Phase II would be a demonstration model.

N90-263 TITLE: On-Line Diagnostic System for Simulator Performance Monitoring

CATEGORY: Engineering Development

OBJECTIVE: To provide an on-line, real-time diagnostic system for monitoring the health of fielded aviation training simulators. If successful, the approach could provide a means for determining when a simulator, or a simulation subsystem, is going out of tolerance.

DESCRIPTION: The amount of performance transfer which occurs from a training simulator to the actual equipment is a function of the simulator's fidelity. Fidelity is reduced, and therefore also training effectiveness, when a simulator goes out of tolerance. For example, even subtle changes in the response times of a motion base or visual system can cause significant performance effects. The human vestibular system can detect such discrepancies and, in the case of unexpected or conflicting inputs from the visual and vestibular senses, initiate an adverse physical reaction in the student. It would be desirable to detect changes in simulator performance before they reach a threshold which would adversely affect student performance.

Phase I should investigate techniques which would be appropriate for implementing such a diagnostic system. At least one similar system has been developed which monitors various operational aspects of electrical power generator turbines. This is implemented as a rule-based system and is able to diagnose problems and schedule preventative maintenance before the symptoms affect generator output. Phase I should also examine a representative set of aviation training simulators to determine the feasibility of implementing and interfacing the diagnostic system.

Phase II should prototype the system and provide functional and design specifications for it.

N90-264 TITLE: Training Optimized Utilization Resource Scheduler

CATEGORY: Engineering Development

OBJECTIVE: Develop a scheduling tool for use by curriculum developers and planners testing alternative curriculum mixes, by training analysis simulating different training alternatives, and by course designers and schoolhouse management personnel responsible for the scheduling of training at their individual schools. It would also serve as a repository catalog of training resource and course constraints for all courses and resources at a school. The use of such a tool could improve training device utilization/availability ratios and result in significant trainer acquisition and maintenance cost savings.

DESCRIPTION: Utilization of a significant number of training devices averages less than 100 hours each per month although a recent sample survey indicated that device availability was above 90%. Scheduling problems are a major cause for the low utilization/availability ratio and results in increased training cost. Although resource scheduling systems have been built, none available address the multiplicity of precedence, conjoint and disjoint scheduling constraints typical of a training curriculum.

A computerized scheduling system capable of addressing these constraints should be designed in Phase I so that effective and efficient training schedules which will optimize device utilization can be built and used. It should operate on a Zenith-248 personal computer (or equivalent) in order to maximize its utility and applicability throughout the Navy training community for use by curriculum developers and planners testing alterative curriculum mixes, by training analysts simulating different training alternatives, and by course designers and schoolhouse management personnel responsible for the scheduling of training at their individual schools.

Phase II should use design approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

NAVAL COASTAL SYSTEMS CENTER

N90-265 TITLE: Video Data Compression

CATEGORY: Exploratory Development

OBJECTIVE: Develop very nigh rate, low-error data compression/ reconstitution algorithms.

DESCRIPTION: In many cases image data in video format is acquired. Algorithms for very high data compression/ reconstitution are required. The range of video data compression of interest is between 50-500 times, with emphasis at the higher rate of data compression. The data compression algorithm should be high compression/reconstitution fidelity and have extremely low (10-8) error rates. Means to characterize the errors should be in design of the algorithm.

N90-266 TITLE: Underwater Covert Communication Links for Short Distances

CATEGORY: Exploratory Development

OBJECTIVE: Develop covert, underwater communication moduies in less than 0.25 ft^3 footprints.

DESCRIPTION. Reliable, covert underwater communication links are required. The receiver/transmitter must support data rates in excess of 10 kilobytes/ second and must not involve any type of wires (e.g., fiber optics/metal conductors) or other physical connecting material between receiver and transmitter. Ranges of operation should exceed 5 kiloyards. Receiver/transmitter diameter should not exceed 6 inches. Power sources should not be considered in the design except that power requirements should not exceed 1 kilowatt. The links may use optics, acoustics, magnetics or any other approach as long as links remain covert (i.e., not detectable by unintended receivers).

NAVAL CIVIL ENGINEERING LABORATORY

N90-267 TITLE: Heat Resistant Airfield Pavements

CATEGORY: Exploratory Development

OBJECTIVE: To identify and evaluate heat resistant materials for airfield pavement application.

DESCRIPTION: The exhaust gas from the auxiliary power unit of the Navy's F/A-18 aircraft causes spalling and erosion on Portland cement concrete (PCC) airfield pavement. The resulting pavement debris present foreign object damage (FOD) problems to aircraft engines.

The research to be conducted relates to the following questions: 1) How can the Navy obtain airfield pavement that is both heat and jet fuels resistant? 2) What new pavement mixes and designs provide both heat and fuel resistance?

PHASE I: The end product of this effort consists of a technical report summarizing research being conducted relative to developing heat resistant airfield pavements. The completed report will identify potential new mixes and pavement designs that can be tested in later phases. Therefore, this work will also include developing both a research plan and a test plan.

PHASE II: This effort consists of conducting tests of promising heat resistant pavements that meet the following requirements: 1) Does not deteriorate (spall, erode, or suffer strength loss) even after saturation with jet fuel and hydraulic fluid and subsequently exposed to repeated high temperature jet exhaust blast. 2) Withstands repeated and prolonged jet exhaust blast of 600 degree Fahrenheit at 250 mph with a one hour heating and one hour cooling cycle. 3) Resists environmental effects such as freezing, thawing and ultraviolet light. 4) The material must be comparable to PCC in terms of strength and skid resistance and be compatible with PCC pavement in terms of adhesion and coefficient of expansion.

N90-268 TITLE: Development of Wall Composite Materials to Prevent Sympathetic Detonation Between Weapons Storage Cells

CATEGORY: Exploratory Development

OBJECTIVE: To explore new design concepts for preventing sympathetic detonation in weapons storage facilities.

DESCRIPTION: A new design concept for weapons storage consists of a series of three-wall cells inside an earth-covered magazine. The concept is based on storage of up to 10,000 lbs. of cased explosives (i.e., containerized missiles or palletized ammunition in each cell in stacks about six feet high, at least five feet below the roof and two feet from any cell wall). The cell walls are designed to prevent sympathetic detonation between weapons stored in adjacent cells, thus limiting the maximum credible event to the explosive capacity of one cell. The research being conducted relates to the following: 1) How can the Navy prevent sympathetic detonation? 2) How can composites be used to achieve this desired result?

If this project is successful, t. e Navy's ordnance storage capacity could be increased significantly by virtue of reducing established explosion arcs. Additionally, real estate could be freed for other uses.

PHASE I: This task involves identification of innovative design concepts, materials and composite wall properties that mitigate explosion effects and prevent propagation by sympathetic detonation.

PHASE II: This task involves the evaluation and testing of composite wall designs. Small scale tests will be conducted to evaluate the feasibility of using composite materials and wall designs for mitigating sympathetic resonance. This phase of the study will include: 1) material selection; 2) development of composite wall designs; and 3) feasibility testing. The effective material and design must be capable of preventing sympathetic detonation caused by initiating mechanisms such as: fragments, debris, overpressure (shock and gas) and temperature.

N90-269 TITLE: Diver-Installed Recoilless Propellant Embedded Anchor (RPEA)

CATEGORY: Exploratory Development

OBJECTIVE: To develop technology for small recoilless propellant embedded anchors (RPEAs), having capacities from 500 to 5,000 lbs., for installation by Navy divers.

DESCRIPTION: The recoilless feature allows the anchor to be operated in any water depth and on dry land. Thus, it is potentially useful for quickly placing guyline anchors and other low-load dry-land applications as well as for expeditious anchors/moorings in the surfzone and in deeper water. This type of anchor will be designed to facilitate placement by divers.

In related research, basic research technologies for gun ballistics and rock projectile designs are currently being developed under the Basic Research and Exploratory Development Programs. The technology for sediment fluke design was developed previously and is in use in Navy and commercial propellant embedded and impact-driven anchor systems. Based on previous concept investigations, small RPEAs are feasible. The Navy wants to develop RPEAs that weigh 30 to 100 lbs. in air and are neutrally buoyant in water. This type of anchor will facilitate placement by divers. Omnidirectional capacities of 500 to 5,000 lbs. would be attained. The research being conducted relates to, 1) How can the Navy develop lighter-weight anchors with equal or increased holding capacity? 2) How can an anchor systems be developed that can be deployed by Navy divers? 3) How can anchors best be developed that are multipurpose?

PHASE I: This effort includes, 1) determining a useful size range for an RPEA, 2) development of preliminary designs for guns and flukes to satisfy needs throughout the ize range, and 3) the development of a Test and Evaluation Plan for experimental validation and refinement of the designs.

PHASE II: This effort includes: 1) developing experimental models; 2) developing a performance data base; 3) developing and designing working experimental hardware; and 4) preparing a report summarizing design and performance data, including recommendations for development of a diver-installed RPEA. Models will be built and tested and performance data obtained and compiled into a performance data base. This data base will be used to develop an engineering design and reliable working experimental hardware for testing and evaluation in commercial and military operations.

NAVAL AIR PROPULSION CENTER

N90-270 TITLE: Turbine Engine Component Deterioration Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop a gas turbine code which utilizes and predicts component deterioration to calculate overall engine performance.

DESCRIPTION: Development of a computer based system or program that would enhance the abilities of aerothermodynamic component technologists in the prediction of turbine engine component performance deterioration with engine use is needed. The current methods for assessing component performance deterioration are not adequate for new engine models or advanced engine concept evaluations. This deterioration model will analytically and/or statistically determine estimated component structural and thermodynamic wear and loss patterns based on inputs of engine configuration, duty cycle, component loading, engine application, etc. The outputs of the program will pertain to individual components as well as overall engine performance and shall include trend charts/curves, component performance changes and the physical phenomenon associated with these changes (e.g. clearances, erosion, etc.)

Phase I would entail theoretical analyses verifying the feasibility of a component/engine performance deterioration model. The results of Phase I will be used to justify the pursuit of the Phase II effort.

Phase II would consist of the development of a user friendly computer based system for deteriorated performance prediction.

N90-271 TITLE: Compressor Boundary Layer Control

CATEGORY: Research

OBJECTIVE: Develop boundary layer control techniques that will enhance axial compressor blade performance.

DESCRIPTION: The three dimensional design tools along with flow field modeling are advancing the designs of axial flow compression systems. Improved understanding of the boundary layer and methods to control the boundary layer for increased efficiency are required to improve overall compression performance.

Phase I effort will identify candidate boundary layer control techniques and conduct preliminary analysis.

Phase II will select the most promising techniques and conduct appropriate rig tests to performance improvements.

N90-272 TITLE: Fuel Atomization Analysis for Advanced Gas Turbine Combustors

CATEGORY: Exploratory Development

OBJECTIVE: Develop a fuel atomization code for gas turbine combustors.

DESCRIPTION: Fuel atomization plays a vital role in advanced gas turbine combustor performance (i.e., pattern factor smoke emissions, ignition/blowout limits, etc.). The significance of modifying the fuel injector and its associated atomization characteristics to improve combustor performance has been shown in both combustor rig and engine tests. However, atomization analysis methods are limited to empirical correlations that are configuration and flow condition dependent, and do not provide a means for improving fuel injector designs. A need exists for developing methodologies of modeling the atomization process from fundamental principals of surface wave formation growth coupled with droplet stripping. The atomization analysis should be fully coupled with aerodynamic analysis of the airflow surrounding the liquid jet/sheet, and include droplet vaporization and combustion. The analysis should culminate in the accurate predication of ignition and/or lean blowout of a generic combustor typical, of advanced military gas turbine combustors.

Phase I-Develop base atomization model and compare it with literature results.

Phase II-Transition model to actual combustor boundary conditions and experimentally validate the results.

NAVAL OCEAN SYSTEMS CENTER

N90-273 TITLE: Sensor for the Detection of Buried Cable From a Remote Tethered Submersible

CATEGORY: Exploratory Development

OBJECTIVE: To develop a relatively small, lightweight sensor to be mounted on an underwater Remotely Operated Vehicle (ROV) which will allow the operator to determine the depth of burial of an underwater cable.

DESCRIPTION: The main method of protecting existing underwater cables from trawling operations is to bury the cable to a depth of around 12 to 24 inches into the bottom. Existing ROVs will locate cables on the floor of the ocean, automatically track the cable, and bury the cable through the use of a water jetting system. There is a requirement to develop a sensor to locate, track, and record the depth of burial for such cable after the jetting operation to insure that the cable is adequate. The sensor should be sufficiently light weight and compact to fit onto either the existing ROV or a generic ROV. Sufficient acoustic or magnetic noise immunity should be built into the unit to allow detection and tracking of the cable while the vehicle is underway and the jetting

system is in operation. The cables cannot be counted on to always have a ferro- magnetic anomaly signature, a d.c. or a.c. active signal imposed, nor a size greater than 1/4 inch in diameter.

Phase I: This phase will consist of investigation into alternative approaches and preliminary design.

Phase II: This phase will be the final design, breadboard, prototype fabrication and test.

N90-274 TITLE: Tools to Assist in Modification and Reuse of Ada Software

CATEGORY: Exploratory Development

OBJECTIVE: To develop software tools that will assist the Ada programmer in understanding existing Ada software so that it maybe more easily modified or reused.

DESCRIPTION: An acute need exists today for tools that will improve the productivity of the programmer who must, or wishes to, make use of Ada code written by someone else. These tools are intended to help the programmer do the following: 1) Install a large existing system that is written in Ada and make modifications to it. (The programmer, who is told to install a 50000 source lines of code Ada software system and to make enhancements to it, needs help.) 2) Reuse one component of a larger system. (An example of this is reusing the user interface from the Inertial navigation system.) 3) Reuse or modify Ada code in some other manner. A great deal of public domain Ada software exists in the SIMTEL20 and other repositories. Usually before software can be reused it must be modified to fit a particular application. Tools that will facilitate the rapid understanding of potentially reusable Ada software are needed. These tools should encourage reuse as well as the use of Ada repositories.

Some examples of such tools are listed below. Certainly there are others.

1) A graphics tool that reads in Ada source code and creates Buhr Diagrams, Boochagrams, or other meaningful graphical representations of the source code. 2) A file that summarizes the content of Ada files. The input is the list of Ada files that contain the software. The output is the list of files and the Ada program units contained within, with indentation to indicate nesting. 3) A tool that automatically expands "is separate" Ada statements to include the code contained in the separate files. Such a tool would eliminate the need for the programmer to examine multiple listings when "is separate" statements are used.

Phase I: Determine capability to develop the tools.

Phase II: Develop specific tools for immediate use in naval systems as specified by DON/SPAWAR/NOSC.

N90-275 TITLE: Miniaturized Radio Relay for UHF/VHF Communications

CATEGORY: Advanced Development

OBJECTIVE: Extend line-of-sight UHF/VHF communications.

DESCRIPTION: The U.S. Navy has the need to extend line-of-sight VHF and UHF communications to provide over-the-horizon connectivity. This can be accomplished through the use of radio relays. These relays could be installed in fixed wing aircraft, helicopters, unmanned airborne vehicles, or buoys , but the use of free floating balloons or kites is of current interest. Using these vehicles, the Navy has a requirement to relay at least two wideband 25 Khz AM Voice and a 25 Khz FM channel to handle data. Because of FAA regulations, the balloon borne relay must not weigh over six pounds (including batteries) and must be able to provide five (5) watts output at 50% duty cycle from the transmitters for a period of 12 hours. These relays should be considered expendable items and therefore must be low in cost in high production quantities.

N90-276 TITLE: Multi-Function Shipboard Antennas

CATEGORY: Advanced Development

OBJECTIVE: Reduce the number of shipboard antennas installed topside.

DESCRIPTION: U.S. Naval ships are currently saturated with a large number of antennas. Each antenna is a single purpose device dedicated to performing in a small portion of the electro-magnetic spectrum. As new systems are installed on ships, they usually include a specialized antenna. The large number of antennas already in use are occupying valuable topside space. It is required that the total number of installed antennas be reduced, while at the same time the ship antenna vulnerability, reliability, and Near Vertical Incidence Skywave (NVIS) characteristics be improved. Innovative approaches are being solicited which will reduce the quantity of shipboard installed antennas through hardware multi-function design.

N90-277 TITLE: Communication Devices and Techniques for Naval Special Warfare

CATEGORY: Advanced Development

OBJECTIVE: Develop communications devices for Special Warfare forces.

DESCRIPTION: The U.S. Navy has a specialized mission to support the Special Operations Force (SOF), and Amphibious Operations. This includes preparing, training and equipping specialized Navy teams to support the SOF in countering unconventional military threats. A vital part of this specialized mission is communication for which solutions are solicited. Primarily, the proposed approaches should address portability, ease of operation, maintenance and susceptibility to counter-measures, and Near Vertical Incidence Skywave (NVIS) operation. The operational applications include man-portable, land vehicles, boats and underwater requirements.

N90-278 TITLE: Miniaturized Antennas and Radio Frequency (RF) Components

CATEGORY: Advanced Development

OBJECTIVE: Develop miniaturized RF components.

DESCRIPTION: All RF systems (radar, communications, ECM, Navigation, IFF, etc.) have undergone tremendous miniaturization during the last few decades. The greatest changes may still be underway, with VHSIC making major contributions. However, the size of RF components such as filters, antennas, duplexers, multicouplers, isolators, etc., have not been significantly effected. It is obvious that the greatest possibility for future miniaturization is in the RF component field. Innovative approaches to this problem are being solicited for all RF components where significant (over 50%) miniaturization can be achieved.

N90-279 TITLE: Solid-State X-Band Radar Transmitter

CATEGORY: Exploratory Development

OBJECTIVE: Develop a modular, solid-state, x-band radar transmitter.

DESCRIPTION: Innovative ideas are being sought on the feasibility of developing an X-Band radar transmitter using solid-state modular components. The following parameters are the performance goals for the transmitter:

120 KW Peak
180 W Avg
9.0-9.2 GHz
0.25 us Pulse
6000 PPS

The modular power amplifier can consist of either existing components or components of own design which can be driven at the required frequency and combined to produce the required total power output to a waveguide. For the purpose of this exploratory development, the number of modules, size, and weight are not restricted. However, future design requirements will include these considerations.

N90-280 TITLE: Message Compression

CATEGORY: Engineering Development

OBJECTIVE: Successful software development would lead to the development of message compression algorithms and significant savings in terms of circuit capacity and throughput over currently operated satellite channels.

DESCRIPTION: Most of the communications bandwidth in the Navy is dedicated to record message data and bit oriented computer data exchange. Innovative techniques based on algorithms implemented in communications processors will help to more efficiently utilize the Navy's allocated communications circuits. The development effort shall demonstrate the capability to compress message and bit oriented data by an order of magnitude with the ability to provide performance in the Navy environments. Environments to be characterized shall include but not be limited to Gaussian and bursty type noise distributions characteristic of current circuit operations. The feasibility demonstration shall be run using actual message and bit oriented data to be provided by the government.

Phase II of the effort shall address incorporation of the tested algorithms in current fleet communications systems. The task/work security level of this effort is SECRET.

N90-281 TITLE: High Data Rate Satellite Communications

CATEGORY: Advanced Development

OBJECTIVE: Successfully develop increased communication data rates with the Navy UHF SATCOM systems.

DESCRIPTION: To achieve the objective, an analysis and architecture study is to be performed to maximize communication data rates between naval surface and shore nodes using UHF SATCOM. The areas of investigation will include adaptive shipboard antennas, advanced modulation techniques, and optimum satellite channel bandwidth assessments. Minimum throughput improvement by a factor of 2 to 3 (i.e., approximately 54 kbps or above) is anticipated. In addition, throughput improvement will have an impact on shipboard terminal size due to the ability to use on equipment at a high data rate rather than multiple equipments at lower bit rates. The task/work security level of this topic is SECRET.

N90-282 TITLE: Small Ship UHF Antennas

CATEGORY: Engineering Development

OBJECTIVE: The successful prototype testing of a small ship UHF antenna would lead to the installation of antennas aboard small ships to support the eventual installation of UHF DAMA.

DESCRIPTION: Innovative techniques and concepts are required to provide for a follow-on UHF SATCOM antenna system which is compatible with small ships (e.g., DDG-51, MCM, PHM). The new antenna must have the potential capability to be retrofit on existing platforms and the performance characteristics necessary to communicate via Demand Assigned Multiple Access (DAMA) processed satellite channels. This effort will require the identification of current and projected small ship antenna related operational requirements. Based on these operational requirements, an antenna specification will be developed. When considering upgrades, existing Navy/DOD UHF SATCOM equipment shall be used or modified. When existing Navy/DOD equipment cannot be used or modified, analysis shall justify proposed alternatives. From this specification a light weight, high gain, satellite tracking UHF SATCOM antenna prototype will be developed and tested to satisfy the small ship communications requirements.

N90-283 TITLE: Graser Communication System

CATEGORY: Research

OBJECTIVE: Determine the feasibility of using Grasers for communications and conduct initial research into Graser transmitters/detectors leading to a complete communications system.

DESCRIPTION: The Satellite Laser Communications (SLC) program has developed a space qualified blue/green laser to communicate with submerged objects. Gamma X-Ray Lasers (Grasers) have been shown to have potential as a weapons system. Grasers, which are the size of a hockey puck, are theorized as being able to destroy a missile. Research is sought into the applicability of Grasers for communications. It is felt that a pellet size Graser can be used for communications. This could lead to an easily reconstitutable and survivable communications system due to the transmitter size.

N90-284 TITLE: Network Control

CATEGORY: Research

OBJECTIVE: Identify network access control protocols needed for a communication system with multiple satellites and multiple fixed, mobile, and transportable satellite access nodes.

DESCRIPTION: A communications system with multiple satellites and multiple fixed, mobile, and transportable nodes requires an access control protocol function to regulate nodal access to the communication system. In one scenario, the fixed nodes may be designated as the primary communication system controller and would share the satellite resources. The mobile and/or transportable nodes would be relegated to operate as a backup to the fixed sites. In other scenarios, primary control may reside with the mobile and/or transportable nodes. Offerors are to identify network access protocols needed for this multi-node system during various operational scenarios. Implementation of the network access control protocol should also address covertness and anti-jam capabilities.

N90-285 TITLE: Economical Environmental Performance Modifications to Commercial and NDI Equipment for Shipboard Command and Control Functions

CATEGORY: Engineering Development

OBJECTIVE: Data is needed to enable an estimation of the effectiveness, cost and schedule impact of possible modifications that can be applied to commercial and NDI computer and peripheral equipment to improve environmental worthiness. It is desired to present such data in a handbook that can be readily used by analysts.

DESCRIPTION: Shipboard command and control systems that employ information processing and display hardware and perform tactical functions must provide sufficient environmental worthiness to operate effectively in the intended shipboard environment. However, environmental performance that is fully compliant with MIL-STDs may exceed required performance and may not be compatible with affordability and constrained schedules. The new Navy instructions on procurement of Non-Development Items (NDIs) dictate that tailoring of MIL-STDs is required if significant cost or schedule benefits can be derived. A trade off analysis of candidate NDI performance, cost and schedule is a required step in formal program planning. Candidate NDI systems may have the potential of providing fully satisfactory environmental performance with application of relatively simple physical modifications. Examples of such modifications could include bracing and padding of printed circuit boards, card cages and equipment covers to protect against shipboard vibration and shock; methods of coating, re-soldering, component substitution, and other means of protecting electronic components from the effects of humidity; dust protection with improved filtering systems and maintenance practices; reduction of electromagnetic interference effects with suppression devices and materials. The contractor shall select environmental specification areas for which documented results are available from own company experience and other creditable sources.

Experimental efforts may be required in Phase II of the program to demonstrate and validate proposed techniques.

N90-286 TITLE: Tradeoff Issues in Massively Parallel Implementations of Real-Time Federated or Distributed Navy Warfare Systems

CATEGORY: Exploratory Development

OBJECTIVE: To determine how the Navy can make best use of new, massively parallel computers in real-time applications.

DESCRIPTION: The Navy's ever increasing requirement to process more data, in shorter times, with improved accuracy will soon outstrip the capabilities of existing standard Navy computers. The need for faster, more sophisticated computer equipment will become ever more pressing. The latest generation of massively parallel computers is expected to help fill the Navy need. However, there is little, if any, knowledge within the Navy of how to apply these new systems to Navy applications. Research is needed to determine the hardware and software tradeoff issues involved in using these massively parallel computers for real-time Navy federated and/or distributed warfare systems, and to identify any unique software implementation techniques required to use parallel computing effectively.

N90-287 TITLE: Workstation Architecture as a Function of Open Systems Architecture in Future Warfare Systems

CATEGORY: Exploratory Development

OBJECTIVE: To determine the impact of the Open Systems Architecture philosophy on workstation technology, and how these technology innovations can be best implemented in future warfare systems.

DESCRIPTION: Two of the most far reaching recent developments in warfare systems design have been the use of the Open Systems Architecture (OSA) philosophy in the design of computer systems, and the advances in workstation technology that make their use in warfare systems so important. As yet the application of OSA has not been fully exploited in the development of workstations, and very little work has been done in the area of OSA workstations for use in warfare systems. The issues of survivability, maintainability and reliability, vital to warfare systems, may not be adequately addressed by commercial developers. Additionally, the ability to tailor OSA compatible workstations to meet specific needs from available and planned capabilities can insure that operational currency is maintained. Work is required to ensure that these issues are addressed adequately and any requirements peculiar to warfare systems are taken into account when OSA workstations are developed for use in warfare systems.

N90-288 TITLE: Directional Communication and ECCM Obtainable Through Architecture in Future Warfare Systems

CATEGORY: Advanced Development

OBJECTIVE: To provide an adaptive, electronic, counter-counter-measure in communications by utilizing randomly located phased-array elements to obtain a high directivity gain to many authorized receivers, simultaneously, but not to a hostile intercepter.

DESCRIPTION: A receiver system which can coherently sum information transmitted from multi-randomly-located antennas is desired in an ECM environment. Each antenna would be capable of operating at a different frequency and the receiver would be

capable of coherently summing signals from these randomly located antennas. It is desirable that the receiver system would, in effect, provide a beam pointing toward the antenna cluster providing highly directional communications. Each element of the antenna cluster should be capable of transmitting the same information at different frequencies based on a coded basis, thus spreading the information over a wide frequency band. The system then benefits from both an equivalent high gain transmitting antenna and a wide RF bandwidth. The feasibility of such a technique or system needs to be explored. The potential advantages in the chosen technology in the presence of real-life noise and its practical limitation, if any, need to be determined analytically.

Elements of the prototype system, which are high risk, should be tested during Phase II.

N90-289 TITLE: Adaptive Diversity Reception at HF

CATEGORY: Advanced Development

OBJECTIVE: To implement a signal processing system for HF shipboard and shore communications that will adaptively avoid signal fading due to multipath, including the ground or ocean, reflected signals.

DESCRIPTION: HF communication signals can undergo fading because of mutually interfering signals arriving at the receiving antenna through various propagation multipaths that may include the ground or ocean reflected propagation path. Often the amplitude and phase changes of the signals introduced by multipath can be severe and unpredictable. A diversity reception system using multiple antennas has been used to minimize fading at times, but such an arrangement is not adaptive and cannot accommodate rapidly varying multipath signals. An adaptive technique or system that can coherently sum the useful multipath signals to avoid fading and enhance the effective signal-to-noise ratio of the received signal is desired. The feasibility of such a technique or system needs to be explored. The potential advantages in the chosen technology in the presence of real-life noise and its practical limitation, if any, need to be determined analytically.

Elements of the prototype system, which are high risk, should be tested during Phase II.

N90-290 TITLE: Natural Operator Input Techniques for Undersea Surveillance Systems

CATEGORY: Advanced Development

OBJECTIVE: Develop techniques that allow the undersea surveillance operator to use natural gestures and writing skills to enter information into and control computer-based systems (e.g., annotations on displays, select from menus, identify acoustic features of interest, etc.).

DESCRIPTION: The Navy has a continuing need for computer-interface designs that simplify the operator's task and reduce the training required to operate complex undersea surveillance equipment. Progress has been made in non-military R&D in using touch-sensitive screens on horizontal display surfaces (CRTs, LCDs, etc.) to record and instantly display the natural motion and writing gesture of the operator as if the operator were writing on a piece of paper instead of a horizontal computer display screen. Further development and application of these techniques to the undersea surveillance operator interface would allow annotation of computer displays just as paper systems are currently marked and would provide easy, natural menu selection and feature identification techniques.

A Phase I effort would require technique design and implementation on existing Navy laboratory equipment to demonstrate the feasibility of the technique with current surveillance system procedures.

A Phase II effort would require further design, technique development and prototyping of equipment specifically selected for natural gesture recording and instant display.

N90-291 TITLE: A Prototype Ada Repository for Command and Control Software Components

CATEGORY: Advanced Development

OBJECTIVE: Software for Navy Command and Control systems is a major product of the Naval Ocean Systems Center. Ada, the programming language mandated for use by the Department of Defense, is now being used in the development of Navy Command and Control systems. Due to a limited number of software engineers, an increase in software being developed, and a shrinking Department of Defense budget, it is critical to gain maximum utilization of our limited resources. One such gain may be in the area of reusable software components. While the information to be processed by the myriad systems currently under development may be unique, many of the capabilities provided by these systems are similar. Being able to design, develop, store and retrieve reusable software components which satisfy the functionality of command and control systems will aid the software engineering in curtailing software costs while contributing to software development productivity. The elements of this effort will include hardware, software tools, a repository of existing reusable components and software engineers assigned to a command and control software development program. The objective is to provide a prototype system that can be easily accessed by software engineers to provide software components for possible reuse in the development of new Command and Control systems.

DESCRIPTION: Phase I: Through domain analysis, specific operations of Command and Control software will be identified and grouped. An example of such functionality may include message origination, message parsing and database updating. A design of a database for Ada software components, a design for the retrieval of the information and tools to assist the software engineer would be specified and made available. The format and method for acquiring software component descriptions, techniques to identify a taxonomy and to locate relevant components, and identification of naming conventions will be developed.

Phase II: Ada software components will be acquired to fill and test the prototype. The system will be made available to software engineers and metrics associated with the use of the prototype will be gathered. An evaluation of these metrics as well as an evaluation of the repository itself will be used to enhance the prototype. Analysis of this information will improve understanding of the policies, methods and tools needed to encourage reuse of Ada software.

Phase III: A follow-on phase will identify methods to improve the organization and expert system tools to aid in the retrieval of information. Additional software components will be identified and added to the software repository; selected components may also be deleted.

N90-292 TITLE: SAFENET Performance Evaluation

CATEGORY: Advanced Development

OBJECTIVE: The objective of the topic is to provide the Navy with an approach for evaluating the performance of the Navy's Survivable Adaptable Fiber Optic Embedded Network II (SAFENET II). Phase II of this topic will develop a software tool which utilizes the method developed in Phase I.

DESCRIPTION: The Navy is developing a standard Local Area Network (LAN) known as SAFENET II. SAFENET II will provide the Navy with an efficient means of communication among its Mission-Critical Embedded Computer Systems. This LAN will replace a large number of point-to-point computer interfaces that currently connect Naval systems both afloat and shore-based. No modeling and analysis methods and tools are currently available for analytically evaluating the performance and design of communication networks such as SAFENET II. The main focus of this topic is to develop a method and a supportive tool which will enable the Navy to analytically evaluate the performance of SAFENET II. The resultant method and tool shall provide important network measures of performance such as the maximum average and variance delay of each message class. Analytic techniques are preferred to simulation because of the simplicity of modeling inputs and outputs in terms of mean steady-state measures of performance. The method shall consist of a technique for applying queueing theory results and algorithms derived from queueing theory. The performance tool shall automate this method.

Phase I of the effort would develop new analytical performance evaluation algorithms for determining the key values of network performance. These key values shall at least include maximum and average message delay, utilization, and maximum and average queue length at each member of the network.

Phase II of this topic shall apply the techniques and results of Phase I work into a software tool suitable to be used by the Navy to evaluate SAFENET II.

N90-293 TITLE: Advanced Receiver Technology

CATEGORY: Advanced Development

OBJECTIVE: To solicit new concepts and approaches in receiver technology which satisfy current deficiencies in size, weight, phase coherency, rapid scanning, programmability, adaptability, and receiver processing of sophisticated signal formats.

DESCRIPTION: A need exists to refine the architecture and organization of surveillance/targeting receivers to detect, classify, and identify a wide range of radar emitters. Determination of frequency, power, deviation, data rate, pulse length, pulse interval, angle of arrival of the signals need to be determined. The methods of search, acquisition, and track must be addressed, with plans for maximizing the throughput of usable data, while achieving rapid acquisition. A system of autonomous operation for the accurate direction finding/location, classification and identification of radio emitters as applied to drone aircraft and missiles requires improved solutions.

Phase I should address methods and means which can be applied to markedly improve the function of receiver/processing systems for rapid search, acquisition, and track of sophisticated RF emitters. Phase II should use the approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

N90-294 TITLE: Advanced Passive RF Surveillance/Targeting Assessment Methodology

CATEGORY: Advanced Development

OBJECTIVE: To develop an interactive encounter model of representative threat electronic environments and Own Force Active/Passive RF surveillance/tracking systems for use as an evaluation tool in assessing system capabilities and their effect on Own Force operations and tactics.

DESCRIPTION: There is a need for the development of an advanced methodology capable of assessing electronic surveillance/tracking systems in representative scenarios typical of the anticipated environment in the post 1990 time frame. The emphasis of the methodology should focus upon detailed modeling of the nodes comprising the systems under evaluation, yet interface at the macro level for the global aspects of the encounter/scenario. The modeling of the threat electronic environment and the interaction of Own Force Active/Passive RF surveillance/tracking systems will allow the assessment of the quality and extent of the surveillance/tracking data in various benign and cluttered environments. Emphasis should be placed upon assessing advanced passive RF systems and their use upon Own Force covert operations and tactics. Critical system parameters and their comparative measure of performance require assessment. The comparative evaluation of those unique technologies/systems capable of providing improved effectiveness form the basis for continued development of electronic defense systems.

Phase I should identify the characteristics and methodology which can be applied to markedly improve the ability to assess the viability and performance of passive RF surveillance and tracking systems.

Phase II of this effort should use approach defined in Phase I to develop and deliver hardware/software to the government for test and evaluation.

N90-295 TITLE: Protective Coatings on Aluminum for High-Efficiency Heat-Transfer Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop a protective coating for aluminum alloys which has abrasion resistance and corrosion resistance comparable to commercial hard anodic coatings but high thermal conduction. Such a process will be used to protect expensive marine propulsion hardware, currently under development, which require very high-efficiency heat-transfer.

DESCRIPTION: The Navy has a need for a protective coating for aluminum alloys which is extremely hard, and has very good abrasion resistance, corrosion resistance, and thermal conductivity. Anodized aluminum coatings (Military Specification MIL-A-8625C, TYPE III) have been used for years to protect Navy equipment from the effects of corrosion and abrasion. The thermal conductivity of typical commercial anodic coatings (produced in sulfuric acid based electrolytes) has been found to be very low, 0.3-0.6 BTU/hr/ft/F or 0.5-1.0 W/m/K. Developmental marine propulsion systems require very high-efficiency heat transfer from the condensing section to seawater. An improved thick anodic coating or other coating of inert material is required for protection against an abrasive and corrosive marine environment.

The coating must provide protection against the effects of abrasion and corrosion equal to or greater than that of commercial hard anodic coatings, but have a thermal resistance per unit area significantly less than that of a 2 milli-inch, thick hard anodic coating. A reduction in thermal resistance per unit area of at least a factor of 3 is desired. The coating must be inert or non-metallic in order to avoid electrolytic corrosion effects between dissimilar metals in a saltwater environment. Also, the coating must provide corrosion protection equivalent to a typical 2 milli-inch thick commercial anodic coating, sealed using a standard hydration technique. The temperature of the aluminum part to be coated must remain low enough during the coating process that the wrought aluminum alloy (typically 6061-T6) does not lose its temper. Ultimately, the process must be capable of coating an aluminum surface area of several hundred square inches.

In Phase I preliminary tests will be performed to demonstrate a process that will have the potential of satisfying the above requirements regarding thermal transfer and abrasion resistance.

In Phase II the process will be optimized to obtain a process which will provide the best coating possible for the above application. Effectiveness against corrosion and abrasion will be demonstrated. Also, tests will be performed to determine the operating conditions necessary to produce consistent coatings in a commercial setting.

N90-296 TITLE: A Tethered Floating Fiber Optic Periscope for Submarines

CATEGORY: Exploratory Development

OBJECTIVE: Submarines are most vulnerable while viewing with the periscope. The object is to devise and construct a retractable/disposable floating periscope system tethered via a suitable fiber optic cable, to a distant submarine, that has full image stabilizer and lock-on target features.

DESCRIPTION: Several high resolution charge coupled device (CCD) cameras, with lock on target features, jointly scanning the 360 degree field of view, convey digitized images, via a low db, single mode, fiber optic cable, to a closed circuit (C.C.T.V.) network aboard the distant submarine.

The scanning camera's lock-on features along with a small gyroscope, or recently used camera accelerometers, should jointly compensate for bounces, jitters, noises, etc. -- due to the ocean waves. Fiber optic systems offers opportunities for

video signals from day or night vision systems, and from thermal imagers, to be brought from the periscope head, through the pressure hull for distribution where required throughout a submarine. This would allow designers to place the control room at the optimum location in the craft, not necessarily directly beneath the sail. A submarine commander could remain seated at a control console from which he and other command team members could view the surface scene on a large screen display (LSD) presentation. The screen could also display data from other sensors and onboard tactical data bases.

During the SBIR Phase I, only the feasibility of the topic will be examined.

During Phase II, however, the full scale of the system shall be tried where test and evaluation will be included. This retractable/disposable floating periscope could be camouflaged deceptively for tactical and operational use. This potentially low cost device (perhaps lower cost than a torpedo) may be retrieved, disposed of, or even destroyed as the tactical situation requires.

N90-297 TITLE: Voice Messaging and Response for Naval Ashore and Afloat Operations

CATEGORY: Engineering Development

OBJECTIVE: This objective is to develop a system that improves operational efficiency ashore and afloat by providing the means to send and receive verbal information and commands reliably and without time wasted waiting for the intended receiver or repeating messages for multiple receivers.

DESCRIPTION: Naval operations require sending and receiving numerous verbal messages and commands. Advanced voice messaging and response systems optimized for naval operations would improve operational efficiency measurably. These systems can include many difference features which can be incorporated in many different ways. Which features to include and how to implement them, on what hardware, using which software, with what security features, are questions that need to be answered before a system can be designed, built, evaluated, and installed. The major features of theses systems are described along with some of the problems they address. When an immediate response is not required, the ability to leave a recorded message eliminates the sender's waiting time and frees up the lines for the messages requiring immediate response. Also messages can be composed off-line and then sent at a rapid rate which serves to relieve congestion on the lines. Auto attendants can reduce the time and personnel required to make connections. Intelligent routing can send a single message to many people, thus eliminating the time and effort for repeat calls. Personal assistants for secondary call answering can provide call transfer, verbal alert to secondary person that transfer call is coming in, notification to caller that transfer is occurring, and voice messaging on command if needed. Remote pagers can alert and inform the intended receiver when away from the workstation, reducing time to make contact and eliminating search efforts. Scratchpad capability permits the caller or receiver to record parts of their conversation for recall. Much information that is requested is database data which can be obtained or entered without a second person in the loop. Interactive "mailboxes" can be programmed with prerecorded questions to obtain database information in the required format. Voice messages and keypad entries can be combined to optimize interactions, such as sorting messages by coded input, redirecting calls by selecting keypad entry from recorded voice menu, providing priority, entering and receiving database information, and access voice bulletin boards.

The Phase I effort should address operational requirements for voice messaging and response and a survey of available hardware/software with small scale testing to evaluate various features.

The Phase II effort should set-up a large scale demonstration system that would be tested in a simulated ashore or afloat naval operation. The work security level for the systems analysis would be secret, the other tasks would be unclassified.

DAVID TAYLOR RESEARCH CENTER

N90-298 TITLE: Marine Paints with Icephobic Properties

CATEGORY: Exploratory Development

OBJECTIVE: Develop topcoats for naval ships that exhibit inherent icephobic properties.

DESCRIPTION: The nation's Maritime Strategy requires the U. S. Navy to operate surface ships at latitudes where environmental conditions conducive to significant topside icing is expected to be encountered. Designing ships to accommodate large ice loads is unrealistic and ships presently in-commission were not designed with the objective of sustained operation in such conditions. Icing will cause impairment of mission and ship operation capability and in the extreme, place personnel safety at risk. State-of-the-art icephobic coatings have demonstrated that it is possible to retard the formation of ice. Undoubtedly these coatings will become more efficient. However, these coatings are parasitic in nature and intrinsically create a maintenance burden. The application requires manpower, renewal is required and their appearance requires that the coatings be removed when the ship is not operating in an icing conducive environment. Modification of marine topcoats to enable them to prevent and/or significantly retard the accretion of ice would significantly contribute to the readiness of all U. S. Navy ships to operate in the northern latitudes without the pre-deployment and post-deployment manpower burden associated with presently available icephobic coatings. Environmental conditions

conducive to severe icing can infrequently develop in lower latitudes. Having a marine top coat with an intrinsic resistance to ice accretion will provide a built-in safety margin in unanticipated environmental situations. Program phases would be as follows:

Phase I - coating development, compatibility with existing Navy paint system, water contact angle, weatherometer tests.

Phase II - anti-icing, ice adhesion, ice impact removal, ice chamber tests; test panel/patch tests aboard ship, application and maintenance requirements.

N90-299 TITLE: Composite Gearcases for Ship Main Propulsion Gears

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the feasibility of advanced composite materials to reduce weight, noise and vibration of main propulsion gear cases.

DESCRIPTION: This effort will investigate and establish the feasibility of employing advanced polymer and/or metal-matrix composite materials to reduce the weight and enhance the vibration and noise damping characteristics of Navy gearcases, for both parallel shaft and epicyclic gearing arrangements. This effort will explore the suitability of advanced composite materials using constrained layer damping to provide adequate structural integrity and bearing support under normal and high impact shock loading conditions. Methods for controlling the stiffness of the gearcase and its interconnection with the ship's structure when operating in heavy seas and under shock loading conditions should be developed and analyzed.

N90-300 TITLE: Optical Fiber Inspection System for Composite Propulsion Shafting

CATEGORY: Exploratory Development

OBJECTIVE: To develop a standard, low-cost method of monitoring for composite shafts that will allow assessment of performance, damage and damage growth in composite shafts.

DESCRIPTION: The Navy is currently demonstrating the feasibility of a standard family of filament-wound, composite propulsion shafts incorporating continuous carbon and glass filaments in a thermosetting epoxy resin matrix. A low-cost enhancement to the "standard" composite shaft is required using a fiber optic maintenance monitoring system to assess performance and damage location/growth. The monitoring system would involve an optical fiber selection and optimization for composite shafting, determination of appropriate optical fiber spacing, and small-scale demonstration of the system in a small-diameter composite shaft to modify Navy standard specifications. The fiber optic system would receive standard light emitters with a demonstration of system practicality.

References:

(1) G. Whilhelmi, W. Appleman, and F. Loo, "Composite Shafting for Naval Propulsion Systems", Naval Engineers Journal, July 1986.

(2) R. Crane, A. Macander, and J. Gagorik, "Fiber Optic Damage Assessment System for Fiber Reinforced Plastic Composite Structures" DWTNSRDC Rpt Sme-82/92, Nov 1982.

N90-301 TITLE: Composite Acoustic Enclosure for Intercooled Recuperated (ICR) Gas Turbine Engine

CATEGORY: Exploratory Development

OBJECTIVE: Develop a lightweight composite acoustic enclosure for the advanced ICR gas turbine engine.

DESCRIPTION: Develop a composite acoustic enclosure for the ICR gas turbine engine. The enclosure should meet the following operational requirements:

1. 84db(A) noise external to the module.
2. 135 F maximum external skin temperature.
3. Withstand a 7 psig peak overpressure resulting from a blast.
4. Prevent nuclear, chemical and biological contamination of the engine room.
5. Protect the engine in the event of engine room flooding.
6. Stop a turbine blade or metal splatter if the engine overspeeds to destruction.
7. Protect the engine room from an internal gas turbine fire or fuel spray leak and vice/versa.

Complete concept design, material selection, and propose development plan.

N90-302 TITLE: Atomized Liquid Filtration for Air Contamination Control

CATEGORY: Exploratory Development

OBJECTIVE: This task would investigate emerging technology in the area of filtration by atomized liquids to develop low impact, shipboard air filtration equipment for use in permanently installed and portable systems that will enhance survivability.

DESCRIPTION: Reduced survivability can result from the hazard to personnel and equipment from Chemical, Biological and Radiological (CBR) warfare agents, the loss of visibility in smoke from fires, and the damage to equipment from the intake of missile exhaust. The damage in all of these examples is created by small particulates (0.01 to 10 microns) and vapors. Filtration of these materials is beyond the capabilities of conventional shipboard systems. Systems developed recently to address these problems use highly efficient barrier type filters to control particulates and activated carbon to physically adsorb vapors. These systems require large amounts of shipboard space and impose increased pressure drop on the ventilation system which has required the development and installation of specialty fans. The filtration performance and useful life of these filter systems are adversely affected by the marine environment.

Atomized liquid spray filtration systems address the deficiencies of the current systems. Pressure drop across the liquid spray is low because there is no obstruction to the airflow; thus the system will require less space and can operate with conventional ventilation fans. The pressure drop does not increase with time because there is no buildup of particulate on a filter media; the contamination is carried from the filtration site by the liquid. The condition of the liquid can be monitored and maintained so that filtration efficiency is maintained with time. Filtration efficiency of the spray is not affected by humidity in the marine environment as is the case with carbon filters. Theory and experiment indicate that high velocity, atomized liquid droplets are required to efficiently filter particulate in the size range of concern. Atomized liquid droplets will also provide the large liquid surface area for vapor absorption which is normally provided by special packing materials in conventional liquid scrubbing towers. Initial efforts should be directed toward identification and development of effective and practical techniques for the generation of high velocity, atomized liquid droplets and evaluation of these techniques for filtration of specific shipboard contaminants. Follow on efforts would develop small scale, ship configured, prototype equipment for laboratory evaluation.

NAVAL AIR TEST CENTER

N90-303 TITLE: Programmed Control of Seaborne Targets

CATEGORY: Engineering Development

OBJECTIVE: A programmable control system for seaborne powered targets to eliminate line-of-sight manual remote control, thereby enabling testing certain weaponry, mission profiles and in operating areas now prohibited. A market for this type of target control, as well as for the logical subsequent development of long range tracking and manual target control, exists throughout the military in the U.S. and friendly nations.

DESCRIPTION: Air-to-surface weapons are tested by firing against small (18 to 55 foot) powered target boats and powered target hulks. These targets are remotely controlled by operators who must be within line-of-sight. Safety of the operators requires safe distance stand-off requirements which severely limits the types of weapons, mission profiles, and the operating areas of these tests. In addition, manual remote control results in inaccuracies and is tedious for the operators. A system is needed that can be programmed with the test profile and autonomously control the target. Development of this system will require the interfacing the technology of target control/autopilot systems with maritime positioning systems such as LORAN-C or satellite navigation. Capability to shut down the target at all times is required.

Phase I requires research of relevant technologies, specification of the system, drawings and possibly a working model.

Phase II will require production of a prototype system and its test on the QST-33 or QST-35 target boats at the Naval Air Test Center.

N90-304 TITLE: Solid State Digital Voice/Data Recorder

CATEGORY: Engineering Development

OBJECTIVE: Develop a prototype recording device utilizing data encryption and data compression, and capable of storing 15 minutes of aircraft flight data along with one channel of voice communications. This prototype will transition into a compact, lightweight, reliable, crash survivable flight data recorder which will be much in demand for both military and civilian aircraft.

DESCRIPTION: Data recovered from a flight data/voice recorder is needed for analysis after an aircraft crash or incident and for monitoring of aircraft maintenance, fatigue, loads and stress. Current flight data voice recorders, for both military and civilian aircraft, employ analog magnetic tape memory technology. These recorders are unreliable, large, heavy, and may not survive a crash. The causes of many crashes go unresolved due to insufficient or nonexistent recorded data. Digital solid state non-volatile memory

technology has recently become available for use in flight data/voice recorders. Employing this technology should result in a compact, lightweight, reliable, crash survivable recorder.

Phase I requires research of existing data compression technology, data encryption methodologies, and high density non-volatile memory devices, and the design and building of a brassboard recording device to demonstrate the results of the research.

Phase II will require the development of a complete flight data recorder capable of interfacing with standard military and civilian aircraft data buses, and flight test demonstration at the Naval Air Test Center.

N90-305 TITLE: Synthetic Rope for Helicopter Rescue Hoists

CATEGORY: Advanced Development

OBJECTIVE: Develop a non-metallic rope for use in helicopter rescue hoists and which will prevent the electrostatic discharges which often injure ground personnel. A large market, both military and civilian, exists for this type of rope for use in almost all helicopters equipped with hoists.

DESCRIPTION: The wire rope used on helicopter hoists presents a safety hazard to ground personnel because of dangerous electrostatic discharge. Additionally, wire rope is heavy and subject to both kinking and corrosion. Synthetic materials such as Kevlar and Spectra are promising candidates for a light weight, strong, electrostatic free rope; however, conductive contaminants can be entrapped in a rope of such materials. Research is needed to develop a synthetic rope with a coating which will bond sufficiently well to withstand hoist cycling under load. The rope should be mechanically equivalent to existing hoist wire rope; however, modifications to the mechanics of the hoists are allowed. Electrostatic nonconductivity or attenuation should be in accordance with MIL-STD-810C.

Phase I will require research and experimentation in the development of the rope.

Phase II will require the production of sample quantities of the rope and testing at the Naval Air Test Center.

NAVAL AVIONICS CENTER

N90-306 TITLE: Threat Missile Simulator Technology

CATEGORY: Exploratory Development

OBJECTIVE. To improve the performance of threat missile simulators while reducing size and weight. These improved threat missile simulators will be required by the Fleet Electronic Warfare Support Group for improved missile defense training. Plans to mount these threat missile simulators internally in aircraft will require significant size and weight reductions.

DESCRIPTION: Procurement is in process to lease/buy commercial aircraft to replace Navy aircraft presently flown by the Fleet Electronic Warfare Support Group. These commercial aircraft will use internally mounted threat missile simulators for fleet training. The AN/ALQ-170 threat missile simulator is in a 17 foot, 28 inch diameter pod which weighs 1800 pounds. The pod shell weighs 600 pounds. The remaining 1200 pounds of electronics needs to be reduced in both size and weight for the proposed internal aircraft installations. The AN/ALQ-170 threat missile simulator was designed using 1980 technology with no emphasis on size/weight reduction.

The goal of Phase I is to develop concepts and technology approaches to reduce the size (volume) by 50% and reduce the weight by 40% while enhancing threat replications and versatility.

If successful, the concepts and technology will be demonstrated under a Phase II effort and transitioned into production of internally mounted threat missile simulators and used by the Fleet Electronic Warfare Support Group for improved missile defense training.

N90-307 TITLE: High Effective Radiated Power (ERP)

CATEGORY: Exploratory Development

OBJECTIVE: To provide a high RF energy source for training Navy electronic warfare personnel. This RF source will be achieved by utilizing the existing RF microwave amplifiers and improving the ERP of the overall system. Specifically, the antenna gain in a narrow portion of the E/F Band will be considerably enhanced.

DESCRIPTION: The present AN/ALT-40 Airborne Jammer Simulator provides realistic EW training and R&D support to Naval personnel and programs. A requirement exists to provide a high energy RF source in specific areas of the RF spectrum. This

capability can be achieved by development of special narrow band high gain antennas to be used with the present AN/ALT-40 microwave amplifiers.

Phase I should investigate the feasibility of the Phase II development of such an antenna. If successful, this antenna will be integrated into the production AN/ALT-40 system and provide enhanced EW training to the Navy.

N90-308 TITLE: Integral Circuit Board/Frame/Heat Sink

CATEGORY: Exploratory Development

OBJECTIVE: Combine several newly emerged technologies to create a high thermal dissipation, highly reliable, integral circuit board/frame/heat sink technology. If successful, this technology could be used in high power electronics with difficult cooling requirements, especially in military avionics.

DESCRIPTION: Modern high power electronics modules dissipate a considerable amount of heat. In standard electronic modules (SEM) and other forms of integrated rack electronics where conductive, cold wall cooling is used, getting the heat out is difficult. Conventional printed wiring board on frame requires that the printed wiring board be glued to the frame. The adhesive always has a poor thermal conductivity as do most printed wiring boards. Normally, frames are machined from aluminum for light weight and high thermal conductivity. The advent of aluminum based metal matrix composites technology means that the potential exists for material specially tailored to the task of high thermal conductivity backplanes. Creation of thin coatings of ceramics (or even diamond) on large substrates are possible, these could provide isolation for circuit panels created directly on the frame. There are several new techniques for creating conductive traces directly on substrates. Combining these technologies could lead to an order of magnitude improvement in thermal performance.

Phase I would involve the examination of existing technology and possibly the development of crude concept demonstration prototypes.

Phase II would involve the development of manufacturing techniques and matching design tools aimed at SEM Format E (approximately 5"x 5") and integrated power supply applications.

N90-309 TITLE: Generic Configurable Microprocessor Simulation Methodology

CATEGORY: Exploratory Development

OBJECTIVE: A methodology must be developed to provide processor loading and backplane input and output timing information for various types of microprocessors running Ada software. If successful, this methodology can lead to the development of a generic configurable microprocessor simulation which provides a suitable method to identify problems and risk in complex advanced avionic architectures without actual hardware or software constraints. The microprocessor simulation results could then be combined with avionic system simulations to study the effects on performance of input/output.

DESCRIPTION: A complete simulation of the modular avionics is necessary in the weapon system's conceptual phase to point out problem areas prior to hardware and software integration. This simulation must focus on communications between functions which occur through the processing of Ada software on various microprocessors with communications between these microprocessors over data buses. The effects of data latency on these functions must be the outcome of these simulations to develop a robustness into the avionics system. A modular approach to such simulation is needed, in which microchips, modules and systems are successively simulated. This SBIR focuses on microprocessors and supporting microchips which are candidates for use in advanced tactical weapons systems.

Phase I should develop the methodology necessary to generically simulate the capabilities of any given microprocessor, and provide a description of the requirements needed for this simulation. For example, Ada compiler timings and instructions, the pipeline controls, and/or the cache replacement algorithms should be demonstrated.

Phase II should develop a simulation, collect the requirements and data for several MIL-STD-1750A microprocessors and potential avionic 32-bit microprocessors, such as reduced instruction set computers, and incorporate these data into the simulation.

N90-310 TITLE: Aircraft Storeloader

CATEGORY: Engineering Development

OBJECTIVE: To transport loads to and raise/attach stores on external racks of aircraft quickly with minimal manual exertion.

DESCRIPTION: While there are vehicles and devices that transport and raise stores to aircraft racks, it has been found that they do not work well or quickly enough. The alternative has been for six strong men to form a team, grab the load/store/weapon and muscle it into place on the bomb rack, launcher, etc. The participants are often at risk, and the store is often in jeopardy.

Phase I should study the problem, specify the desired parameters, and suggest/build several alterative devices for consideration in Phase II.

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Systems Command Deputy Chief of Staff for Technology and Requirements Planning. The Air Force SBIR Program Manager is R. Jill Dickman. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of the Air Force
HQ AFSC/XTXC (SBIR Program Manager)
Andrews AFB DC 20334-5000

Do NOT submit a SBIR proposal to the AF SBIR Program Manager under any circumstances.

Send five (5) copies of each Phase I proposal and three (3) additional copies of appendices A and B to the office designated below:

TOPIC NO.	ACTIVITY/ADDRESS
AF90-001 thru AF90-020	MSD/PMR (SBIR Program Manager) Bldg 350, Rm 428 Eglin AFB FL 32542-5000
AF90-021 thru AF90-025	AEDC/PKP Bldg 100 Arnold AFB TN 37389-5000
AF90-026 thru AF90-029	ESD/XTP (SBIR Program Manager) Hanscom AFB MA 01731-5000
AF90-030 thru AF90-051	RADC/XPX (SBIR Program Manager) Bldg 106, Rm B-109 Griffiss AFB NY 13441-5000
AF90-052 thru AF90-056	HQ AFESC/RDXP (SBIR Program Manager) Bldg 1120 Tyndall AFB FL 32403
AF90-057 thru AF90-068	HSD/XART (SBIR Program Manager) Bldg 1155 Brooks AFB TX 78235-5000
AF90-069 thru AF90-073	ASD/XRX (SBIR Program Manager) Area B, Bldg 56, Bay 10 Wright-Patterson AFB OH 45433-6503
AF90-074 thru AF90-075	ASD/VFLH (SBIR Program Manager) Area B, Bldg 56, Bay 4 Wright-Patterson AFB OH 45433-6503
AF90-076 thru AF90-085	WRDC/AAOP (SBIR Program Manager) Area B, Bldg 22, Rm S-110 Wright-Patterson AFB OH 45433-6543
AF90-086 thru AF90-92	WRDC/ELA (SBIR Program Manager) Area B, Bldg 620, Rm C2069 Wright-Patterson AFB OH 45433-6543

AF90-093 thru AF90-106	WRDC/FIOP (SBIR Program Manager) Area B, Bldg 45, Rm 219 Wright-Patterson AFB OH 45433-6543	
AF90-107 thru AF90-121	WRDC/MLK (SBIR Program Manager) Area B, Bldg 653, Rm 406 Wright-Patterson AFB OH 45433-6533	
AF90-122 thru AF90-133	WRDC/POMX (SBIR Program Manager) Area B, Bldg 18A, Rm A-103 Wright-Patterson AFB OH 45433-6563	
AF90-134 thru AF90-135	HQ AFSTC/XNE (SBIR Program Manager) Bldg 497, Rm 239 Kirtland AFB NM 87117-6008	
AF90-136 thru AF90-143	*AFSTC/OLAB (SBIR Program Manager) P O Box 92960 Los Angeles AFB CA 90009-2960	*Hand Delivery Accepted: Bldg A2, Rm 2213-B 2350 East El Segundo Blvd El Segundo CA 90245-4691
AF90-144 thru AF90-146	SAMTO/XOO (SBIR Program Manager) Bldg 8500 Vandenberg AFB CA 93437-6021	
AF90-147 thru AF90-153	AL/TSTR (SBIR Program Manager) Bldg 8353, Rm 116B Edwards AFB CA 93523-5000	
AF90-154 thru AF90-159	GL/XOP (SBIR Program Manager) Bldg 1107, Rm 240 Hanscom AFB MA 01731-5000	
AF90-160 thru AF90-166	WL/PRC (SBIR Program Manager) Bldg 413, Rm 139 Kirtland AFB NM 87117-6008	
AF90-167 thru AF90-183	BSD/MYST (SBIR Program Manager) Bldg 523, Rm 305 Norton AFB CA 92409-6468	
AF90-184 thru AF90-191	*AFOSR/XOT (SBIR Program Manager) Bldg 410, Rm A-119 Bolling AFB DC 20332-6448	*Hand Delivery Accepted: After calling ahead to 767-4969
AF90-192 thru AF90-199	AFSC/NAT (SBIR Program Manager) Wright-Patterson AFB OH 45433-6503	

NO additional technical information (This includes specifications, recommended approaches, and the like.) can or will be made available by the Air Force during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to section 7.1 in this solicitation for further information on DTIC.

Any administrative question regarding the preparation and processing of a proposal should be referred to the Air Force Small and Disadvantaged Business Utilization (SADBU) Specialist identified below:

ACTIVITY	SADBU SPECIALISTS
MSD AFESC	Munitions Systems Division (BC) ATTN: Mr Ralph Frangioni Eglin AFB FL 32542-5000 (904) 882-2843
AEDC	Arnold Engineering Development Center (BC) ATTN: Mr G. Earl Pendley Arnold AFB TN 37389-5000 (615) 454-4407
AFSTC/XNE WL	Air Force Space Technology Center (BCW) Kirtland Contracting Center Kirtland AFB NM 87117-5023 (505) 844-3819
AL	Air Force Flight Test Center (BC) ATTN: Mr James Beucherie Edwards AFB CA 93523-5320 (805) 277-2619
AFOSR	Air Force Office of Scientific Research (BC) ATTN: Ms Louise Harrison Bolling AFB DC 20332-6488 (202) 767-4943
ASD WRDC AFSC/NAT	Aeronautical Systems Division (BC) ATTN: Mr George Laudenslayer Wright-Patterson AFB OH 45433-6503 (513) 255-5422
BSD	Ballistic Systems Division (BC) ATTN: Mr Terence Carey Norton AFB CA 92409-6468 (714) 382-4304
ESD GL	Electronic Systems Division (BC) ATTN: Mr Alan Hart Hanscom AFB MA 01731-5000 (617) 377-4973
HSD	Human Systems Division ATTN: Major Dolores Dever Brooks AFB TX 78235 (512) 536-9006
RADC	Rome Air Development Center (BC) ATTN: Mr Richard Smith Griffiss AFB NY 13441-5700 (315) 330-4020
AFSTC/OLAB SAMTO	Space Systems Division (BC) ATTN: Mr Charles Willett Los Angeles AFB Postal Box 92960 Worldway Postal Center Los Angeles, California 90009-2960 (213) 643-2855

INDEX
DEPARTMENT OF THE AIR FORCE
FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

Munitions Systems Division, Eglin AFB FL

AF90-001 Armament Research

AF90-002 Innovative Electromagnetic Launcher Concepts

AF90-003 Monostatic, Bidirectional Laser Reflectometer

AF90-004 Inertial Guidance Technology Demonstration (IGTD) Seeker Develpment

AF90-005 Critical Humidity Detector and Warning Device

AF90-006 Thermoplastic Binders for High Explosives

AF90-007 Reactive Kill Mechanism Instrumentation and Modeling

AF90-008 Laser Beam Steering Technology

AF90-009 Barrier Coatings for Hermeticity of Encapsulated High-G Electronic Devices

AF90-010 Remotely Monitored Tactical Sensor Suite (RMTSS)

AF90-011 Corrected Optical Window for Missiles

AF90-012 Doppler Signal Processor

AF90-013 Fiber Optic Measurement of Shock Waves

AF90-014 Infrared Image Resolution (IRIR)

AF90-015 Real Time Airborne Flow Visualization

AF90-016 Binary Explosive

AF90-017 Waveguide/Fiber Transmission Lines for Long Wavelength Infrared Sensors for Fuzes

AF90-018 Fault Tolerant Processors for Guided Interceptors

AF90-019 Diamond Films and Coatings for Missile Radomes

AF90-020 Target Neutralization Mechanisms

Arnold Engineering Development Center, Arnold AFB TN

AF90-021 Aerospace Ground Environmental Simulation Testing

AF90-022 Nonconventional Precision Traverse System

AF90-023 Cryogenic High Resolution Linear Actuator

AF90-024 High Temperature Rake Probe for Arc Jet Tests

AF90-025 Submicron Monodispersed Aerosol Generator for Laser Doppler Velocimetry (LDV)

Electronic Systems Division, Hanscom AFB MA

AF90-026 Command, Control and Communications Systems/Subsystems

AF90-027 Tactical Command, Control, Communications and Intelligence (C^3I) Systems/Subsystems

AF90-028 Military Airlift Command Aircraft Mission Planning Workstation

AF90-029 Imagery Compression/Decompression

Rome Air Development Center, Griffiss AFB NY

AF90-030 Highly Programmable Architectures

AF90-031 Spatial Optical Objects

AF90-032 Desktop Thermal Design Evaluator

AF90-033 Integration of Simulated and Measured Vibration Response of Microelectronics

AF90-034 Incipient/Intermittent Failure and Degradation Detection for Cables and Connectors

AF90-035 Multilevel Knowledge Bases

AF90-036 Optical Memories for High-Speed Electronic Computers

AF90-037 Database Administration Assistant

AF90-038 Temperature Monitor for Advanced Electronics Processing

AF90-039 MOCVD Reaction Chamber for Compound Semiconductor Deposition

AF90-040 Electromagnetic Characterization of Superconductors

AF90-041 Vapor Concentration Measurement for MOCVD and MOMBE

AF90-042 Thin Film Permanent Magnets

AF90-043 Near Field Adaptive Array Test Facility

AF90-044 Active Programmable Microwave Directional Coupler

AF90-045 Optical Logic Gates

AF90-046 Photonics Measurements and Calibration

AF90-047 Very High Speed Signal Processor (VHSSP)

AF90-048 Co-site Interference Reduction

AF90-049 Communications Applications for Neural Net Technology

AF90-050 Target Angle Tracking in Adaptive Airborne and Space Based Radars

AF90-051 Constant False Alarm Rate Techniques and Algorithms

Air Force Engineering and Services Center, Tyndall AFB FL

AF90-052 Disposal of Manufacturing Wastes from Composite Materials

AF90-053 Effects of Structures on Toxic Vapor Dispersion

AF90-054 Innovative Concepts for Hardened Aircraft Hanger Doors

AF90-055 Rapid Soil Stabilization

AF90-056 Visual Spectrum Flame Recognition

Human Systems Division, Brooks AFB TX

AF90-057 Human Systems/Subsystems Research

AF90-058 Innovative Analysis Procedures for Environmental and Occupational Health Surveys

AF90-059 Distributed Command and Control (C^2) Research and Decision Analysis Tools

AF90-060 Telepresence Dexterous Manipulator Technology Under Human Control

AF90-061 Crew Station Design

AF90-062 Application of Artificial Intelligence Technologies to Training Systems

AF90-063 Concurrent Engineering

AF90-064 Contingency Task Training

AF90-065 Analysis of Air Force Officer Accession and Retention

AF90-066 Life Support Systems Development

AF90-067 Systems Analysis of Aerospace Medical Technology

AF90-068 Chemical Modeling of Halocarbon Toxicity

Aeronautical Systems Division, Wright-Patterson AFB OH

AF90-069 New Concepts and Innovations for Aeronautical Systems/Subsystems

AF90-070 Artificial Intelligence Applied to Aeronautical Systems

AF90-071 New Concepts and Innovations (NCI) to Enhance the Cost Estimation of Aeronautical Systems/Subsystems

AF90-072 Determination of Effects of Interoperability Issues on Intratheater Airlift

AF90-073 Vulnerability Assessment Techniques for Conceptual Aircraft

AF90-074 Consolidation of Leadless Chip Support for the F-15E

AF90-075 Consolidation of Electrical Standard Set (ESS) Equipment

AF90-076 Maintenance System for Artificial Intelligent (AI) Knowledge Bases

AF90-077 Instantaneous Frequency Measurement (IFM) Correlator Using Optical Approach

AF90-078 Environment Generator for Coherent Radar Hybrid Simulator

AF90-079 Tactical Fighter X-Band Radar Coherent Sidelobe Canceller

AF90-080 Innovative Electrooptical Sensors

AF90-081 Engagement Visualization for Electronic Combat (EC) Simulation and Modeling

AF90-082 Avionics Software Performability (ASP)

AF90-083 Model-Based Vision (MBV) Technology Components

AF90-084 Computer Aided Software Engineering (CASE) Tools for Total-Integration Avionics (TIA) Systems

AF90-085 Application of Multiple Model Adaptive Estimation to Adaptive Navigation

AF90-086 Electronic Packaging and Interconnection Technology

AF90-087 Integratable Die for Advanced Packaging Assemblies

AF90-088 Optical Analog to Digital (A/D) Conversion

AF90-089 Concepts, Models and Techniques for Advanced Multifunctional Optoelectronic Devices

AF90-090 Process Modeling of Microwave Heterojunction Transistors

AF90-091 In Situ Sensors for Semiconductor Processing

AF90-092 Novel Laser Host Materials

AF90-093	Low Profile Capacitance Strain Measurement System for High Temperature Materials
AF90-094	Design Guidelines for Multivariable Flight Control
AF90-095	Stability Theory for Hypersonic Boundary Layers
AF90-096	Thermal Protection Technologies for Hypersonic Crew Escape Systems
AF90-097	Design Criteria for Multidisciplinary Optimization
AF90-098	On-Line Adaptive Networks Applied to Aircraft Control
AF90-099	Postprocessing for Computational Fluid Dynamics (CFD) Methods
AF90-100	Aircraft Tire/Wheel Interface-Load Distribution Measurement
AF90-101	Fluctuating Pressure Loads Definition for Hypersonic Vehicle Structures
AF90-102	Model-Bourne Data Management System
AF90-103	Performance Assessment and Analysis of Rod End Bearing Systems
AF90-104	Airborne Graphics Generation Technology Issues
AF90-105	Unique Light Source for Full Color, Dot Matrix Cockpit Displays
AF90-106	Autostereoscopic Three-Dimensional (3-D) Cockpit Display
AF90-107	Manufacturing as a Natural Adaptive System
AF90-108	Computer Aided Abstract Reasoning for Conceptual Design
AF90-109	Biotechnology for Aerospace Materials Requirements
AF90-110	Advanced Processing for Thermoplastic Matrix Composite Materials
AF90-111	New High Performance Polymers
AF90-112	High Temperature Structural Materials for Advanced Air Force Systems
AF90-113	Improved Nondestructive Evaluation
AF90-114	High Performance Light Metal Alloys and Metal Matrix
AF90-115	High Temperature Superconducting Materials
AF90-116	Nonlinear Optical Materials
AF90-117	Repair of Plated-Through Holes (PTHs) in Multilayer Printed Wiring Boards (PWBs)
AF90-118	Light Curing Fuel Tank Repair Sealant
AF90-119	Concurrent Engineering

AF90-120 Machine Tool Products and Processes

AF90-121 Electronic Packaging and Interconnect Multichip Package Automated Assembly Yield and Cost Versus Complexity

AF90-122 Space Power Energy Conversion and Thermal Management Systems

AF90-123 Pulsed Power for Airborne/Spaceborne Applications

AF90-124 Strategic and Tactical Missile Power

AF90-125 Aircraft Power and Power Electronics

AF90-126 Computer Aided Structural and Life Analysis of Turbine Engine Components

AF90-127 Weaving and Braiding Techniques for Turbine Engine Composite Components

AF90-128 Multifunctional Additives for High Temperature Fuel

AF90-129 Solid Lubricants and Their Distribution for Advanced Aircraft Gas Turbines

AF90-130 Lubrication of High Temperature Bearing Surfaces by Vapor Deposition

AF90-131 Surface Deposit Analyzer

AF90-132 Air Breathing Propulsion Using Antimatter

AF90-133 Nonintrusive Velocity Measurements of Supersonic Combustion

Space Systems Division, Los Angeles Air Force Station, CA

AF90-134 High Energy Radiation Discrimination for Long Wavelength Infrared Detector Arrays

AF90-135 High Throughput Detector and Hybrid Array Production Testing

AF90-136 Innovative Concepts for Space Control

AF90-137 Innovative Concepts for Force Support from Space

AF90-138 Innovative Applications of Emerging and Mature Technology for Air Force Space Capabilities

AF90-139 Innovative Concepts for Improved Space Object Surveillance and Classification

AF90-140 Stabilized Sensor Platform for Manned Space Observations

AF90-141 Respiratory Protection Device

AF90-142 System to Measure Currently Unfulfilled/Partially Satisfied Environmental Data Parameters

AF90-143 Improved Lens Polishing and Coating Techniques for Zinc Selenide Optical Components

AF90-144 Retrodirective Flight Test Article Instrumentation Antenna

AF90-145 Space Launch Complex Water Treatment Plan

AF90-146 High Power Microwave Detector

AF90-147 Innovative Concepts for Structure Dynamic and Control Space Experiments

AF90-148 Innovative Models of Propellant Combustion

AF90-149 Advanced Turbomachinery Systems and Components

AF90-150 Technology for Storage, Handling or Use of Antimatter

AF90-151 Innovative Concepts for Ground Testing Spacecraft Structures

AF90-152 Innovative Pumping Concept for Supporting Ammonia Aerojet Propulsion Research

AF90-153 Electrochemical Energy Storage

AF90-154 2.10 Micron Doppler Lidar Detection System

AF90-155 Knowledge Based Seismic Event Automatic Association and Location Estimation

AF90-156 Surrogate Cloud Information from Satellite

AF90-157 Ionospheric Tomography System

AF90-158 Instrumentation to Measure Low Electron Densities in Laboratory Vacuum Chambers

AF90-159 Variable Polarizaton Lidar Optics System

AF90-160 Phased Array Telescope Image Processing

AF90-161 Nonlinear Optical Target Recognition

AF90-162 Modular, High Efficiency, High Temperature Energy Conversion Systems

AF90-163 Anechoic Chamber Performance in the Near Field of High Power Antennas

AF90-164 Advanced Suspension/Isolation System

AF90-165 Optical Parametric Oscillator (OPO) with a Diode Laser Pump Source

AF90-166 Large-Scale Scientific Programming in a Supercomputer Based Object Oriented Environment (OOP)

Ballistic Systems Division, Norton AFB CA

AF90-167 Ballistic Missile Research

AF90-168 Alternate Laser Initiated Detonator (LID) Designs

AF90-169 Development of a Standard Propellant to Liner Peel Test Method

AF90-170 Abrasive Waterjet Machining/Diffusion Bonding of ICBM Isogrid Structures

AF90-171 Noncontact Small Diameter Bore Gauge

AF90-172 Automatic Manufacture of Very Small Electric Hand Wound Motors

AF90-173 Nondestructive Test and Evaluation (NDT&E) Techniques for Solid Rocket Motors

AF90-174 Information States, Paths and Timelines for Strategic Offense/ Defense Integration

AF90-175 Diamond Technology for Intercontinental Missile (ICM) Applications

AF90-176 ICBM Guidance Technologies

AF90-177 Strategic Relocatable Target (SRT) Sensor Technologies

AF90-178 ICBM Power Technologies

AF90-179 ICBM Penetration Aid Technologies

AF90-180 ICBM Reentry Vehicle Technologies

AF90-181 ICBM Command, Control, Cummunications and Intelligence (C^3I) Technologies

AF90-182 ICBM Advanced Basing Structures Response Technologies

AF90-183 ICBM Testing Technologies

Air Force Office of Scientific Research, Bolling AFB DC

AF90-184 Life Sciences Basic Research

AF90-185 Quantum Structures and Devices

AF90-186 Development and Application of New Theories and Concepts Relating to Structures

AF90-187 Multifunctional Nonmetallic Materials Processing and Characterization

AF90-188 Atmospheric Science Modeling Technology

AF90-189 Development of New Scientific Research Instrumentation for Electronics

AF90-190 Routing and Scheduling on Microcomputers

AF90-191 Novel Electron Beam Driven Sources of Millimeter-Wave Radiation

National Aero-Space Plane Joint Office, Wright-Patterson AFB OH

AF90-192 Emerging Technologies Resulting in Lighter Aircraft Weight, Increased Engine performance (ISP) and Improved Design Tools

AF90-193 Development of High Temperature ($T \geq 3000^{o}F$) Heat-Pipe Wing Leading Edge

AF90-194 Advanced Algorithms for Hypersonic Flows

AF90-195 Innovative High Temperature Nonintrusive Diagnositic Instruments for Reactive Flow Field Measurements

AF90-196 Ceramic Fibers and Coatings

AF90-197 Oxidation Protection Coating for Titanium Aluminides

AF90-198 Hydrogen Effects in XD Titanium Aluminides

AF90-199 Nondestructive Inspection Methodology for Thin Oxidation Resistant Carbon-Carbon Composites

AF90-001. TITLE: Armament Research

OBJECTIVE: To develop innovative concepts in areas associated with air deliverable conventional munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered nonnuclear munitions and armaments. These include energy sources and conversions, bombs, submunitions, warheads, fuzes including safe and arm devices for air-to-air missiles, dispensers, rockets, sensors and seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid state inertial components, exterior ballistics, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, fuze and electronic component sealing techniques, unique initiation techniques, compact high voltage storage and switching techniques, compact short-term cryogenic cooling for passive IR fuzing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal explosive-formed penetrator warheads, heavy metal shaped charges, long rod penetrators, reactive fragment warheads, and computational fluid dynamics including interactive grid generation techniques.

AF90-002. TITLE: Innovative Electromagnetic Launcher Concepts

OBJECTIVE: Explore and combine new technologies to enhance existing electromagnetic launcher (EML) capabilities.

DESCRIPTION: Innovative concepts to advance the technology of hypervelocity electromagnetic launchers should be directed toward the following: 1) lightweight technology (especially projectiles); 2) mega ampere switching (opening and closing switch technology); 3) directional control concepts for distribution of electrical and thermal currents (advanced concepts required for armatures and projectiles); 4) energy recovery; and 5) high strength-to-weight electromagnetic launchers. Continuous development of key technology areas are required to address critical issues (e.g., velocity limitations caused by inbore rail damage) which limit the performance and efficiency of electromagnetic launchers. The knowledge to be gained will be assessed with regard to the use of advanced materials and structural designs, especially the compatibility of the armature and/or the projectile with the rail conductors. The knowledge also will be evaluated by the capacity to obtain more reliable measurements to better establish the maturity and performance potential of EMLs, and by the feasibility of merging new technology with system requirements. Phase I should focus on expanding existing knowledge of EMLs and should provide recommendations as to how this increased knowledge will advance the state of EMLs. Phase II should incorporate hardware or experimental demonstrations resulting from the concerns defined in Phase I. Phase III should produce prototype devices that will advance technology applicable to space based EMLs in areas such as power requirements, platform mass, cooling requirements, and system efficiency.

AF90-003. TITLE: Monostatic, Bidirectional Laser Reflectometer

OBJECTIVE: To design and fabricate a monostatic, bidirectional laser reflectometer system.

DESCRIPTION: The design of laser radar and tracking systems (seekers) requires a large base of accurate monostatic reflectance data. That is, how a wide variety of target materials react to far-field laser illumination at the many wavelengths that are or may be employed. Available reflectance data that has been taken with nonmonostatic measurement geometries can be incorrect by large factors and completely mislead design and feasibility studies. The needed data must be obtained under conditions which accurately reproduce or simulate operational conditions. It must be true monostatic measurement of reflections from coherently polarized radiation with the target in the far field of the transmitter and the receiver in the far field of the target. It must account for speckle, opposition effects, and any other phenomena of importance under these conditions. These far-field, monostatic measurements can be obtained from field experiments. A laboratory system which can accurately simulate these conditions and geometries in a controlled environment is more cost effective and less time consuming. A laboratory system is therefore preferable and essential to providing accurate, efficient measurement. The technical challenge is to provide the techniques and design needed to make monostatic measurements on the order of 10^{-4} esteradian, an order of resolution compatible with the seeker technology under development. Phase I of this task is to develop the technique and system design necessary to make the appropriate measurements. Phase II of the SBIR will include fabrication and demonstration of the monostatic, bidirectional laser reflectometer system designed in Phase I.

AF90-004. TITLE: Inertial Guidance Technology Demonstration (IGTD) Seeker Development

OBJECTIVE: Develop a low cost imaging seeker and/or the algorithm for application of this sensor in support of the Inertial Guidance Technology Demonstration (IGTD).

DESCRIPTION: The ability to guide bombs to targets using low cost inertial guidance has been demonstrated. The accuracy of this bomb demonstration provides the opportunity to couple the inertial guidance systems to very low cost seekers which need operate only within a narrow field-of-view and short acquisition range. In this effort a very low cost seeker will be designed for use with inertially aided bombs to acquire and track large features such as roads, bridges, runways, POL tanks, and buildings. The cost of any terminal seeker for this study must be less than $5,000 including the sensor/seeker, signal and data processor, and interfaces. Test results indicate an area of only $4 \times 10^4 ft^2$ needs to be searched for a point target for inertially guided bomb applications. If the target is a large part of the search area and presents a large number of pixels for the seeker, a seeker with appropriate algorithms should be able to locate and track the target. The target set is restricted to large image features such as roads, runways, bridges, buildings, and POL tanks. This should minimize the required signal processing and target recognition requirements. The sensor/seeker will also be restricted to TV, lasers, and Imaging Infrared (IIR) types. The images will be generated from the aforementioned sensor at ranges of 1-2 km. The algorithms developed must be compatible with low cost designs, volume, and processing restrictions applicable to inexpensive weapons of the future. Future developments in computers should also be considered for this application. Phase I efforts should be devoted to the hardware design of the low cost seeker for IGTD applications and/or the examination of the signal, data and image processing algorithms required for systemization. In Phase II, hardware and/or software will be developed and tested in a breadboard configuration. Feature detection, tracking, and processing algorithms will be evaluated for further development.

AF90-005. TITLE: Critical Humidity Detector and Warning Device

OBJECTIVE: Develop an accurate, positive indicating, resettable relative humidity indicator.

DESCRIPTION: Military hardware that requires long term storage with environmental protection is often packaged in sealed storage containers designed to maintain low relative humidity conditions. These containers are equipped with humidity indicators that allow monitoring of relative humidity levels within the container. As specified in MIL-I-26860, humidity indicators have a chemical type, color change element, which turns from blue to lavender to pink as the relative humidity increases and then back to blue when the humidity decreases. These indicators have been used for decades but have been known to be unreliable. Also in use is an irreversible color stain element in which crystals dissolve when subjected to a high relative humidity and permanently change the indicator from white to orange. This style has a tendency to prematurely actuate causing unwarranted maintenance action. The goal of this task is to develop a humidity detector and warning device designed specifically for use on sealed, rigid type, shipping and storage containers. It must be rugged, compact, accurate, relatively fast acting, provide positive indication when the critical relative humidity is exceeded for a prescribed time, and allow manual reset. Phase I of this SBIR task is to develop concepts and document advantages and disadvantages of the various approaches. Phase I will include the recommendation of candidates to be demonstrated in Phase II. Phase II shall consist of building prototypes of the approved concepts and subjecting them to qualification testing. Phase III is expected to result in a low rate initial production of the successfully qualified device. These devices may be integrated with an appropriate container production program.

AF90-006. TITLE: Thermoplastic Binders for High Explosives

OBJECTIVE: To identify promising thermoplastics which may be used as inert or energetic binders for explosives.

DESCRIPTION: Plastic binders currently used in high explosives are typically thermosetting. At elevated temperature these binders cure into a rubbery solid. Disadvantages of these binders include short pot life, low cure time, high viscosity during blending and attendent long mix cycle, difficult demilitarization and toxicity. To achieve proper curing requires many additives, some at very low concentrations. This requires high shear mixers and extensive

agitation. The large family of thermoplastics, especially in the melt range of 80-100° C, should include many candidates for explosive application. Some of these candidates may even contribute energy to the explosive reaction. Phase I of this program should provide a selection methodology and listing of potential thermoplastics for explosive binder applications. Chemical properties for all candidates should be defined. Phase II should characterize chemical, physical and mechanical properties of the selected thermoplastics with explosive or simulated explosive ingredients. Selected explosive systems should be characterized in terms of performance and sensitivity. The end product should be new families of explosives for DOD applications. This is a new initiative which should expand the market for explosives manufacture and loading.

AF90-007. TITLE: Reactive Kill Mechanism Instrumentation and Modeling

OBJECTIVE: Develop instrumentation and/or modeling to characterize high energy rate reactive kill reactions.

DESCRIPTION: Certain combinations of materials (solid/solid, solid/liquid, solid/gas, and liquid/gas) in highly dynamic environments will rapidly react either hypergolically, pyrophorically, or oxidatively. If warhead fragment materials are able to react in such a way with the materials making up an aircraft target, for example, greater damage occurs than with an inert collision. The extent of this greater damage is a matter under investigation and requires the development of both instrumentation and modeling to promote greater understanding of the reactive kill mechanism. The damage mechanism, or how the energy is coupled to the target, is of great interest. The effects to be modeled and/or instrumented include projectile/target interaction, the vaporific effects and the energy release (rates). The Phase I effort should clearly define the approach to design instrumentation or methodology to measure or model the reactive kill mechanism quantities defined above Instrumentation should be designed to answer the basic questions about the functional relationships between the quantities of interest. Any modeling should delineate the intensive and extensive state variables and their relationships. Phase II should be devoted to fabricating and testing instrumentation selected in Phase I or exercising and validating the model developed. Any instrumentation developed should be fully tested along with data reduction techniques; any model developed must include the data used to validate the model. Phase III should extend the instrumentation and/or model designed to a system concept to fully measure, analyze and predict the appropriate variables that define the reactive warhead phenomenology.

AF90-008. TITLE: Laser Beam Steering Technology

OBJECTIVE: To develop solid state scanner technology for active laser seekers.

DESCRIPTION: One of the fundamental difficulties for producing an inexpensive active imaging infrared seeker is the current state-of-the-art of the scanner. Certain tactical laser radar (Ladar) seekers (CO_2) use an inertial operating scheme that employs a single range image to update the seeker position before returning the guidance control back to the inertial unit. The mechanical, push-broom scan used in this system is not fast enough to allow more than one image position update in the terminal phase of the flight. A solid state scanner will not only reduce the cost of the seeker, but will allow multiple image updates, which will increase the probability of acquiring the correct target and/or correct aimpoint. Additionally, it will provide target information at the rate needed for accurate terminal guidance. The goal of this program is to investigate the feasibility of developing a solid state scanner for active Ladar seekers. Timely development of a solid state scanner for the carbon dioxide laser would yield an increased probability of true target selection, more accurate aimpoint and a reduced CEP. Phase I of this SBIR task will investigate various solid state, beam steering devices and identify the one(s) with the greatest overall potential for active laser applications. Several promising devices such as Magnetooptic and Electrooptic Light Deflectors may be explored as well as newly emerging devices/ techniques which may be identified. Phase II of the SBIR task will select, design, and fabricate a breadboard of the device that offers the greatest potential in the active laser seeker mission. The breadboard will be used in the laboratory for concept demonstration. Phase III may include building a brassboard to be used for hardware-in-the-loop simulation testing, tower testing and possibly captive flight testing.

AF90-009. TITLE: Barrier Coatings for Hermeticity of Encapsulated High-G Electronic Devices

OBJECTIVE: To demonstrate improved hermeticity through use of nonpermeable coatings applied at relatively low temperature.

DESCRIPTION: Hermetic electronic components have traditionally been specified for military hardware to help assure operability following long term storage. For postimpact fuzing, hermetic components often will not suffice. Microcircuit chips and lead frames must be rigidly encapsulated and potted in order to enhance their ability to survive in a high-G shock environment. However, epoxy encapsulation of electronic devices has never been an ideal substitute for hermetic packaging. Microcircuits encapsulated with epoxies containing chlorine and sulfur will undergo premature failure in humid environments. Use of high purity encapsulants improves device longevity under all conditions, yet direct comparisons indicate that hermetic packaging results in fewer corrosion related failures and higher reliability. Coatings have been applied to microchips in the past with questionable benefit. A coating thick enough to inhibit diffusion, yet not too thick to thermally insulate the microchip, has not been possible via glassivation, nitriding or conformal coating. In addition, a low temperature process is required to coat the microcircuit with an electrically insulative, thermally conductive layer of impermeable material having a thermal expansion coefficient similar to that of silicon. Phase I of this task shall examine the properties of various types of coatings and weigh the advantages of each. Impermeability shall be the primary consideration, followed by electrical insulative and thermal conductive characteristics, thermal expansion coefficient, and ease of application. Experiments shall be conducted to measure the diffusion coefficients of these materials in thin film form and confirm their projected usefulness as barrier coatings. Phase II of this task shall explore methods of applying these coatings to microchips and other electronic devices. Application of each coating shall be performed at temperatures below 300° C to avoid damage to the microcircuit elements, and in such a way as to preserve the characteristic properties of the material. Preliminary accelerated life testing of epoxy encapsulated microcircuits (both coated and noncoated) shall also be performed. Phase III could pursue both the military, commercial, and space applications of the barrier coating process.

AF90-010. TITLE: Remotely Monitored Tactical Sensor Suite (RMTSS)

OBJECTIVE: To develop a low cost seismic and infrared recoverable sensor suite.

DESCRIPTION: Tactical intrusion sensors are needed by the security police to protect overseas bases. Existing sensor suites are expensive or too difficult to use. The sensors must be compact and rugged. The detection capability of the seismic sensors should range from 0 (off) to 25 meters. To adapt to their topology, the detection range should be adjustable in four or more discrete gain settings. The gain settings must be controlled from a remote device. Hardwired or RF units are preferable. The sensors must be camouflaged in the field, but must be easily found for redeployment. The unit will be deployed for long periods. Long battery life is desirable. Investigation should include using an alternate energy source to reduce the need to change batteries. After deployment, up to 200 seismic and infrared sensors must be monitored from a single control unit. The display must show at least 10 alarms simultaneously, preferably showing sequence of activation. An interface port to relay sensor activation information to command and control systems is desirable. Phase I would investigate the technology for the best approach to building a sensor suite. The recommended approach should be detailed with some laboratory or field testing of prototype components desirable. Phase II would demonstrate a sensor configuration in a realistic setting and provide a product specification for manufacturing the sensor suites. Phase III may lead to low rate initial production and fielding of a sensor suite.

AF90-011. TITLE: Corrected Optical Window for Missiles

OBJECTIVE: To design aerodynamic optical windows that will achieve diffraction limited or near diffraction limited operation.

DESCRIPTION: Current optical window designs for missiles are hemispherical to obtain diffraction limited performance. Unfortunately, hemispherical windows create aerodynamic heating and drag problems at high speeds. The challenge is to change the shape of this window design to reduce aerodynamic heating and yet obtain diffraction limited or near diffraction limited performance over either the 3 to 5 micrometer band or the 8 to 12 micrometer band. The offeror will investigate the feasibility of applying different refractive window materials in a sandwich construction to correct for changes in refractive indices due to complex shapes. This technique has been successful in microwave radome designs. The window diameter at its widest base point is 7.6 centimeters. The surface of the window is a circular tangent ogive of 3 to 1 fineness ratio. If diffraction limited requirements cannot be obtained with a tip of a tangent ogive surface, the surface of the tip may be formed by putting a radius of 0.6 centimeters to 1.3 centimeters

thick at the edge and at least that thick everywhere else. The optical detector scans 30 degrees from the ogive axis in all directions, and the detector is located at the base of the window on centerline. *The offeror shall determine* the shapes and refractive indices of the layers of materials that will produce diffraction limited or near diffractive limited operation. Since there are likely to be difficult mechanical, optical, and thermal requirements for the materials in the layers, the analysis, if possible, should give the shapes and refractive indices in general terms so that suitable optical materials can be found. Basic materials of interest include: 3-5 micrometer region; AL_2O_3 (Sapphire), $AL_{23}O_{27}V_5$ (Alon), $MgA1_2O_3O_4$ (Spinel), and Y_2O_3 (Yttria) and 8-12 micrometer; ZnS, ZnSe and $CaLa_2S_4$. Phase I should define the experimental techniques, materials, coatings, etc. The shapes, indices and design rules should be investigated with some experimentation desirable. Phase I will culminate with recommendation of the candidate approaches to be demonstrated in Phase II. Phase II of the SBIR task is expected to demonstrate in the laboratory the material properties that can correct optical window indices of this shape. Phase III is expected to produce a prototype corrected optical window that can be integrated with a RF radome.

AF90-012. TITLE: Doppler Signal Processor

OBJECTIVE: Demonstrate real time signal analysis and bandwidth compression for advanced doppler radar tracking systems.

DESCRIPTION: Laser radar systems are being developed with a number of Air Force applications. One in particular involves the analysis of the return from various velocity targets transiting the beam. The baseband doppler signal for a CO_2 Ladar is approximately 188 kilohertz per meter per second. For instantaneous velocity shifts, such as a gun firing, a signal processing technique is needed that will provide a lower bandwidth tracked signal in real time for recording and for closed loop tracking of the projectile. Anticipated testing of hypervelocity projectiles in excess of 10 kilometers per second is required in the data analysis. For instrumentation purposes a spatial resolution of 0.1 meters is required for a spectrum sample rate of 100 kilohertz. For some applications an intermittent burst mode of much higher sampling rates is envisioned for high resolution analysis at points along the projectile trajectory. The desired technique will provide a spectral output of the velocities of targets in the beam that are recordable with current state of the art digital or other technologies and a real time servo input for driving range tracker mirror and focusing systems. The Phase I effort will address the design and bench simulation of the waveform analysis of the modulated doppler waveforms anticipated from advanced laser radar systems. The Phase II effort will brassboard and test in actual environments the processing and data acquisition techniques for the doppler output of the Ladar tracking system. The Phase III effort will entail systemization of the modular and severe environment (flight) configurations required to utilize this technique in actual aerospace and space flight testing of high/hypervelocity projectiles.

AF90-013. TITLE: Fiber Optic Measurement of Shock Waves

OBJECTIVE: To develop fiber optic shock front velocity measurement system for use in explosives testing.

DESCRIPTION: The detonation velocity of shock fronts in explosives is measured either by using piezoelectric pins spaced down the length of the explosive charge or by the use of streak camera records. The streak camera has the advantage of producing a continuous velocity record but is time intensive in both set up and analysis of the record. Piezoelectric pins have the advantage of easy set up and data reduction but produce only an incremental velocity curve and have a high cost. Fiber optics have been used in a variety of applications. Exploration of the feasibility of using fiber optics to replace current piezoelectric pins for shock front velocity measurement is desirable. Whether a method for continuous velocity measurement of the shock wave can be developed should also be investigated. The goal of Phase I is to investigate the feasibility of using fiber optics to study shock phenomena. Development of possible methods and validation of these methods through small scale testing should be included. Phase II should include validation of the Phase I design through fabrication and testing using explosive charges. Systemization of the concept to include fiber optics instrumentation and data reduction techniques should be explored. Phase III should explore the military or commercial use of fiber optic systems to record shock fronts in high temperature applications.

AF90-014. TITLE: Infrared Image Resolution (IRIR)

OBJECTIVE: Independent determination of image pixel resolutions for detecting, recognizing and identifying targets.

DESCRIPTION: Most active and passive IR image systems are developed with a particular optical sensor and image algorithm in mind at the start of the design process. Therefore, starting with the sensor and algorithm, pixel resolution becomes a tradeoff parameter which is given a lower priority in the design process. This program will emphasize and start with pixel resolution as the first parameter to be defined. Phase I will research and establish the methodology and criteria to define pixel resolution for three levels of image detail for the near IR region. Resolution is defined by the number of pixels on target, size (or area) of the pixel, and the number of grey levels. There are three levels of image detail: detection, recognition, and identification. At the detection level, the target is represented as a blob; while at the recognition level, the target is seen as a group; and at the identification level, the target is seen as a particular type within the group. Both fixed and moving targets should be studied. Groups of targets are buildings, tanks, tractor trailers, small trucks and people. The resolution will be determined independently of optical sensor and image algorithm for each level of image detail. The rationale and supporting evidence defining the resolution for each level should be provided by the research. Phase II will refine the methodology of Phase I to define pixel resolution including mid and far IR regions and multiple target images. System analysis and tradeoff studies on both IR sensors and image algorithms, using the pixel resolution defined during the study, will be performed. System parameters such as field of view, instantaneous field of view and processing time will be determined. The research should include artificial intelligence (AI) computer vision and knowledge-based techniques so that the IR system indicates target types and pointing error signals. Phase II should investigate the effects of both scanning and staring sensors, target search and track capabilities, and tradeoffs. Phase III would support the systemization of a sensor designed and optimized by the process selected from Phases I and II.

AF90-015. TITLE: Real Time Airborne Flow Visualization

OBJECTIVE: Develop real time in-flight visualization and measurement for the flow and shock around airframes and stores.

DESCRIPTION: A major problem in stores certification and the testing of experimental armaments is the effect between the aircraft structure and the stores. Boundary layer measurements provide little information to the analyst or test engineer to define the complex fluidic interaction that is occurring. In anticipation of the development of high speed and high resolution video imagers, the capability is desired to generate calibrated imagery of this flow structure during flight and especially during transient events such as stores separation and maneuvers or ballistic range events. This effort will define the feasibility of generating interferometric or other nonseeded flow images which can be stored on film or recorded via an electronic imaging device. The technique must be compatible with a high performance aircraft environment, fit into an aircraft instrumentation pod (10 feet by 16 inches diameter) and provide single-ended measurement capabilities. Short exposure times are required to minimize the effect of the aircraft or ballistic range vibration and to provide information on transient shock formation and travel. For ballistic range applications, the requirement is to apply large format imaging focal plane sensors to arc gap/laser diode synchronized shadowgraphic image capture of projectiles or models which are gun launched in ballistic ranges. For current test configurations a resolution of 0.004 inches is required over a four by eight foot area of interest (field of view) for each camera. A single or multiple exposure is required for each camera with the data temporarily stored in a memory device until transmitted to an image storage and processing workstation. Phase I will be a study of the application of flow visualization techniques to the aircraft/ballistic range/wind tunnel environment and a laboratory demonstration of the applicable phenomena. Phase II will be the proof of principle systems demonstration for ballistic range, wind tunnel, and/or flight testing. Phase III may provide follow on systems development and transition to the Air Force Seek Eagle Program Office or application to ballistic ranges.

AF90-016. TITLE: Binary Explosive

OBJECTIVE: Identify and characterize binary explosive compounds and mixtures.

DESCRIPTION: To date most explosives are either monomoleculars, intermolecular salts, or mixtures of each. Some are melt cast, plastic-bonded, pressed, gels or slurries. However, they all have in common the problem of being sensitive to inadvertent initiation by various stimuli either during processing, manufacturing, or storage. There are many systems known that can be mixed to formulate explosives, but are inert or nonexplosives when unmixed. Many of these systems use strong oxidizer salts, e.g., ammonium nitrate or perchlorates with other salts, liquids and sensitizers.

Explosive systems that can be mixed in the hardware before or during release from the aircraft are conceivable. Systems with energy equal to or better than the current tritonal fill are desired. New materials exhibiting a variety of physical and chemical properties are needed for these type systems. The benefits are rapid, safe and economical weapons replenishment for the services. The goal of Phase I is to study the feasibility of various compounds which are explosives only when mixed. These systems would then be physically and chemically characterized to verify they are not explosives as separate items, but are explosives when indeed they are mechanically mixed. Safety screening and explosive characterization tests will be conducted on all components and systems. Phase II would continue the study on a larger scale by testing and characterization of the detonation properties and mixing techniques for these systems. A warhead design will be developed and feasibility tests performed on selected systems.

AF90-017. TITLE: Waveguide/Fiber Transmission Lines for Long Wavelength Infrared Sensors for Fuzes

OBJECTIVE: Develop miniature waveguides or fibers suitable for photon transmissions

DESCRIPTION: In the past, air-to-air missile fuzes have typically employed either radio frequency (RF) or active optical methods of target detection. RF fuzing is susceptible to countermeasures, while active optical fuzing has all weather limitations. The possibility of using long wavelength infrared (LWIR) sensing for air-to-air missile fuzes is being explored. The purpose of this program is to develop miniature waveguides or fibers suitable for photon transmission over the 8 to 15 micron wavelength band in order to advance the state-of-the-art in target detection technology for air-to-air missile proximity fuzes. LWIR transmission lines analogous to optical fiber bundles (used in active optical fuzes) must be developed to achieve target detection with a wide field of view. Presently, no available fiber material or waveguide exhibits good (>50%) LWIR transmission over path lengths as small as one tenth of a meter; significantly better transmission is required in order for LWIR fuzing to become practical. Phase I should be devoted to a study of possible transmission devices. Trade studies are needed to ascertain possible viable concepts to be validated in Phase II. Phase II will require the development and fabrication of the transmission concepts recommended in Phase I. All transmission characteristics of the developed concept should be verified by actual laboratory tests. Development of prototype devices based on the concepts tested in Phase II would be the focus of Phase III. Military, commercial, and space applications should be explored.

AF90-018. TITLE: Fault Tolerant Processors for Guided Interceptors

OBJECTIVE: To identify fault tolerant methods of signal and data processing for guided interceptors.

DESCRIPTION: The Air Force is currently investigating the use of signal and data processors for interceptor applications requiring long lifetimes, high reliability, and low maintenance. Processors are required for this application which have extended operating capabilities and which include features such as redundancy and error checking. The processor to be developed for this interceptor must be able to withstand a harsh storage and launch environment and must have a shelf life of up to ten years in orbit. The ability to perform prelaunch checkout of the processor is limited due to the extremely short engagement times for the interceptor. Also, the end game processing rate requires that the processor be functional throughout this critical time. The volume and mass available onboard the interceptor are extremely limited and therefore minimize the amount of redundancy which can be employed. The primary goal of this effort is to develop fault tolerant techniques which will allow the interceptor to perform its mission. The developed techniques should allow for error checking of functions during flight of the interceptor and should provide for alternate paths and graceful degradation in the event of component failure. Phase I of this effort will be a study of the requirements for fault tolerance onboard the interceptor including a list of critical functions and timing required for those functions. The study will also identify available techniques for implementing fault tolerant schemes to insure that essential functions are performed. The study should include an assessment of the impact of each technique on processing speed, and on interceptor mass and volume. Phase II of this effort will be design and development of a breadboard processor employing the technique from Phase I which appears most capable of meeting the interceptor goals. The breadboard will implement a subset of the interceptor processing functions and will be tested to demonstrate its performance. Phase III of this effort will be development of a prototype unit for the interceptor processor which uses the fault tolerant techniques generated in Phases I and II.

AF90-019. TITLE: Diamond Films and Coatings for Missile Radomes

OBJECTIVE: Develop diamond coatings/films to increase survivability of infrared domes without degradation of optical properties.

DESCRIPTION: None of the electromagnetic windows for tactical missiles currently in use which are transmissive in the 8-12 micron range can survive hypersonic flight through adverse environmental conditions. This particular requirement has arisen from the advent of effective countermeasures in the RF and 3-5 micron range and the substantial increase in target velocities. A solution may be within reach due to recent major breakthroughs in the manufacturing technology for diamond coatings/films. Diamond exhibits excellent structural properties and IR transmission characteristics. The fundamental goal of this task is to develop the ability to apply a diamond film/coating to the substrate dome material of a tactical hypersonic missile operating in the 8-12 micron region. The technical challenge is to apply the diamond coating to a hemispherical substrate material without seriously degrading the transmission characteristics through material bond disunities, the polycrystalline structure of the coating, or mismatches between the refractive indices. The cost of a diamond coated dome must not exceed the current cost for a dome by more than a factor of two. During Phase I, a study will be conducted of substrate materials and diamond coating methods to determine the combination having the highest probability of successfully meeting the requirements. The final product of Phase I will be a report which ranks the surveyed materials and diamond coating techniques. The ranking will be justified by an accompanying explanation of the predicted mechanical and optical properties, cost estimates, and the advantages and disadvantages of each material. During Phase II, the diamond coating will be applied to the most promising candidate substrate material. The mechanical and optical properties of the resulting window will be validated through laboratory testing and analysis. During Phase III, a prototype missile dome will be manufactured. The mechanical and optical properties will be verified through exposure of the dome to dynamic testing.

AF90-020. TITLE: Target Neutralization Mechanisms

OBJECTIVE: To develop advanced mechanisms by which various military targets can be neutralized or defeated.

DESCRIPTION: Today's weapons rely on the impact of metallic projectiles or blast overpressure as the primary kill mechanism. Many of these weapons employ electrooptical sensors and others rely on some type of mechanized vehicle for their effectiveness. Some neutralization mechanisms have been investigated to blind electrooptical sensors or incapacitate mechanical systems, but have not gained operational status due to the difficulty in employing them. Neutralization mechanisms are needed which can render various military targets unusable for their designed missions. Examples are aerosols or coatings which would blind sensors; application of sticky substances which would limit vehicular speeds; and substances which would drastically reduce engine life once ingested. Innovative applications of technology are sought which result in target neutralization. Ideas and concepts are not limited to the above examples. The Phase I effort will assess potential innovative neutralization mechanisms and determine their feasibility. Trade studies should be conducted to assess the strengths and weaknesses of each proposed neutralization scheme. In Phase II, the results of the studies in Phase I will be used to determine viable candidates for further development. The selected neutralization mechanisms will be fabricated and tests conducted sufficient to determine initial performance levels. Phase III systemization may result in the integration of the concept for field use.

AF90-021. TITLE: Aerospace Ground Environmental Simulation Testing

OBJECTIVE: Develop advanced test and evaluation techniques, instrumentation and facilities.

DESCRIPTION: New and innovative ideas and concepts are needed to develop facilities, methods and techniques to accomplish testing needed to meet requirements for aerodynamic, propulsion, space, and reentry testing. Simulation of aerodynamic flight conditions in large test facilities is a very expensive and technically challenging endeavor. Means of generating the flow conditions, the test technique and the measurement of performance and flow parameters is of interest. One specific example of a technical need is a method to heat and contain air on a large scale for true temperature conditions for testing at hypersonic flight conditions. Some examples of needs are aircraft/store separation, turbulence measurement, boundary layer diagnostics, diagnostics of high enthalpy flows, hypersonic nozzle design and throat heat transfer, and real gas computational analysis. Other examples of areas of desired research are aerostructural, aerothermal, and propulsion testing in ground facilities. Generation of the test environment, measurement of the test conditions, analysis and interpretation of the test results are also within the scope of

interest. Space propulsion testing, contamination effects and scene sources are of interest. Hypervelocity launchers for reentry and impact testing, along with associated operational and measurement problems are of interest. Many of the methods of simulation now used for these technical areas either involve compromise of test conditions, high cost, poor productivvity, or other major problems where innovative approaches might provide much needed benefits.

AF90-022. TITLE: Nonconventional Precision Traverse System

OBJECTIVE: Develop a nonconventional 3-axis traverse system to support the use of electrooptic instruments in AEDC Hypersonic Wind Tunnels.

DESCRIPTION: Lack of a proper traversing mechanism will often prevent application of electrooptical instruments in existing aerodynamic and aeropropulsion test facilities. Three recently developed laser based, nonintrusive instruments could be productively applied in two AEDC wind tunnels if a proper traversing mechanism were available for the tunnels. A single portable traversing system could be used for either tunnel since the mechanical dimensions and optical access features of these two tunnels are virtually identical. The three instruments are the Boundary Layer Transition Detector, the Multibeam System and the Laser Doppler Velocimeter. A nonconventional traverse system is required because the system must accomodate a cantilevered optics mount table with a large moment (600 ft-lbs). The load capacity of the traverse should be at least 500 lbs. The traversing range for each axis should be axial - 45 inches, vertical - 20 inches, and traverse - 18 inches. The position resolution for each axis should be 0.001 inch or better and the position accuracy should be 0.0001 inch per inch or better. The traverse should be designed to be operated manually or by computer inputs.

AF90-023. TITLE: Cryogenic High Resolution Linear Actuator

OBJECTIVE: Develop a device for fast, accurate, high resolution, linear motion in vacuum at 20 deg K.

DESCRIPTION: Design and develop a linear actuator capable of operating continuously in a vacuum environment as low as 10^{-7} torr, while all components of the actuator are cooled to a temperature of 20 deg K. Additional requirements are a total motion of 25 mm with a minimum step size of 0.1 m. The actuator must also be controllable up to a minimum speed of 2 mm/sec with higher speeds desirable. The actuator should exert a minimum force of 1 kg. Accuracy of obtained position should be +/- 10^{-6} m and the repeatability of returning to a given position should be within +/- 0.25×10^{-6} m. The actuator package must also fit into a cube with sides of 200 mm. Control of actuator position and operating speed should be by computer through an R8232 interface. Computer recording of position and speed data should also be available. Manual control of the actuator should also be provided. Good vacuum practice should be observed in construction. Materials in the actuator should be chosen to minimize contamination.

AF90-024. TITLE: High Temperature Rake Probe for Arc Jet Tests

OBJECTIVE: Develop a rake probe and pressure retrieval hardware capable of measuring and mapping arc jet exit plane flow quantities.

DESCRIPTION: Design and develop a multielement rake probe and pressure retrieval hardware capable of measuring data which can be used to calculate arc jet exit conditions. The probe rake elements should be able to measure local freestream total pressure, static pressure, total temperature, and freestream flow angles. The probe rake should be able to map these flow quantites over the entire arc jet exit plane. The probe should also be able to map out flow field vorticity. The probe should have retrieval rate for pressure and temperature data such that the probe can be quickly swept across the arc jet exit plane to reduce probe cooling requirements. The probe may require water cooling. The rake probe should be able to survive repeated tests in the arc jet facilities at AEDC. At present arc jet flow conditions are derived. The probe date should be in a form that mass-averaged flow quantities of total pressure and static pressure can be calculated for comparison to derived arc jet results. Also inherent in arc jet operation is swirling flow, which is not calculated in exit flow conditons.

AF90-025. TITLE: Submicron Monodispersed Aerosol Generator for Laser Doppler Velocimetry (LDV)

OBJECTIVE: Develop a monodispersed seed particle aerosol generator for LDV applications in aerodynamic and aeropropulsion testing facilities.

DESCRIPTION: In the LDV technique, gas velocity is inferred from velocity measurements on small particles (seed particles) entrained in the gas. To adequately measure velocity gradients in supersonic and hypersonic flows, seed particles of 0.1 micron and smaller must be detected. Besides being small, the particles should be of low mass density (<4.0 grams/cm^3) and strictly monodispersed. The particles and carrier gas should be nontoxic, noncontaminating, chemically inert and reasonably priced. A need presently exists for low temperature (<200 deg F) as well as high transmission.
temperature (200-5500 deg F) particles. A maximum particle production rate in the range of 10^{10} particles per second or greater is required. Some means of controlling the production rate is also desirable.

AF90-026. TITLE: Command, Control and Communications Systems/Subsystems

OBJECTIVE: Develop innovative concepts for Air Force Command, Control and Communications (C^3) Systems and Subsystems.

DESCRIPTION: This covers all aspects of AF C^3 systems and subsystems. Proposals may address subjects not specifically given in other SBIR topics. Proposals may be for any aspect of AF C^3 missions including: Strategic C^3 General Purpose Forces C^3; Ballistic Missile Tactical Warning/Attack Assessment C^3; Atmospheric Surveillance and Warning; World Wide C^2, Air Traffic Control; all AF ground based and airborne early warning systems; all communications systems; and C^3 Countermeasures and Electronic Warfare. This topic offers great flexibility to both proposers and Air Force managers. Past submissions included 1) advanced communications systems concepts, 2) data base management systems, 3) novel information processing systems, 4) multilevel communications security concepts, 5) artificial intelligence applications to AF systems, 6) air surveillance systems, and 7) target detection systems. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF90-027. TITLE: Tactical Command, Control, Communications and Intelligence (C^3I) Systems/Subsystems

OBJECTIVE: Develop innovative concepts and initiatives for Air Force tactical C^3I systems and subsystems.

DESCRIPTION: Topic centers on increasing the warfighting capabilities of the Tactical Air Forces (TAFs) in the areas of command, control, communications and intelligence. The systems covered in this topic include, but are not limited to, the Airborne and Ground Tactical Air Control System (TACS), NATO Air Command and Control System (ACCS), and the Korean TACS (KTACS), and improvements to these systems. Specific areas of interest are interoperability in joint and combined operations, upgrades and improvements through technology and application of existing and planned systems into architectures for the future. Proposals may address specific elements, such as the Tactical Air Control Center (TACC) or Air Support Operations Center (ASOC), etc. New concepts can also be explored addressing technology's impact on future systems in terms of operational capability, logistics, mobility, etc. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF90-028. TITLE: Military Airlift Command Aircraft Mission Planning Workstation

OBJECTIVE: Define an automated Aircraft Mission Planning capability based on current off-the-shelf Workstation Technologies.

DESCRIPTION: Military Airlift Command (MAC) air crews daily fly worldwide missions in support of DoD operational requirements. Currently air crew members spend large amounts of time manually computing the various segments of each mission. These computations contain large amounts of data concerning fuel loads, cargo weights, passengers, threat avoidance, flight parameters, meteorological conditions, etc., to improve operational efficiency. MAC requires a portable automated Mission Workstation capable of airborne operation. Initial effort should focus on the C-17 Aircraft. The workstation would accept inputs from multiple remote worldwide data bases and air crew derived, weighted and prioritized mission inputs. Based on these inputs, rapidly select the most effective minimum risk route capable of meeting the Operational Mission requirements. System outputs would include hard copy graphics of required charts and

forms and digital files for automated aircraft uploading. The workstation must also be capable of handling the following functions/capabilities: 1) Intelligence products handling: serve as an interface to and manipulate world wide intelligence data bases (threat data, order of battle, and imagery); 2) Complex Algorithms: incorporate sophisticated terrain masking software, display threat model data at variable altitudes; and generate optimized routes automatically; 3) Simple Algorithms: plan flights based on normal aircraft preformance data; 4) Graphics: portray digital and analog terrain maps, imagery, simulated radar mapping and graphics for threat envelope overlays. High speed black and white high resolution printer to print out various forms of terrain maps should be used. Color would be desirable; 5) Communications: access worldwide intelligence data bases, access weather networks, access specific command and control networks, and 6) Aircraft Interface: load pertinent data to avionics equipment onboard the aircraft via a 1553, RS 232 or ARINC 429 data bus.

AF90-029. TITLE: Imagery Compression/Decompression

OBJECTIVE: Develop computationally nonintensive methods and algorithms for optimal imagery compression and decompression suitable for current DoD communication networks.

DESCRIPTION: The presently available DoD communication networks are severely stressed and in the near future will be unable to handle the large amounts of information currently involved in imagery transmission. Efficient compression algorithms can help alleviate the impending strain on our limited DoD communications resources. The currently available methods and algorithms are computationally intense and do not yield optimal results. The resulting hardware is complex and current processing capabilities and speed limit the optimality of results. Phase I of this effort would involve development of methods and algorithms suited for optimal compression/decompression of imagery over currently available DoD communication networks. Phase II would involve the simulation/prototyping of hardware/software to implement one or more of the developed algorithm(s). A minimum design goal would be a capability to handle a 512 by 512 by 8 bits per pixel image with an ultimate goal in the area of 4k by 4k by 12 bits per pixel.

AF90-030. TITLE: Highly Programmable Architectures

OBJECTIVE: Examine and evaluate highly programmable architectures for unique programmability characteristics, for both numeric and nonnumeric applications.

DESCRIPTION: While hardware capabilities (VLSI, WSI integration) have enabled the design of large-scale multiprocessors, software techniques have not kept up, thereby keeping low the programmability of these machines. The data-flow model of execution has been proposed as a solution to this problem as it allows the synchronization of instructions, based not upon a central controller, but rather on the arrival of their operands. This methodology has been studied for almost a decade now. Originally proposed by Professor Dennis at MIT in 1968, the principles of execution were first implemented in the LAU architecture (Toulouse, France). Several projects in this country (the Hughes Data-Flow Machine, the Texas Instruments Data-flow architecture, etc.) and several academic projects are still in existence (MIT Arvind's Monsoon, IBM hybrid and USC macro data-flow model). Many data-flow projects are currently pursued outside this country (Australia, Canada, the United Kingdom, and Japan). Basically, in most of these studies numerical applications have been targeted. The data-flow model of computation has long suffered from comparison with von Neuman's model of computation. However, sufficient software advances have been made (high-level data-flow languages, etc.) which will allow great strides in architectural developments. A unique opportunity exists to examine this model of computation for highly programmable architectures. Phase I will examine both U.S. and foreign data-flow projects for programmability options. Phase II will propose development and prototyping of an architecture for numerical and nonnumerical applications.

AF90-031. TITLE: Spatial Optical Objects

OBJECTIVE: Investigate optical computing techniques to represent spatial three-dimensional data objects.

DESCRIPTION: The approach will be to examine/evaluate various optical architecture configurations combined with data base object oriented paradigms to optimally select configurations for representation, manipulation, and managing spatial data representations of three-dimensional data objects. Innovative optical techniques, including speed of

light, dimensionality, and holography will be evaluated to determine effectiveness for integration of multisource data to create, project, and join objects in various configurations. Alternatives to be investigated include achieving tera-op processing speeds using optical associative, neural, and/or connectionism architectures to formulate, store and manipulate massive quantities of data using various object formulations. Phase I should result in techniques for optical spatial visualization of three-dimensional data objects. For Phase II, results for multisource optical data bases will be used to begin preliminary evaluations of potential optical data base machines.

AF90-032. TITLE: Desktop Thermal Design Evaluator

OBJECTIVE: Develop desktop assistant for evaluation of system thermal designs.

DESCRIPTION: The present lack of thermal design evaluation is inconsistent with the impact that high temperatures have on the reliability of electronics. This lack of review can lead to incorrect reliability analyses, which lead to low reliability designs. The Air Force is then left with a costly redesign of the system. Reliability and system engineers do not have the technical training for this evaluation. The thermal design should be reviewed at the same time as the reliability design. But there is usually a shortage of time and thermal design information. An in-house research project at RADC has shown that the basic technology to solve this deficiency exists today. The in-house project also evaluated the existing thermal analysis computer programs. These programs did not meet the need for the system thermal evaluator because of their complexity. The in-house project produced a proof of concept expert system for a printed circuit board thermal analysis. This expert system combined artificial intelligence techniques and nontraditional thermal analysis methods to create a program that incorporated the analysis experience of a heat transfer engineer. This enabled a printed circuit board thermal analysis when many "necessary" design details were not available. Additional research into this area is needed to develop a desktop computerbased thermal evaluator for electronics systems that would be used by program managers and reliability engineers. Phase I will assess the information necessary to accomplish the thermal evaluation of systems and modules for all types of cooling. This will require clever approximations sufficient to the task in order to evaluate thermal designs. This phase will also examine the various expert systems and artificial intelligence techniques that can be applied to this problem resulting in a selection of techniques and a definition of the rules and input information needed for the software to be written. Phase II will develop software for a desktop thermal design evaluator. The software will be written for an IBM compatible computer, the industry's and the government's de facto standard. This design evaluator will incorporate the results of Phase I and be designed for use by program managers and reliability engineers. It will evaluate the thermal designs of electronic systems and modules with all standard forms of cooling. The program will be resident on a floppy disk.

AF90-033. TITLE: Integration of Simulated and Measured Vibration Response of Microelectronics

OBJECTIVE: Develop analytical/test integration techniques to predict electronic device response in vibration and shock.

DESCRIPTION: Finite element analytical simulations allow material response of modeled structures to be predicted early in the design cycle. The predicted material response allows a potential failure mechanism to be identified and corrective design modifications to be made. Two technical problems, particularly with vibration simulations, often occur. First, there may be unknown or poorly known required finite element analysis input data. This includes 1) knowledge of the vibration and shock loadings; 2) attenuation or magnification of the loading due to structural interfaces between the load application region and the potential failure regions; 3) physical or structural support stiffnesses; and 4) material properties, especially damping valves. The second problem, particularly with microelectronic devices, is excessive modeling effort due to the large relative size differences between the stress and failure regions of interest and the device size. Experimental testing, on the other hand, has shortcomings. Prototypes must first be fabricated. Interfaces with the upper level hardware must be simulated with appropriate mockups. Locations of force application and response measurement points are uncertain, and without any prior experience, are likely to be inadequate. Appropriate vibration experimental measured data could be used to help solve the above problems. Test data may help define analytical loadings, determine boundary conditions such as support stiffnesses, verify or disprove modeling assumptions, define structural interfaces, and provide better estimates of material properties. Phase I of this effort will determine the feasibility of combining the information available from vibration and shock measurements with analytical simulation results in order to eliminate or reduce problems and

shortcomings of both. Phase II will develop the analytical and test techniques, plus their proper interfaces, in order to effectively predict electronic device response when operating in vibration and shock environments. This effort would use the synergism of simulations and testing in order to allow effective responses and reliability assessments to be made.

AF90-034. TITLE: Incipient/Intermittent Failure and Degradation Detection for Cables and Connectors

OBJECTIVE: Develop practical test methods for detecting degraded or soon-to-fail cables and connectors.

DESCRIPTION: Many sources indicate that cable and connector failures are the cause of between 30 and 50 percent of all system failures. Cables and connectors are also especially prone to intermittent types of failure. Practical techniques are not available to determine whether or not a cable or connector is in an advanced state of degradation; is causing intermittent system failures (false indications of failures leading to could-not-duplicate (CND) or retest-OK (RTOK) reports); or is in such a state that it is likely to cause a CND, RTOK or complete system failure within a relatively short time or a few mission cycles. The objective of this effort is to develop practical/cost effective nondestructive test methods that can be performed at organizational, shop or depot level to detect cables and connectors which are approaching a degraded state such that they are soon-to-fail, or are prone to cause intermittent failures. Degradation of the type caused by corrosion, vibration, thermal stressing and wearout, as well as degradation resulting from frequent or careless handling, shall be considered as candidates for detection technique development. Emphasis shall be placed on developing techniques which are practical and cost effective for detecting the cable/connector anomalies. In addition, techniques for nondestructively precipitating intermittent failures should also be investigated/developed (e.g., performing connector continuity check during a vibration sweep). Phase II of this effort will develop methodology and hardware for the field implementation of the two most promising of the techniques identified in Phase I.

AF90-035. TITLE: Multilevel Knowledge Bases

OBJECTIVE: Investigate implications of knowledge in multilevel knowledge base being contradictory and impacts of contradiction on security.

DESCRIPTION: Inferences are drawn by a user when submitting a query to a database management system. Recent research in the area of multilevel secure database management systems has shown that queries operating on different levels of data can produce divergent results. This problem of divergent results is sure to exist in multilevel secure knowledge base systems. In fact, the problem of divergence is likely to be far greater in multilevel secure knowledge base systems due to the higher level of abstraction at which this information is manipulated. Phase I will result in a definition of what constitutes sensible operation of such a system, where security classifications and information at different levels may lead to contradictions. Phase II will result in the demonstration of a prototypical implementation of the solution identified in Phase I.

AF90-036. TITLE: Optical Memories for High-Speed Electronic Computers

OBJECTIVE: Develop optical memory architectures.

DESCRIPTION: In the 1990's supercomputers will have computational performances approaching one trillion floating point operations per second. Conventional memory technology will not meet these increased demands. Typically the on-line memory requirements approach a factor of 50% of the computational performance and the off-line memory requires a 16:1 improvement. Phase I will identify potential memory architectures to accommodate Input/Output (I/O) rates for orders of magnitude increases. Minimum demonstration of critical components is desirable. Phase II will implement at minimum a sector of the memory approach chosen.

AF90-037. TITLE: Database Administration Assistant

OBJECTIVE: Apply expert system and advanced data dictionary technology to the problem of database administration.

DESCRIPTION: Operational databased system performance and responsiveness is hampered by the lack of adequate database administration tools. Advanced data dictionaries provide valuable capabilities for the database administrator (DBA). Unfortunately, the proper use of advanced data dictionaries involves many activities that are labor intensive, requiring intimate insight into the structure and implementation of the database. An intelligent database administrator assistant system which interfaces to the data dictionary system could reduce labor intensive activities in logical database design, physical database design, entity name analysis/reconcilliation, performance tuning, capacity planning, and integrity control. This capability would also be an invaluable tool for the familiarization and support of less experienced database administrators, especially in light of the fact that the DBA is often an officer with a limited tour of duty with the system. Phase I will result in the definition and specification of a DBA Assistant. A prototype implementation shall be demonstrated at the end of Phase II.

AF90-038. TITLE: Temperature Monitor for Advanced Electronics Processing

OBJECTIVE: Develop a quantitative thermal monitor system with fast response time to control epitaxial growth parameters.

DESCRIPTION: Thermal information with good temporal and spatial information is needed to achieve the full potential of state-of-the-art electronics processing equipment. For example, in certain phases of semiconductor processing it is necessary to heat the wafer for a cycle with very short duration known as Rapid Thermal Processing (RTP). In order to effectively monitor and control this processs, it is desirable to have thermal data with the following characteristics: The thermal monitor must be noninvasive, noncontaminating and completely compatible with vacuum technology, vapor deposition procedures and radio frequency heating. The thermal readout should be accurate and repeatable to +1 K over the range 400 K-1300 K. The instrument must follow rapid thermal cycles with rates of change up to 500 K/second. The spatial resolution must <0.2 cm and be addressable to multiple regions within the process zone. The instrument must be compatible with the chemicals used in processing a diverse array of semiconductor materials, such as Silicon, GaAs, InP and CdTe. The instrument should be applicable for wafers from 1"-8" and be cost effective in terms of original cost, lifetime and reliability. The Phase I objective is to demonstrate quantitatively the aforementioned aspects with a point source detector. Phase II will include the fabrication and test of a system capable of addressing multiple wafer locations, processing the thermal data in near real time and feeding control signals to the heating package.

AF90-039. TITLE: MOCVD Reaction Chamber for Compound Semiconductor Deposition

OBJECTIVE: Develop a safe reaction chamber for use of epitaxial deposition of III-V and II-VI compounds by MOCVD.

DESCRIPTION: Current MOCVD systems used for the deposition of III-V compounds have advanced in several areas over the first generation of machines. The use of tube welding and improved plumbing fittings have reduced leaks to a manageable level. Activated charcoal filters and other types of scrubbing systems have matured to the point that the toxic effluents can now be handled with reasonable safety. However, one area of MOCVD systems that has not changed much from earlier designs is in the reaction chamber section. Quartz tubes or bell jars are still the rule. The gas injection scheme is usually designed by intuition and verified by experiment rather than starting from a fundamental understanding of the gas flow dynamics. Current reactors have a large throughput of unreacted gases that are a safety concern and wasteful. A fundamental change in the manner in which gas is delivered to the substrate wafer is sought that will remedy these deficiencies. This system will have optimized gas flow dynamics over wide pressure and flow regimes that will insure high purity and uniformity, abrupt compositional and doping profiles, minimize gas phase depletion effects and at the same time reduce the amount of unreacted toxins. The reactor should have a load lock and a stainless steel shell for safety that will not degrade the epitaxial deposits. Phase I will involve the design and optimization of the reactor design. Phase II will follow with the construction and verification of the Phase I effort.

AF90-040. TITLE: Electromagnetic Characterization of Superconductors

OBJECTIVE: Develop methods/apparatus for improved DC or AC electromagnetic characterization of high temperature superconducting materials/devices.

DESCRIPTION: Research and development on high temperature superconducting materials and devices require tools that probe their characteristics with accuracy and sensitivity, but which also make measurements rapidly and are not unduly taxing to operate. For example, improved measurement techniques for DC and wideband AC magnetic susceptibilities of bulk and thin film materials as a function of temperature are required for the rapid progress of research into properties of practical significance (e.g., critical current and microwave surface resistance). In Phase I a preliminary but practical design must be completed, together with an experimental demonstration, on high temperature superconductor materials, of its feasibility, practicality, and key advantages over present measurement techniques. The demonstration must be at selected temperatures above and below the superconducting transition temperature of the demonstration material. In Phase II the complete apparatus must be designed, constructed, and tested. The apparatus must be capable of performing measurements between 15 degrees Kelvin and room temperature. Deliverables will include the apparatus and a final report.

AF90-041. TITLE: Vapor Concentration Measurement for MOCVD and MOMBE

OBJECTIVE: Develop a noninvasive vapor concentration measurement system for MOCVD and MOMBE deposition of III-V and II-VI compounds.

DESCRIPTION: Metal Organic Chemical Vapor Deposition (MOCVD) and Metal Organic Molecular Beam Epitaxial (MOMBE) systems are widely used in the semiconductor industry for the active layer epitaxy of III-V and II-VI compounds. One requirement common to all these reactors is a gas vapor metering system that controls the concentration of the reactants injected into the reactor. Presently, heat capacity based Mass Flow Controllers (MFC) having a repeatability of .1% are commonly used to control the carrier gas flow through a liquid or solid metal organic reactant bubbler. From the reactants equilibrium vapor pressure, a vapor concentration can be assumed. Unfortunately, this assumption is not always valid. Some metal organic reactants such as Trimethyl Indium have been shown to have a long startup transient to reach a steady state and to change its vapor pressure with use. Another shortcoming with the present gas metering systems is that for some applications such as the deposition of InGaAs on InP, the .1% repeatability of the MFC is marginal. Therefore, an innovative vapor concentration metering system would have widespread application. Most important, it would improve the yield of the semiconductor devices for use in Air Force systems. The metering system must be compatible with ultrahigh purity semiconductor deposition systems. It should be a reasonably priced standalone instrument that can be retrofitted into existing systems. The components should be commercially available if possible. Concentration measurement and control in the .1%-.01% range for chemical vapors (e.g., trimethyl indium in a hydrogen carrier stream) is desired. Phase I work will involve proof of concept. Phase II will emphasize the design, construction and testing of a system for general use in the MOCVD industry.

AF90-042. TITLE: Thin Film Permanent Magnets

OBJECTIVE: Develop design criteria, techniques and structures to use thin film rare earth permanent magnets.

DESCRIPTION: Present circulators/isolators are magnetically biased using large, inefficient permanent magnet (PM) structures. New design criteria and techniques are required to provide miniature and lightweight magnetic biasing magnets for microwave/millimeter magnetic devices. Factors such as bias field uniformity, elimination of undesireable magnetic flux leakage, field orientation, plating PM films with conductors/superconductors to prevent RF fields from entering the films, and temperature sensitivity are to be considered. Also, compatibility of fabrication techniques with standard MMIC (Monolithic Microwave Integrated Circuit) processing methods is important, as ultimately, planar versions of magnetic nonreciprocal devices and their biasing circuits are to be monolithically incorporated with MMICs. High field strength magnets such as those provided by the materials SM2Co17 and Nd2Fe14B are to be incorporated in the program. Phase I should result in a demonstration by the contractor of the ability to deposit thin film permanent magnets suitable for biasing a nonreciprocal, magnetic microwave device (see reference by Stancil). The magnets should be deposited on a microwave substrate that is both suitable for microwaves and also for the deposition of a ferrite film required by a nonreciprocal device such as Gadolinium Gallium Garnet (GGG-host substrate for Yittrium Iron Garnet or YIG). In Phase II the contractor should produce a nonreciprocal device, biased by thin film PMs and that is complete, self contained and functional. A laboratory demonstration of its operation should be provided. A hybrid device is acceptable, but a complete monolithic device is preferred. Phase II will require some expertise in the design of a nonreciprocal device (perhaps through the use of a consultant), and could involve, in the case of a totally monolithic device, the deposition of a ferrite film.

AF90-043. TITLE: Near Field Adaptive Array Test Facility

OBJECTIVE: Develop a near field measurement technique for characterizing adaptive array antennas.

DESCRIPTION: Adaptive array antennas are vital to cope with intensive jamming environments. Determination of the adaptive performance of an array antenna by illuminating it with multiple, mobile jammers at an outdoors antenna range is both time consuming and costly. Hence, it is important to develop a new technique for determining far field properties of an adaptive array antenna (e.g., null depth, pattern response to platform and jammer dynamics, loss of mainbeam gain efficiency of adaptive algorithms) from measurements taken in an anechoic chamber using near field jammers. Such techniques should allow for efficient data collection and calculation of the predicted far field adaptive properties of the antenna. The goal of the Phase I should be to conduct a feasibility study to design a near field adapt. array facility. The emphasis should be placed on the practical limitations of implementing a theoretical technique to predict the far field response from the near field measurements. Taken under consideration must be an anechoic chamber or its equivalent. The study should also include a jamming radar environment. Phase II should result in the practical design of a near field facility lined with anechoic material having the capability of implementing the theoretical technique developed in Phase I.

AF90-044 TITLE: Active Programmable Microwave Directional Coupler

OBJECTIVE: Design/build a programmable, active microwave directional coupler as part of a T/R module for an airborne phased array.

DESCRIPTION: Reliability and affordability are the two key promises of technology for airborne active aperture powered radar systems of the future. By moving more electronics and photonics closer to the radiating aperture, microwave systems will be much simpler mechanically and will take advantage of most of the unused surface of aircraft for antenna placement (may be an integral part of the aircraft skin). On transmit, the directional coupler asked for in this effort should pass with unity gain, no loss, and no phase dispersion for the exciter signal that provides the transmit pulse for the radar. On receive, each coupler in the T/R Module at each radiating element should split a Taylor weighted excitation into two signals that will be collected by two uniform analog beamformers that operate in a vertical, curved dimension of an airborne array. One signal should leave the T/R module along the path of the transmit signal previously described while the second coupled signal needs to be weighted by the ratio of the Bayliss to Taylor distribution at each element. The challenge of this effort is the development of a programmable directional coupler that will be affordable due to the mass production capabilities of Gallium Arsenide technology by replicating one copy thousands of times. Depending upon its unique position in the phased array, the proper coupling ratio of input to output will be programmed as a function of scan angle by the use of small expert systems residing at the radiating element level. In Phase I of this effort, a design of such a device is asked for along with a trade study that should estimate the overall system costs in terms of dollars, DC power and computer control and storage requirements to have such a programmable directional coupler at each radiating element. In an array of tens of thousands of elements, Gallium Arsenide is the preferred material since all of the existing T/R module devices are in this technology. Phase II should seek to build one of these devices.

AF90-045. TITLE: Optical Logic Gates

OBJECTIVE: Develop approaches for low energy, all optical or electrooptical logic gates, and arrays of gates for high throughput digital optical signal processing applications.

DESCRIPTION: Planned Air Force missions may utilize digital optical signal processors since it is estimated that these missions will require computational capabilities several orders of magnitude beyond that expected from projected electronic computer technology. To implement digital optical signal processors, optical gates and arrays of gates which are compatible with planar and/or three dimensional signal processor architectures are required. The primary problem is that current arrays require too much switching/bias power at this time to be of practical use. In addition they generally have output signals which are too weak to allow cascaded operation. In Phase I, develop current or new low power innovative gates with gain, and perform iterative fabrication and test studies to engineer down the required

gate power. Fabrication may be performed in the nearby National Nanofabrication Facility, at the contractor's expense, with processing and testing done in the Photonics Laboratory using government resources. In Phase II, working in the Photonics Laboratory and the NNF, develop the Phase I optimal concept into a functioning optical gate, and, if possible, demonstrate logic cascading using functional arrays of gates.

AF90-046. TITLE: Photonics Measurements and Calibration

OBJECTIVE: Investigate measurement and calibration concepts for photonic components.

DESCRIPTION: Photonics has the potential to revolutionize the communication and computer industries over the next several decades. The key to tapping this potential is the development of components such as spatial light modulators, fiber optic links, and high bandwidth temporal modulators, fiber optic links, and high bandwidth temporal modulators that allow the potential of photonic systems to be achieved. Development of these components in turn requires the development of methods to properly characterize (e.g., speed of response, resolution, added noise) these components so that their performance in various systems applications can be predicted. The current capability to characterize photonic components and systems is immature compared to the electronic components and systems. In Phase I component parameters to be measured will be determined. A test set up to perform the measurements will be developed. In Phase II concepts will be demonstrated and specialized. Test and calibration equipment may be developed. All work may be performed in the RADC Photonics Laboratory.

AF90-047. TITLE: Very High Speed Signal Processor (VHSSP)

OBJECTIVE: Develop means of applying emerging high speed A/D/A converter and signal processing technology (>100 MIPS) to achieve directly programmable real time processing for Signal Modulation and Adaptive Receiver Terminals (SMART).

DESCRIPTION: The impetus for implementation of post-2000 programmable integrated SMART systems employing multilayer intelligent application of spatial, temporal, and optimal detection technology, relies on special purpose devices, such as those planned for Air Force applications such as ICNIA, Tactical C^3I, and strategic and satellite applications. The thrust of this effort is to develop those concepts and recommend those technologies and computational signal processors that would allow the modular (software) synthesis of programmable tranceivers using general purpose computational capabilities. The Phase I effort would be to review the signal processor developments, such as the programmable processor, the 3-D processor, and others, to obtain the design for demonstration of the VHSSP with real time signal and interference environments. The Phase II effort would be to develop a brassboard demonstration model using the appropriate available processors and computerized controllers.

AF90-048. TITLE: Co-site Interference Reduction

OBJECTIVE: Evaluate theoretically the applicability of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) programmable transversal filters for co-site interference rejection of Frequency Hopping (FH) radios.

DESCRIPTION: Co-located FH radios suffer a co-site interference problem due to the "uncleanliness" of the transmitted frequency bursts, as well as a lack of frequency selectivity at the receiver. This interference manifests itself as a desensitization of the victim receiver or complete jamming. The intent of this study is to evaluate FIR and IIR filter structures for transmit and receive filtering of FH signals. Study shall address programmable filters which can be reprogrammed to new center frequencies in less than 100 micro seconds. Critical issues to be addressed include dynamic range, noise floor, frequency hopping bandwidth and hop bandwidth. Frequency hopping bandwidth of interest is from 225 MHz to 400 MHz. Other attributes include hop bandwidth of 25 KHz and a noise floor less than that of any other components in the receiver section. The techniques investigated should be robust against multiple strong hopping interferences which could form undesirable inband spurious signals in nonlinear sections of a FIR or IIR filter. Phase I of this effort should theoretically evaluate the performance and applicability of FIR and IIR filters to the reduction of co-site interference between multiple FH radios. Phase II of this effort should be a hardware development of co-site interference rejection system which can demonstrate the performance against multiple FH radio interference.

AF90-049. TITLE: Communications Applications for Neural Net Technology

OBJECTIVE: To investigate neural net technology and identify specific applications to communications.

DESCRIPTION: Artificial neural net models have been studied for many years in the hope of achieving human-like performance in speech and image recognition. New net topologies and algorithms, analog VLSI implementation techniques, and the belief that massive parallelism is essential for high performance speech and image recognition has brought this technology more attention. Much of the work, which has been very promising, has been for speech and image processing problems. There are many communications signal processing problems that could benefit from application of neural net technology. Adaptive spatial and/or temporal signal processing and high level intelligent control of communications systems are two important areas of interest. Phase I work consists of identification of specific communications neural net architectures and algorithms, simulation and modeling. Phase II would involve a hardware brassboard development of one specific application.

AF90-050. TITLE: Target Angle Tracking in Adaptive Airborne and Space Based Radars

OBJECTIVE: Development of algorithms and methodology for measuring the angular position of targets with adaptive airborne or space based radars where the receiving antenna patterns have been modified for rejection of mainbeam clutter.

DESCRIPTION: The motion of the radar platform in airborne and space based coherent radars spreads the clutter Doppler spectrum. Clutter scatterers at different angles in the mainbeam of the radar have different radial velocities and Doppler frequencies. As a result of this clutter spectral spreading, some targets of interest have Doppler frequencies within the clutter spectrum and cannot be detected using conventional AMTI or FFT processing. Adaptive space-time processing techniques have been developed for detecting these targets. An example is displaced phase center antenna (DPCA) which was demonstrated in flight tests by Lincoln Laboratories. Other alternative adaptive radar designs use multiple receiving beams or fully adaptive arrays where all receiving element outputs are weighted adaptively. As a result of adapting the receiving array weights for clutter rejection, the receiving patterns are changing and distorted from the quiescent patterns. Conventional monopulse and dual beam algorithms for angle measurement cannot be used in these adaptive systems. Methods of simultaneously adapting the radar for clutter rejection and measuring target angle are required. Phase I will develop algorithms and methodology for measuring the angular position of targets with adaptive airborne or spaceborne radar where the receiving antenna patterns have been modified for rejection of mainbeam clutter. Phase II will obtain data and test the algorithms developed in Phase I.

AF90-051. TITLE: Constant False Alarm Rate Techniques and Algorithms

OBJECTIVE: To analyze, develop, simulate and evaluate Constant False Alarm Rate (CFAR) techniques and algorithms.

DESCRIPTION: Efforts to date have concentrated mainly on system tradeoff and risk reduction studies in operating frequency, antenna/receiver/transmitter configuration and power/aperture product. A serious problem with CFAR is how to handle the interface between nonhomogeneous clutter, such as land and sea. Special techniques are required to maintain false alarm control and detectability at such boundaries. In addition, if the threat consists of a very dense multitarget raid, then background interference estimates using adjacent range bin data will be contaminated by targets, desensitizing the detector. Therefore, some advanced techniques and algorithms are required for CFAR noise estimation. This task should analyze the specific aspects of the CFAR problem and develop, simulate and evaluate a CFAR algorithm. Phase I will develop and evaluate CFAR techniques. Phase II will obtain data to test the techniques.

AF90-052. TITLE: Disposal of Manufacturing Wastes from Composite Materials

OBJECTIVE: Develop technnology to dispose of wastes generated from fabrication and repair of components made of composite materials.

DESCRIPTION: Fiber-reinforced polymers ("composites") comprise a significant fraction of the materials used in the

fabrication of recent and developing Air Force weapon systems. However, incineration or autoclaving and landfilling are the only present methods to dispose of waste materials generated during preparation, molding and finishing of composites. Hazardous wastes requiring disposal may include (but not be limited to) any of the following: uncured resin, initiator, uncast polymer or composite, mold trimmings, finishing dust and rejects at all stages of the fabrication process. Technology is required for the efficient, nonpolluting, cost-effective disposal and/or minimization of the various forms of waste generated during manufacture and repair of various forms of composite components. Phase I effort should assess the feasibility of developing economic treatment and/or minimization of wastes generated during composites manufacture and refurbishment. Phase II will develop and test the most promising techniques identified in Phase I.

AF90-053. TITLE: Effects of Structures on Toxic Vapor Dispersion

OBJECTIVE: Develop methods to quantitatively evaluate the effects of large buildings on the dispersion of hazardous chemical vapors.

DESCRIPTION: Computer models currently used to predict toxic vapor cloud length, concentration, and duration at Air Force installations are generally of the gaussian plume or puff variety. Vapors are assumed to travel at the ambient wind speed and to disperse at a rate dependent on atmospheric stabillity, wind speed, and horizontally homogeneous surface roughness parameter. This ignores the potential for large buildings and "street canyons" near an accidental release site to trap hazardous gases in stationary eddies, quiescent zones, and inside open structures such as hangers, warehouse, and maintenance facilities. Parameterization of such building effects has been attempted in some long-term air quality assessment models, but not in hazard response systems. Computer algorithms are needed which can quantify changes in the rate of concentration reduction that arise due to vapor trapping. Both neutrally buoyant and dense gas cases should be considered. The ultimate product of this research would be a microcomputer compatible system adaptable to base-specific building configurations and capable of interfacing with gaussian puff (passive tracer) and box-type (heavier than air) dispersion models. Phase I work should realistically assess the feasibility of producing a viable system and whether the buiolding effects in question are significant relative to over all dispersion model uncertainty. Phase II will scale up the concept and fully characterize its performance capabilities in preparation for subsequent advanced development.

AF90-054. TITLE: Innovative Concept for Hardened Aircraft Hanger Door

OBJECTIVE: To develop new and innovative ideas for semihardened aircraft shelter door systems.

DESCRIPTION: The Air Force has a need for a new semihardened protective door system for aircraft shelters. The door system should be resistant to jamming after blast pressure loading. The operation of the door should not be hindered by the presence of debris. A powered opening/closing system must provide for rapid opening and closing of the shelter door. A backup manual opening/closing system will be necessary in the event the powered systems fail. The door shall be protected from fragmentation and direct hot threats as well as blast overpressures. The capability of the door should not degrade from exposure to heat or fire. The structural design shall consider normal "static" loading conditions (dead and live loads), and the dynamic loads associated with the threat. Dynamic designs shall consider both localized weapons effects on individual structural members and overall weapons effects on the entire structural system. Design shall analyze weapons effects and structural configurations to determine whether critical loads are related to the peak pressure or total impulse. High pressures of short duration often result in localized effects while longer duration total impulse loads typically involve more extensive portions of the structure. Phase I will develop new and innovative ideas for semihardened aircraft shelter door systems. Phase II, if approved, should evaluate the concepts and materials identified in Phase I, and develop a complete door system for installation.

AF90-055. TITLE: Rapid Soil Stabilization

OBJECTIVE: Develop innovative materials and methods of rapid soil stabilization for worldwide construction of wartime airfields.

DESCRIPTION: Current methods of stabilization involve mechanically compacting soil or mixing in chemical agents. For sandy soil, geosynthetics may be used to provide added strength. In clays, lime may be added to chemically alter soil

properties and provide increased strength. These methods, however, are time-consuming, labor-intensive, and rely heavily on logistical support. Required strengths may not be reached for weeks. Additionally, conventional methods require disturbing the original soil and affect any preconsolidation or strength a soil may have naturally achieved. This effort is to push technology forward in the area of rapid, unconventional in situ soil stabilization. Materials and techniques investigated should maximize the use of on site materials and be reasonably priced. Materials must require little preparation and handling, be quick-setting and readily available. Methods must be simple and adaptable to any scenario. Equipment must be uncomplicated, air-transportable, and field-mobile. Phase I will propose several innovative approaches. For each approach, perform feasibility analysis to indicate probability of stabilization success, evaluate each for compliance with system objectives, and investigate prototype fabrication. Phase II will consist of fabrication and/or demonstration of the most promising approaches on in-place soils.

AF90-056. TITLE: Visual Spectrum Flame Recognition

OBJECTIVE: Develop accurate and reliable fire detection systems via machine vision that can assist mission readiness and prevent major loss of Air Force weapons and support facilities.

DESCRIPTION: Fire detectors which work by the principal of heat and smoke detection are slow. Therefore, significant damage in the protected area can occur when using the heat and smoke detectors. Fire detectors which work by the principal of detecting electromagnetic radiation are fast but not of desirable accuracy. Many flame radiation or Optical Fire Detectors (OFDs) have been taken out of service because of false activations causing release of fire fighting agents and resulting in lack of protection and costly replacement. Optical Fire Detectors work in narrow radiation bandwidths which yield limited information for judging fire. This program will develop criteria for detection of fires and collect data that will be used by a machine vision fire system. The approach will use recent developments of Machine Vision (MV) hardware. Machine Vision hardware is now cost competitive with existing fire detector hardware because fewer Machine Vision subsystems will be required as compared to narrow bandwidth Optical Fire Detectors. Information more familiar to human experience may be gathered by a Machine Vision system and the fire judgment criteria, which is not as tangible as for existing Optical Fire Detectors, will be based more directly on human experience which is accurate for fire detection. New developments in Machine Vision hardware also allow the analysis speed required for fire detection. Phase I will identify recent developments of machine vision (MV) hardware and develop an approach for Phase II. Phase II, if approved, will determine appropriate and sufficient data criteria to support rapid fire detection by machine vision. Further, validation of criteria (via hardware/software testing) for military standard will be conducted.

AF90-057. TITLE: Human Systems/Subsystems Research

OBJECTIVE: To develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: This topic is intended to provide an opportunity for the proposer to submit ideas directed towards enhancing man's capability to function effectively and safely as an integral part of Air Force systems and military operations with the overall objective of increasing mission success. This general area includes: 1) human factors engineering, such as methods improving man/machine interfaces or enhancing human physical or cognitive performance; 2) personnel protection/life support, such as life support and crew escape from a transatmospheric vehicle; 3) chemical warfare defense, such as advanced personal and collective protection equipment; 4) occupational/environmental hazards, such as identification of and protection of toxic materials and electromagnetic or ionizing radiations; and 5) personnel training and simulation, such as new technologies that improve the effectiveness or efficiency of training programs and methods. Ideas are solicited that effect any or all of the operations, maintenance, and support roles of Air Force personnel.

AF90-058. TITLE: Innovative Analysis Procedures for Environmental and Occupational Health Surveys

OBJECTIVE: Analytical procedures and equipment for determining presence and amount of environmental and occupational contaminants.

DESCRIPTION: The USAF has a need for reliable methods of sampling and analysis of many environmental and occupational health type of chemicals and materials in different media. Some examples are: (Note: Proposals should identify specific subtopics as listed below).

a. The USAF has a need for a reliable means of evaluating vapor and particulate fraction exposure to various forms of isocyanates during applications such as painting and foam production. In the absence of a reliable method, overprotection in the form of costly and uncomfortable respiratory protective equipment must be used. The National Institute for Occupational Safety and Health (NIOSH) analytical method for isocyanates was withdrawn by NIOSH from approved methods leaving no acceptable method for evaluating exposure. Surrogate techniques involving calculations based on solvent content of paint or measurement of pigment are inadequate. A method which captures and measures both free and polymer foam is needed.

b. This study would determine the feasibility/cost effectiveness of using soil gas survey methods in the remedial performance and long-term monitoring stages. The law requires performance monitoring at least every five years after the enacting of remedial action at Installation Restoration Program sites. The Air Force also considers long-term monitoring as an alternative to remedial action. The Occupational and Environmental Health Laboratory (AFOEHL) is charted for the long-term monitoring and is likely to perform the performance monitoring as well. This requires field sampling and laboratory analysis which are expensive and have at least a 2-month time lag after sampling. Soil gas methods may be cost-effective and produce real-time data at wells and grids dedicated for performance and long-term monitoring purposes. However, there is no record of this application. There is a need to determine the feasibility of soil/well-head gas survey with comparison to the collection of water and soil samples and established protocols for the implementation.

c. The USAF needs to determine the influence of purging and sampling methods on volatiles in low permeability wells. Many Air Force Installation Restoration Program monitoring wells are installed in low permeability clay/rocks which run dry after purging one well bore volume. Consequently, it takes a long time for the well to recover and to sample. The problem is when to sample--after four hours, one day, or after the well is almost returned to its static level? This is not only tied to the representativeness of the collected water sample but also requires significant labor hours compared to a high permeability well. The effect of annular space and filter pack on the water sample shall be determined. It is claimed that ground water seep through the dewatered filter packs will be aerated and thus lose its volatiles. Sand tank experiments and field tests are necessary to determine the design of a monitoring well and the time of sampling. The result of this study will enable the Air Force and DoD to set protocols for sampling low permeability wells.

AF90-059. TITLE: Distributed Command and Control (C^2) Research and Decision Analysis Tools

OBJECTIVE: Schema sharing and synchronizing in distributed C^2 environment and analysis of dynamic C^2 networks.

DESCRIPTION:

a. Knowledge Transference and Innovative Decision-Making in Distributed Command and Control Environments. Objective of research is to investigate the group decision making issues that arise when the group is 1) in a "distributed" or noncollocated environment; 2) linked by a computerized network; and 3) attempting to maintain an innovative stance when planning for the inherent uncertainty of battle. In order to protect resources in the event that an attempt is made to neutralize command center functions, the option to distribute command and control (C^2) is a consideration. If one node within a C^2 network is neutralized, another node should be able to overcome the loss and continue operations. This presents a difficult and unpredictable situation as C^2 network functions are increasingly computerized. One of these functions, battle planning, may suffer greatly if there is 1) an inability to rapidly share/trade understanding of situation assessment information (often across a computerized network) with other nodes in the C^2 network and 2) a propensity to rigidly follow "old" battle plans which are not keeping up with the rapidly shifting battle. In other words, how does the battle management team deal with replanning "on the fly?" Prior research dealing with expert knowledge mental models, indicates resolution may be determined by a greater understanding of the process by which situation assessment information is shared in a "chunked" fashion. These "chunked" pieces of information (such as mental models or schemas) must be transferred from one group/team to another in rapid succession. Examples of group concerns are ability to "synchronize" their understanding of the battle situation and ability to rapidly change and/or improve their decision making to accommodate the rapid changes in the battle. Along these lines,

if the battle management group is able to share a "mental model," how do they rapidly change that model commensurate with the change in the battle situation? Can this method of knowledge transference be captured and built into a group training system?

b. Reorganizing, Dynamic Network Performance Analysis Tool. Complex systems, such as C^3 systems, can be represented in terms of the processes which are performed, the resources which are used to accomplish the processes, the organization which define the lines of authority and coordination for the processes and resources, and the goals which are established for the organizations and processes. Current network analysis tools, such as Structured Analysis and Design Technique (SADT) and Colored Petri Nets (CPN), allow for ways of analyzing dynamic networks based upon the structural and behavioral relationships which exist between processes and resources. This existing tool kit must be augmented by including the goals and organization dimensions into the analysis methodology. The four dimensions of process, resources, organizations, and goals should be organized into a data base which relates the mappings of each dimension onto each other. Using these interrelated elements, algorithms should be developed which allow the resulting network description to be reorganized and restructed as changes occur to the four analysis dimensions. The Phase I product should be a technical report giving complete description of 1) how the four dimensions are related, 2) the format of how the relationships should be defined, and 3) the algorithms which map the descriptive elements onto the network model. Along with the technical report, a story board, portraying how the resultant system would operate, should be delivered. The Phase II product should be a working prototype of the reorganizing, dynamic network performance analysis tool.

AF90-060. TITLE: Telepresence Dexterous Manipulator Technology Under Human Control

OBJECTIVE: Develop new technologies and evaluation tools to advance and assess Robotic Telepresence master-slave systems.

DESCRIPTION:

a. Design (Phase I) and fabricate (Phase II) a standardized task battery to quantify and assess the key metrics of dexterity, manipulation, and force feedback for human controlled robotic systems. Presently, no standardized approach exists to identify and measure these key parameters. The challenge is to identify and design a set of instrumented tasks that measure the important parameters of telerobotic task accomplishment and force feedback. Also needed are data acquisition set ups and authenticated analysis routines.

b. Design (Phase I) and fabrication (Phase II) of a force reflecting master for telerobotic (supervised autonomy) aerial refueling. Current technology relies heavily on direct viewing with little or no visual signals of successful boom insertion. Force reflection to the boom operator could help to prevent over stressing of refueling components. System design and force reflection algorithms should be compatible with existing boom paradigms (flaperons and ailerons instead of motors, for example). The technologies should also be integrable into existing aircraft. Technologies could include machine and operator vision systems for supervised autonomous (with human backup) insertion operations. One challenge is to provide useful feedback to the operator while accounting for the dynamics of three independent coupled systems.

c. Design (Phase I) and develop (Phase II) advanced interactive graphics models for real time visual display of flexible telemanipulator arms. The challenge is to acquire and integrate real images with graphical representations of refueling aircraft and boom in real time to portray the actual state of the operation and dynamics of the system. Enhanced situational feedback might add macroscopic and microscopic views to the standard view. Solutions should minimize modifications to the involved aircraft (i.e., use existing light of receiving aircraft).

d. Design (Phase I) and fabricate (Phase II) instrumented generic master/slave tools for robotic grasping research. Routinely robotic systems measure the forces, torques and tactile pressures at the end effector. The challenge is to instrument generic tool shapes to quantify internal strains along principal axes and locate grasper contact points/forces. The objective is to quantify manipulation parameters at the tool level. The tools may provide force feedback to the operator and should permit human use or one tool and robotic use of a replica tool.

AF90-061. TITLE: Crew Station Design

OBJECTIVE: Devices and technologies which improve mission performance through better design of crew systems and interfaces.

DESCRIPTION:

a. Advanced Line-of-Sight Helmet Orientation and Position Measurement Systems need reduced sensitivity to field distorting materials and reduced system installation complexities in aircraft cockpits. Current military systems that incorporate rugged, lightweight, helmet mounted transducers use A-C coupled magnetic fields sensitive to conductive and ferromagnetic materials in cockpits, etc. Other environments produce enough field scattering to prohibit A-C coupled transducing schemes (e.g., M1 tank turret application). An alternate remote sensing or transducing technique is needed which is insensitive to conductive surfaces, simplifies individual site installation, and is small, lightweight, and rugged. End product Phase II: Flyable Brassboard hardware militarized for the fixed-wing fighter or multiengine military aircraft environment. End product Phase III: Preproduction hardware for general application to Tri-Service vehicles.

b. Advanced Optical Materials/Devices for Aircraft Cockpit Helmet Mounted Displays (HMD) that provide more design degrees-of-freedom per element, reducing weight and improving performance. Current HMDs must obtain monocular fields-of-view of thirty to fifty degrees, provide an unvignetted exit pupil size of 14 to 18 millimeters, provide image source-to-eye transmission efficiencies above 50 percent, and accommodate eyeglasses. Binocular systems with full, or almost full, eye overlap are desired. Keeping head-born weight below 3.5 pounds and maintaining a reasonable head/helmet center-of-gravity is difficult. Weight savings must be obtained in the helmet without sacrificing protection and in the optics without sacrificing performance. Aspherical and holographic elements often have insufficient performance. New materials and optical elements, such as gradient index materials or selective narrow-bank coatings/gratings, are needed. End product Phase II: Prototype HMDs with improved lightweight optical designs. End product Phase III: Flight advanced optical materials for operational evaluation.

c. Develop a new HMD design. The helmet-mounted display (HMD) should permit simultaneous viewing of the display image and the outside world. Some project a collimated image onto a helmet-mounted combining surface positioned between the outside world and the eye. Designs that position the display away from the eye and route its image to the combiner via lenses, mirrors, and/or fiberoptics, tend to be bulky, heavy, and pose center-of-gravity problems. The ideal approach would place a flat, lightweight, transparent display directly in front of the eye, integrating the functions of the display and combiner. Flat-panel display technologies hold promise. Problems include the following: 1) simultaneous clear vision of distant (outside world) and near (display image), and 2) adequate transparency and luminance of the HMD. End product Phase I: Design and construct a Combiner Display technology demonstrator with display and optics — may be monocular, need not be head-wearable or helmet-mountable. Image generator may be self-contained and need not interface with external graphics devices. Provide a final technical report. End product Phase II: A fully functional binocular prototype, suitable for head-worn or helmet-mounted operation and capable of displaying dynamic images from external graphics devices.

AF90-062. TITLE: Application of Artificial Intelligence Technologies to Training Systems

OBJECTIVE: Apply Artificial Intelligence Technologies to Training Systems.

DESCRIPTION: Artificial intelligence technologies hold significant promise for developing automated Intelligent Tutoring Systems (ITS) that achieve a student-to-teacher ratio of one-to-one by customizing presentation of instruction to an individual student. All proposed software systems should run on an IBM/XT compatible microcomputer under MS/DOS. Within this broad topic we invite proposals which address one of the following areas: (Proposals should address the specific subtopic below)

a. Knowledge representation can run the gamut from formal logic grammars (most rigorous) to freedom text (least rigorous). Much research suggests that an optimal approach to knowledge representation in an ITS may be "semiformal" in nature. Examples of semiformal approaches to knowledge representation include hypermedia and frame languages. We wish to examine the semiformal approach to knowledge representation. Proposals in this area, therefore, should cover

the specification, design, and implementation or a proof-of-concept ITS in an Air Force domain which uses just such a semiformal approach to knowledge representation. All media, including interactive videodisk (IVD), should be considered.

b. In order for ITSs to adapt to the instructional needs of individual students, they must be able to diagnose skills and knowledge a student posesses at various stages of training. On-line diagnosis of problem solving abilities is a viable near-term goal. Research on student models and Psychometric Theory feed the design and development of a prototype computer based diagnostic testing system. A successful project in this area must 1) design specifications for student modeling, 2) identify psychometric issues and solutions in Computer Based Diagnostic Testing (CBDT), and 3) design, develop, and document a prototype CBDT Software Shell.

c. Artificial Neural Networks (ANNs) may provide significant capabilities for ITSs in areas such as student modeling, recognition of patterns of "paths" students take through instruction, intelligent interfaces, rule generators for expert systems, and others. Proposals in this area should emphasize a novel application of ANN technology to ITSs.

AF90-063. TITLE: Concurrent Engineering

OBJECTIVE: Develop information architectures and new applications of decision science methodology within concurrent engineering environment.

DESCRIPTION: In order to fully exploit the potential benefits of concurrent engineering, the following research area is of specific interest.

a. Information Architecture. Develop information architectures, as well as the methodologies and tools to support and implement them, which will provide the data integration required in a concurrent engineering environment. Such architectures must support the complex, heterogeneous, and distributed data environment characteristic of concurrent engineering applications. The goal of these information architectures is to facilitate the sharing of data and to allow design parameter tradeoffs horizontally and vertically in the design hierarchy.

b. Design Decision Support. Determine and develop new applications of decision science methodology that allows the design team to tradeoff the various design attributes such as performance, cost, schedule, supportability, operability, and producibility within a Concurrent Engineering environment. These attributes may have logical measures of merit which are either qualitative or quantitative in nature, or the measures of merit may have to be derived as part of the decision support system. The goal of these decision models is to provide the design team with the capability to judge the relative merits of various design options and to evaluate the final design with respect to life cycle implications.

AF90-064. TITLE: Contingency Task Training

OBJECTIVE: Predict critical enlisted specialties, develop procedure to determine training requirements, and apply across AF specialties.

DESCRIPTION: The Air Force does not have sufficient capacity for effectively predicting which tasks are needed in critical contingency situations. The present method utilizes Subject Matter Experts (SMEs) who identify which tasks they feel are critical during the last few moments of an annual review of Air Force Specialty Training Standards (STS). The first objective of this research need is to develop methods for predicting which peacetime enlisted specialty tasks are critical to the mission of the Air Force during wartime or Low Intensity Conflict (LIC) situations. Secondly, a procedure must be developed for determining the training requirements to perform those critical tasks under a range of contingencies. As a minimum, this project requires the creation of a "scenario analyzer" which determines the tasks required to support each wartime scenario presented. For example, a PC based scenario analysis program might be developed to facilitate the analysis of wartime or LIC task requirements. Then, research based procedures might be developed for linking scenario task analysis to Air Force occupational task survey data and SME judgments in the specifications of task criticality and performance requirements. The final phase of the project might determine the tasks within and across Air Force specialties which are critical to mission completion during contingency situations and describe what their extraordinary training requirements are. Phase I will result in prototype development of

technology and software for analyzing scenarios. Phase II should develop linking procedures for scenario task analysis to occupational task surveys.

AF90-065. TITLE: Analysis of Air Force Officer Accession and Retention

OBJECTIVE: Develop a model capable of explaining and predicting officer accession and retention behavior in critical occupations.

DESCRIPTION: In determining the Air Force's ability to attract and retain officers in critical fields such as flying, engineering, and medicine, it is crucial that the Air Force make the best informed use of limited fiscal and personnel resources tempered with an understanding of how future demographic patterns and national trends affect officer accession and retention. The recent implementation of a pilot retention bonus is but one example of the use of retention models on which to base policy decisions. Phase I of this project would see a review of relevant military and civilian labor market and demographic models with the emphasis on theoretical and empirical soundness. The usefulness of the models as aids to decisions, such as pay, bonuses, retirement, length of initial service commitment, career retention, and desired experience policies as well as how these policies should be modified in light of increased knowledge about future demographic trends would be key areas of concern. The final part of the first phase of the research would construct a model, based upon the results of the review of existing models, which would be most suitable for Air Force needs. Such a model would include not only pay, compensation, policy, and demographic variables, but also attitudinal factors such as perception of the military, job performance, job satisfaction, accommodation to military life, trends in national attitudes, and others that affect accession and retention behavior. A preliminary test of the model's capability to explain and predict officer accession and retention behavior in critical occupational areas would be conducted. This test would also focus on how the Air Force must adapt its economic, accession and retention policies to meet changing national and regional demographic patterns. Phase II of the research would see the development of a large-scale officer accession and retention model capable of modeling the flows into and out of officer job specialties. The impact of the civilian labor market such as airline hiring patterns and other civilian occupational trends would be studied. Special emphasis would be on incorporating and testing in the model critical demographic factors and future demographic trends determined to be relevant during the Phase I effort. The total officer force accession and retention model would permit the joint estimation of accession needs with the Air Force's ability to retain qualified and experienced officer personnel in specific occupations, with the required experience and training in light of future demographic trends. An interactive personal computer-based model would be developed to assist personnel managers in making the most effective force policy decisions for the officer force.

AF90-066. TITLE: Life Support Systems Development

OBJECTIVE: Develop advanced life support systems for aircrews.

DESCRIPTION: Aircrew of advanced systems technologies requires improved environmental protective systems in order to provide sustained operator capabilities. The development of advanced systems and improved psychophysiologic performance measurements remains imperative for man-machine interface. Proposals should specifically address subtopics:

a. Aircrew of high performance fighter aircraft capable of sustained 9-G and high altitude aircraft capable of altitudes >60 K, have unique requirements providing for their basic physiologic functions to allow adequate performance. Frequently this performance requires nonmachine interface at a highly technical level; i.e., a compromise in performance results in a less than satisfactory equipment function. These environments include high-thermal stress, high-sustained $+G_z$ exposures of 9-G for 30 seconds, long-term continuous operations, hypobarism, rapid decompression, laser eye hazards, and chemicals of warfare. Although protective methods and systems are available for these extreme environmental changes, they frequently do not provide adequate protection for optimal performance. These systems frequently need to be refined or new solutions provided. The Phase I efforts shall address methods and systems capable of improving physiologic aircrew functions.

b. There are many life-threatening situations inherent in a chemical warfare scenario. In addition to the obvious risk of exposure, individuals working and wearing the Chemical Defense Ensemble face the extreme hazard of becoming thermal casualties. A device to gather and integrate the biophysical data necessary to determine if a person is a heat casualty, without compromising the integrity of the Chemical Defense Ensemble, would assist in the

determination of appropriate medical treatment. Measurements applicable to this task include heat flux, vapor flux, temperature inside the Chemical Defense Ensemble, heart rate, skin temperature, and core temperature estimates. The device would incorporate these values to calculate a category, or rating, of the individual's thermal status. This information could be used to "triage" heat casualties, determine the extent of treatment needed to alleviate heat stress/illness, and ultimately return the individual to duty. Phase I is envisioned as a concept and requirements analysis and design of a device for demonstration purposes. Phase II product should be a prototype device that has undergone initial testing.

c. Provide on-line physiological assessment of pilot workload and state in aircraft and simulators. Real-time monitoring of pilot state is required now and will be essential on newer aircraft and simulator systems. A physiological monitor is required which will provide on-line collection, analysis and storage of information about pilot's heart rate, heart rate variability in two bands, eye blink rate and duration, and respiration. These are reliable measures of operator state and workload. The device can be modular, but must be capable of being worn by pilots during flight and should weigh no more than currently available on-body physiological recording devices. Up to eight hours of battery operation and storage capacity is required. All amplification, signal processing and storage must be accomplished by the device. End product Phase I: Design and prototype development of the device. End product Phase II: Fabrication and testing of the actual simulation and flight environments.

d. Use neural networks to process real-time physiologic data to generate a mental workload metric. Classic analysis of physiologic data has failed to measure small changes in mental effort required for different tasks except in tightly controlled, non real world tasks. What meaningful data are generated are often time and computing intensive and thus not available until long after the data are collected. Using the proper set of physiologic measures and applying concatenated neural nets of both supervised and unsupervised types might recognize subtle patterns in data. Even more powerful would be the ability to do this in real time while the subject is performing. Various measures such as EEG, EKG, respiration, temperature, facial muscle signals, GSR, and others have shown some promise when both classic analysis or neural net analysis techniques are used. However, putting a collection of this type of data into a complex neural net has not yet been reported. Phase I product would be a proof of concept demonstration of non-real time analysis with a net and the generation of a trial mental workload metric. This demonstration could use a laboratory type simplified task. Phase II products would be a full system that produces a useful mental workload metric in real-time from a complex real world task.

e. Agile laser effects and countermeasure interests include methods to evaluate safety hazards from lasers and optical munitions, risk and effectiveness assessment of electro-optical countermeasures, and T&E methodologies for holographic and fast-switch protective devices. Phase I shall include assessment of laser effects and countermeasure methodologies, and Phase II shall address protective devices.

AF90-067. TITLE: Systems Analysis of Aerospace Medical Technology

OBJECTIVE: To develop analytical tools for diagnostic systems and subsystems used in aerospace medical technology

DESCRIPTION: Medical standards for aircrew selection and evaluation change frequently. The current emphasis is on flying stress associated with new aircraft/missions. Aerospace medical technology is used to determine fitness to fly. Analytical tools for aerospace medical diagnostic (sub)systems need to be developed. The product of Phase I will be proof-of-concept of a systems-oriented, analytical technique. The product of Phase II will be a new methodology for diagnosis based on analysis of aerospace medical technology. This systems-analysis approach should be applicable to other aspects of military and civilian health care.

AF90-068. TITLE: Chemical Modeling of Halocarbon Toxicity

OBJECTIVE: Predictive structure/activity relationships for estimating the toxicity of halocarbon compounds.

DESCRIPTION: Many of the hydrocarbon-based fluids currently in use by the Air Force as solvents, degreasers, lubricants, hydraulic fluids, and pump oils often pose significant fire and environmental hazards. For these reasons, the Air Force has been investigating alternate nonflammable, chemically inert halocarbon-based replacements for many of the fluids found in its inventory. Unfortunately, commercially available halocarbon fluids currently under evaluation

may pose significant health risks to personnel exposed to these materials. The chemical structure/property relationships involved in halocarbon toxicity and potential for biological reactivity appear to be significantly different than those for hydrocarbon compounds. A predictive quantitative structure/activity relationship (QSAR) model for the toxicity of halocarbon fluids needs to be developed and validated. Phase I would develop a predictive QSAR model for halocarbon fluids using available data to relate structure, chemical reactivity, and toxicity. Phase II would test the predictions generated by the QSAR model through the synthesis of model halocarbon fluids for assessment of toxicity and metabolic potential by the Air Force. Data generated through the evaluation of these model compounds will allow the development and Phase III application of the validated QSAR model, leading potentially to commercialization of nontoxic, nonflammable compounds capable of performing to appropriate MilSpec requirements.

AF90-069. TITLE: New Concepts and Innovations for Aeronautical Systems/Subsystems

OBJECTIVE: To develop new concepts and innovations for aeronautical systems/subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical systems/subsystems research, development, and acquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, training, strategic, transatmospheric, etc.). Emphasis is placed on potential long-term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Additionally, innovative proposals which address Logistic Technology Needs are encouraged. Some other areas of interest are very low or maintenance free systems, countermeasures, and innovative R&D systems/subsystems concepts. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF90-070. TITLE: Artificial Intelligence Applied to Aeronautical Systems

OBJECTIVE: To develop artificial intelligence systems applications applied to all aspects of the Air Force mission.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of artificial intelligence in aeronautical systems. It is meant to provide the innovator with latitude to include areas of application not addressed by other specific aeronautical R&D topics. This general area covers all aspects of artificial intelligence (i.e., knowledge representation, innovative architectures, expert systems, neural networks, etc.). This subject area is to be considered as applying to all aspects of the Air Force mission with special emphasis on solutions to operational or logistics needs. Therefore, it applies to systems applications such as UAVs, hypersonic system, decision aiding, training, etc, logistics, and maintenance, and as innovataive applications of the science of artificial intelligence in solving Air Force problems.

AF90-071. TITLE: New Concepts and Innovations (NCI) to Enhance the Cost Estimation of Aeronautical Systems/Subsystems

OBJECTIVE: To develop or upgrade cost estimating tools to evaluate the Life Cycle Cost effects of NCI during the conceptual phase of aeronautical systems/ subsystems development.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of cost estimating from the laboratory technology phase to the fielding of weapon systems/subsystems. It is also intended to provide latitude of the innovator to cover specific technologies as well as the accumulation of these initiatives into a total systems/ subsystems cost model for application to estimating the cost of "integrating" combinations technologies in an operational system including the cost and cost benefit of prototyping for functional demonstration as a prelude to full scale development/production. Lack of an ability to evaluate the cost of technologies being considered across the Project Forecast arena will severely impact out-year budgetary planning resulting in project cancellation due to the unpredictable "cost growth." High Temperature Materials; Ultralight Airframes; Smart Skins; High Performance Turbine Enginers; Combined Cycle Enginers; STOL/VTOL Technology; Advance Manufacturing Technology advanced avionics; every imaginable new system (hypersonic, supersonic VTOL, special operations, etc.) are all beyond today's cost estimating capability and should be addressed individually and in combination. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF90-072. TITLE: Determination of Effects of Interoperability Issues on Intratheater Airlift

OBJECTIVE: Devise/develop effective methods of cargo transfer between USAF intratheater airlift and army transportation assets.

DESCRIPTION: Determine what technology improvements may be possible for future theater airlift designs with emphasis on rapid loading and unloading. Conventional transports require externally-provided material handling equipment (MHE) and considerable time to load/unload palletized cargo. All types of cargo transfers between USAF theater airlift and Army transportation assets in Europe, Southwest Asia, Central America, etc., should be examined. Such factors as the compatibility of USAF/Army material handling equipment (MHE), USAF intratheater airlifter cargo handling compatibility with Army helicopters, trucks, palletized loading systems and International Standards Organization shipping containers must be treated. The availability, reliability, ability, maintainability, survivability and rough terrain capabilities of cargo transfer assets also require evaluation and understanding. Self-contained loading/unloading approaches, either fixed to the aircraft or preferably removable, featuring ease of operation, structural integrity, reliability, maintainability, lightness of weight, rapid load/unload times, and reasonable costs need to be investigated. Phase I will review all available military and commercial data sources, define key issues and problems and recommend possible options and potential innovative solutions to develop further in Phase II. Phase II will examine in-depth key issues and problems and further develop technological solutions to cargo loading, unloading and transfer from USAF aircraft to Army transportation system.

AF90-073. TITLE: Vulnerability Assessment Techniques for Conceptual Aircraft

OBJECTIVE: To develop rapid assessment techniques for evaluating vulnerability of conceptual aircraft.

DESCRIPTION: An innovative approach is required to rapidly estimate vulnerabilities for conceptual aircraft versus a range of nonnuclear weapons. These estimates are needed to provide inputs to survivability and effectiveness simulations and to develop desired hardness levels. Typically they must be generated with only minimal design data and within two-three weeks to meet analysis schedules. Responsiveness is critical if the analysis results are to be usable to develop desired hardness levels. Vulnerability analysis techniques such as FASTGEN/COVART have been developed and documented. However, they are principally applicable to aircraft in final design phases and are not usable for preliminary design concepts. Some development of approximation techniques has been done, but a highly experienced analyst is still currently required to generate data within the time constraints. Phase I is expected to consist of a review of typical levels of design data available, usages, and analysis time and threat requirements. Based on this review a set of analysis requirements would be developed and compared to existing analysis techniques, and a suggested approach would be developed. Phase II would consist of developing, implementing, and documenting the suggested approach.

AF90-074. TITLE: Consolidation of Leadless Chip Support for the F-15E

OBJECTIVE: Determine vendors using leadless chip carriers in their circuit card assembly design, and the support method they plan on recommending to the Air Force. Methods are to be consolidated.

DESCRIPTION: Leadless chip carriers are used by various Line Replaceable Units (known ones at this time are the APG-70 Radar, Remote Map Reader and Multipurpose Display Processor) in the F-15E, Dual Role Fighter. Currently there is no consistent method of providing for the organic depot support (procedures and tooling) of these chip carriers. With each F-15E vendor proposing his own different support method this leads to an over proliferation of depot support equipment. This requires the depot maintenance personnel to learn many different support systems. Phase I activity will include consolidating the list of all F-15E systems that use leadless chip carriers and their proposed method of support. This leads to the Phase II activities of researching and determining if there is a generic method to support leadless chip carriers and if this method can be utilized by the F-15E vendors using leadless chips.

AF90-075. TITLE: Consolidation of Electrical Standards Set (ESS) Equipment

OBJECTIVE: Research and determine how existing F-15 ESS equipment can be consolidated and reduced.

DESCRIPTION: The F-15 ESS currently contains several programmable controllers and numerous manual programming devices. This equipment is used to program Programmable Read Only Memory (PROMs), Eraseable Programmable Read Only Memory (EPROMs), and load computer programs into LRU and support equipment memories. Maximum consolidation of this equipment into a multipurpose device would both reduce mobility requirements and proliferation of support equipment. Additionally, reliability could be increased and supportability improved. Travel to Air Logistics Centers and Operational Sites would be required to investigate current procedures. Phase I activity will consist of a feasibility report to insure the validity of consolidating ESS equipment. Phase II will consist of identification of equipment required to perform the function of the various components of the ESS.

AF90-076. TITLE: Maintenance System for Artificial Intelligent (AI) Knowledge Bases

OBJECTIVE: To develop methodologies/techniques for developing/maintaining robust AI systems without sacrificing real-time performance.

DESCRIPTION: A growing number of "real-time" Artificial Intelligence (AI) Systems are being developed to quickly and efficiently analyze large amounts of data. These systems, such as the Adaptive Tactical Navigation System or the Pilot's Associate System, must find innovative ways to quickly and efficiently process their knowledge base to obtain accurate solutions in real time. Conventional AI development environments have had difficulties in producing efficient run-time systems. This is due to the fact that the same code necessary to enhance the development environment tends to slow down the system during run-time. In order to overcome these limitations, AI system designers have had to embed the knowledge base into their own custom run-time AI shells to achieve real-time performance. Unfortunately, the deeper the knowledge base is embedded into the actual code, the harder it is to change the knowledge base when maintenance is necessary. Even though AI development environments offer the knowledge engineer a quick way to develop, test and maintain the AI system, the run-time shells are too slow for large robust real-time systems. Therefore, the AI system designer must constantly balance system performance versus ease of maintaining and manipulating the knowledge base. One method to resolve this problem would be to develop and test the system using an AI development environment and then strip out the environment and recode the system to optimize performance. However, if the knowledge base is changed, the knowledge engineer has no easy way to change the run-time environment, and may be forced to recode the Under Phase I of the proposed research, the contractor shall develop a preliminary design of a real-time AI development/run-time shell which will provide the user with a good development system without sacrificing run-time efficiency. This real-time tool must give the knowledge engineer the ability to easily develop, test, and maintain a real-time AI system while producing efficient run-time code. At the conclusion of Phase I, the contractor shall produce a final report which documents the design of the real-time AI development/run-time shell along with a proposal for Phase II. Under Phase II of the proposed research, the contractor shall fully develop the real-time AI development /run-time shell. This system shall be thoroughly evaluated via computer simulation. This effort will culminate in a laboratory demonstration which illustrates all salient features of the real-time AI development/run-time shell as a software tool. At the conclusion of Phase II, the contractor will produce a final report which documents the system, as well as possible future enhancements. The contractor shall also provide the documented software code that was developed under this effort.

AF90-077. TITLE: Instantaneous Frequency Measurement (IFR) Correlator Using Optical Approach

OBJECTIVE: To investigate techniques to implement IFM correlators using optical approaches.

DESCRIPTION: One of the most important problems in IFM receivers is to remedy the receiver deficiency to process simultaneous signals. An in-house effort to improve the performance of IFM receivers to receive simultaneous signals has produced satisfactory results. However, with this new approach a large number of IFM correlators are required. The conventional IFM correlators which are made of microwave components are, in general, complicated. It is possible to make correlators through optical approaches. Phase I will address different optical approaches to implement IFM correlators through optical means and compare their results. Phase II will actually fabricate some optical IFM correlators from the results of Phase I.

AF90-078. TITLE: Environment Generator for Coherent Radar Hybrid Simulator

OBJECTIVE: To develop a cost-effective, modular environment generator for real-time hybrid simulation of coherent, monopulse threat radars.

DESCRIPTION: A cost-effective method of providing high fidelity real-time simulation of the full range of modern coherent, monopulse threat radar systems is essential to the efficient development of effective countermeasure techniques and systems. Past hybrid simulators have been designed as clones of individual threat radars to ensure simulation fidelity. This approach limited their availability since it required extensive hardware development for each system and a separate simulator for each threat system of interest. Recent efforts have been made to develop truly reconfigurable threat radar simulators to lower the required investment needed to perform simulation testing. To guarantee simulation fidelity, the proposed simulators plan to perform their signal modulations for modeling antenna patterns, clutter, and target returns at the operating radio frequency (RF) of the threat system. This approach presents difficulties due to the cost and complexity of RF circuit design. An alternative method is to perform the signal modulation at the intermediate frequency (IF) of the threat systems (typically 20 to 60 MHz) and up/down convert at the interface to the electronic countermeasure system under test. IF signal processing is much more economical and opens up the potential for direct digital signal modulation with the inherent modeling flexibility that such processing provides. This project will address all aspects of signal modulation up to the threat system's signal processor and the feasibility of implementing these effects at IF to provide a high fidelity simulation. Such factors as target modulation, clutter, space loss, antenna effects, and receiver effects should be addressed as a minimum. Consideration of simulation fidelity and cost tradeoffs should be given to various potential approaches. The contractor will develop a proposed environment generator with an analysis of feasibility and cost/fidelity tradeoffs for the various simulation aspects in Phase I. Phase II will consist of fabrication and demonstration of the proposed design.

AF90-079. TITLE: Tactical Fighter X-Band Radar Coherent Sidelobe Canceller

OBJECTIVE: To formulate and evaluate adaptive array processing techniques and new air-to-air radar architectures that allow the detection of future airborne threats in difficult electronic countermeasures and interference environments.

DESCRIPTION: Internetting, collocated electronic surveillance measures (ESM) equipment, and other synergistic techniques may allow the enemy to deploy his standoff airborne and ground based electronic countermeasures (ECM) assets to reduce the effectiveness of Air Force tactical air-to-air radars. Considering that future airborne threats are likely to have radar cross sections (RCS) greatly reduced in magnitude from contemporary targets, the ECM sidelobe jamming performance penalty incurred by the X-band fighter radars could be severe. Historically, tactical airborne radars have not incorporated sidelobe ECM cancellers for several reasons. The conventional spatial jammer nulling and subsequent temporal nonadaptive (doppler filter bank) ground clutter cancellation two-stage processing has fundamental limitations. Clutter in the auxiliary antenna channels results in the adaptive spatial system attempting to form a null in the mainbeam direction thus cancelling the target. Conversely, the adaptive nulling process raises the antenna sidelobe level which results in increased sidelobe clutter in the doppler filter bank. Even if clutter is not present, the convergence rate for the class of adaptive algorithms which could be practically implemented is very slow requiring tens of thousands of samples to effect an adapted solution. This slow adaption drastically limits cancellation performance against blinking jammers or when tactical aircraft maneuvers require an inherent "null steering" capability. Finally, radar receiver hardware errors limit channel matching and sidelobe nulling to orders-of-magnitude less than desired. The state-of-the-art in adaptive processing and digital equipment has, however, progressed to a point where coherent sidelobe cancelers, having the desired rapid convergence rate and ECM nulling performance, are becoming feasible. The Phase I activity will systematically investigate the exploitation of these technologies which include the following: 1) joint space-time adaptive processing to eliminate the degrading interactions between jammer nulling and clutter cancellation that exist in a two step process; 2) adaptive weight formation by digitally implemented sample covariance matrix inversion (or equivalent Gram Schmidt orthogonalization) techniques to eliminate the slow convergence iterative methods; 3) adaptive finite impulse response (FIR) filters (i.e., transversal filters, taped delay lines) to reduce receiver hardware channel match requirements; and 4) specialized high speed digital single autonomous node circuits that can be configured to implicitly perform the matrix formation/inversion, adaptive weight determination, and adaptive beamforming computations in real-time when utilized in high throughput systolic array signal processor architectures. The Phase I output will consist of an adaptive processing algorithm design, radar architecture definition, and digital computer simulation sidelobe canceler performance predictions. These activities

will lead to the Phase II effort of laboratory demonstrating sidelobe canceler nulling performance in real-time utilizing breadboard digital signal processing, analog-to-digital converter, and IF/low pass filters to emulate a radar.

AF90-080. TITLE: Innovative Electrooptical Sensors

OBJECTIVE: To develop novel active and passive electrooptical sensor techniques.

DESCRIPTION: Improved electrooptical sensors are required for airborne and spaceborne application against ground and aerospace targets. This includes target detection, recognition, and tracking. Particular areas of interest include, but are not limited to: 1) Laser radar receiver techniques, both for coherent and incoherent laser radars. Methods of improving sensitivity and resolution without increasing laser radar transmitted power or physical aperture size are desired. Techniques applicable eventually to diode pumped solid state laser radars are preferred. 2) Passive techniques to increase sensor sensitivity or resolution without increasing physical aperture size are desired. 3) Active or passive electrooptical techniques to provide increased target detection or recognition information content by novel methods are desired. Wide area search techniques against a concealed ground target are of special interest. 4) Methods of rapidly moving an electrooptical field-of-view with no moving parts are a strong interest, especially broadband techniques for use with both active and passive sensors. Broadband techniques must either be nondispersive or compensated such that each wavelength within the band is directed to the same angular position. 5) Other novel electrooptical sensor techniques. It is desirable if limited experimental proof-of-principal as well as design of a more complete demonstration can occur in Phase I. Phase II should perform the more complete experimental demonstration.

AF90-081. TITLE: Engagement Visualization for Electronic Combat (EC) Simulation and Modeling

OBJECTIVE: Develop and demonstrate a viable method for generic real-time visualization portrayal of EC interactions/engagements for Electronic Warfare (EW) simulators and real-time digital models.

DESCRIPTION: Historically, the ability to assess the effectiveness of an EC system was dependent upon the assimilation of vast amounts of data collected from the system under test and/or digital model, and subsequent execution of manual or semiautomated post analysis methods. The recent evolution of complex multispectral EC systems and corresponding integrated air defense system threat infrastructure have compounded the problem of EC system effectiveness evaluation. Current test and analysis techniques have become cumbersome and unresponsive to rapidly changing EC technology. To overcome this difficulty, the ability to graphically portray threat interactions and engagements is anticipated to show significant promise in the evaluation of complex systems by reducing the overall problem of representing system/threat relationships. Hence, the ability to dynamically display threat engagement, scenario and threat characteristics data in a cost-effective manner is needed. This effort involves the development and demonstration of graphics tools for EC digital models and simulators in the Air Force community. Special emphasis on generic tools and standardized graphics software interfaces is important to ensure portability between differing digital models and simulators, and their acceptance by the EC community. The Phase I effort will involve the selection of one or more digital models/simulators for application of the visualization tools, visualization requirements definition, software architecture development and, if possible, small-scale development and demonstration. The use or modification of existing software for the Phase I effort is encouraged. The Phase II effort will concentrate on full-scale implementation and integration of developed visualization tools with selected digital models and/or simulators. A demonstration of the full-scale implementation at the Integrated Defensive Avionics Laboratory located at Wright-Patterson AFB, OH will conclude the Phase II effort.

AF90-082. TITLE: Avionics Software Performability (ASP)

OBJECTIVE: To develop a general modeling framework that will allow the development of a unified performance -reliability (performability) measure for avionics software.

DESCRIPTION: To properly evaluate the effectiveness of avionics software, one must consider both performance and reliability, i.e., "performability". Performability modeling requires a "capability function" that relates low level

system behavior to user-oriented levels of performance. By formulating the capability function, performability can be evaluated. Currently, modeling schemes have been developed to measure the effectiveness of aircraft computers. With software being the current cost driver in avionics, these same concepts need to be applied to the avionics operational flight programs. This work will allow the Air Force to acquire a capability for measuring the effectiveness of the avionics system by taking into account performance and reliability for both the hardware and software. Work performed under this effort can be divided into two phases. Phase I will identify concepts that currently exist in measuring the performability of computer hardware that can be applied to avionics software. Phase II will include the implementation of the capability function for avionics software. Also, modeling and analysis techniques will be demonstrated that use performability to measure avionics software effectiveness.

AF90-083. TITLE: Model-Based Vision (MBV) Technology Components

OBJECTIVE: Establish the utility of a qualitative physics approach to target model prediction; develop new approaches to multisource information integration with uncertainty representation.

DESCRIPTION: MBV Automatic Target Recognizer (ATR) systems are composed of a predictive component and a descriptive component. The descriptive component examines sensor imagery and extracts potential target features to build a hierarchical representation of candidate targets and to form an initial target identity hypothesis. The predictive component consists of geometric and signature models which are utilized to estimate target features which are then matched to candidate target descriptions at the feature, feature grouping, and object levels. These two components are unified by a central data and data uncertainty representation and reasoning scheme which enforces a uniform representation paradigm for descriptive and predictive data and provides a standard control and integration mechanism for these disparate information sources. Based upon initial match results, feedback is employed to refine the target model prediction and extract additional descriptive evidence in an iterative manner to narrow the uncertainty associated with target parameters such as pose, configuration, and phenomenology. Sources are sought for research in two MBV component areas:

a. Multisensor target phenomenology prediction via qualitative physics. The above factors in combination place constraints upon geometry, signature and sensor phenomenology models that are unique to MBV. State-of-the-art qualitative signature estimation approaches generally fail to capture all the necessary attributes required for MBV prediction mechanisms. It is anticipated that a qualitative physics approach to target signature estimation may more readily support critical MBV prediction requirements such as distributed control and uncertainty representation, target feature prediction at variable resolution and accuracy, aggregate feature prediction as opposed to complete target visual renderings, and cause and effect reasoning about energy exchange mechanisms which drive signatures. Phase II effort will consist of concept implementation in the government supplied Sensor Algorithm Research Expert system testbed.

b. Theoretical development of information and information uncertainty representation techniques and reasoning paradigms. Existing approaches to MBV information management and reasoning control include probability theory (Bayesian networks) and Dempster-Shafer theory. Each of these approaches possess advantages and disadvantages with respect to MBV. In Phase I extensions/combinations of these existing approaches or new alternative approaches are sought which can accomplish the predictive and descriptive information integration and reasoning management task at the heart of an MBV recognition system. Phase II effort will consist of further development and implementation to augment/replace the information management techniques in the government supplied Sensor Algorithm Research Expert system testbed.

AF90-084. TITLE: Computer Aided Software Engineeringg (CASE) Tools for Total-Integration Avionics (TIA) Systems

OBJECTIVE: Develop CASE tool requirements and capabilities for the specification, design, and prototyping of total-integration avionics.

DESCRIPTION: The evolution of advanced avionics architectures over the past ten years has begun to focus on functional integration, resource sharing, sensor/data fusion, and fault tolerant techniques. In particular, current programs such as ICNIA, INEWS, and PAVE PILAR, as well as future programs such as PAVE PACE, are concerned with resource sharing activities (e.g., sensors, processors, data, etc.). Collectively, this resource-sharing concept is referred to as

Total-Integration Avionics (TIA). Reliability, supportability, availability, and mantainability, of these advanced avionics systems are not only desired goals, but, indeed, critical requirements. Emerging technologies such as wafer scale integration, photonics, artificial intelligence, parallel processing, neural networks, etc., will play a vital role in bringing the concept of TIA to fruition. Furthermore, it must be acknowledged that a vital part of these aforementioned technologies is software. While hardware resource sharing and functional integration are certainly key elements, it is intricate and complex software systems which represent a driving force behind these technologies. Also, it is well recognized and understood that real-time avionics software design, development, testing, implementation, and maintenance are extremely resource intensive activities, in terms of personnel, time, and cost. Unfortunately, the emerging CASE tools do not adequately address (if at all) the full life cycle from requirement specification through design, development, testing, implementation, and maintenance. Further, these CASE tools, in many instances are diverse, ill-matched, and not suitably integrated in terms of being capable of sharing data and information between other tools. Critical issues such as data-interchange formats, user interfaces, common databases, and tool environments remain heretofore unresolved. Yet, it is these CASE type tools which are needed in order to address these monumental software problems. Therefore, Phase I will examine the current state-of-the-art in the CASE tool arena, identify specific gaps and shortcomings in terms of both TIA considerations and spanning the complete software life cycle spectrum (with the focused goal of meeting real-time avionics software development requirements), and provide precise recommendations as to how these deficiencies can be addressed. Phase II of this acitivity will be the development, implementation, and demonstration of a fully integrated and user-sensitive CASE tool suite based upon the insight gathered from Phase I.

AF90-085. TITLE: Application of Multiple Model Adaptive Estimation to Adaptive Navigation

OBJECTIVE: To enhance navigation system accuracy while maintaining system robustness using Multiple Model Adaptive Estimation techniques.

DESCRIPTION: Kalman Filters may be tuned to operate at peak performance for a given system by iteratively adjusting elements of both the system dynamic noise covariance matrix, Q, and the measurement noise covariance matrix, R. Although the performance of an optimally tuned filter provides accuracy, it does not provide robustness, that is, any change in the real-world system not modeled by the filter may cause the filter to diverge. Thus filter robustness suffers at the expense of accuracy and visa versa. Current efforts in adaptive navigation concentrate on optimally sombining information provided by robust yet suboptimal local filters. Multiple Model Adaptive Estimation techniques adapt to predictable real-world inconsistencies (e.g., jamming, terrain map boundaries, and sensor failure modes), which occur at unpredictable times, by providing filters that are tuned for each mode of sensor operation. In Multiple Model Adaptive Estimation, each sensor then has its own bank of filters, running in parallel, from which to extract state estimates. The filter which correctly models the sensor's current mode of operation is determined via a residual monitoring technique which compares each filter's measurement estimate with the actual sensor measurement. The filter with the most well behaved residual history is then chosen for implementation by the navigation system. To provide robustness, divergent filters in the bank are continually reset until they sufficiently model the sensor's mode of operation. The proposed research will therefore attempt to enhance local filter accuracy while maintaining overall system robustness by adapting the filter to the environment in real time. Phase I of this effort will be a feasibility study to determine what benefit Multiple Model Adaptive Estimation can provide the filter architecture proposed by the Distributed Kalman Filter Architecture effort. At the conclusion of Phase I, the contractor will produce a final report which documents the contractor's approach, results and a recommendation as to the potential benefits provided by optimally tuned filters on navigation system accuracy. Phase II of this effort will develop a residual monitoring filter implementation technique to take advantage of the enhanced local filter performance obtained in Phase I.

AF90-086. TITLE: Electronics Packaging and Interconnection Technology

OBJECTIVE: To develop materials, processes, techniques and concepts relating to the various levels of packaging and assembly of electronic systems.

DESCRIPTION: Present electronics assembly technology which utilizes multilayer, board-mounted, ceramic packaged circuits aggregated in rack-mounted subassemblies severely limits the electrical, mechanical and thermal performance of systems. Progress in numerous technology areas such as coatings, nonconventional packages, multichip packages, silicon chip-on-silicon substrate, appears to allow significant and beneficial departures from the present methods of packaging

and assembly. Programs are solicited which would contribute to the maintenance of chip level performance through two-three subsequent levels of interconnection, while advancing reliability and assuring a maintainable product.

AF90-087. TITLE: Integrable Die for Advanced Packaging Assemblies

OBJECTIVE: To develop processes and techniques for semiconductor die integration in multichip packages and chip-on-board assemblies.

DESCRIPTION: In order to achieve high performance systems, the performance provided at the device level must be maintained within a factor of two at the next level of interconnect. One method of achieving this is to mount devices closer together using multichip packaging or chip on substrate/board approaches. As the density and value added of the assembly increases, it becomes critical that bare die testing techniques be developed which allow bare die to be fully characterized (i.e. at speed and over temperature driving comparable loads) prior to their being committed to the final assembly. Device driver size, choice of metallizations, and mechanical and electrical interconnects must be optimized to yield a reliable thermally manageable assembly. Die attach materials and processes must be developed and understood so that these procedures do not change the characteristics of the fully tested device. In addition, the properties of passivations or coatings used to provide reliability without hermeticity and their effects on the performance of the device must be fully understood. The above description defines a broad area of interest and proposals addressing individual or combined areas are strongly encouraged as long as they are clearly targeted to the final objective. Phase I will identify, analyze and trade off techniques, processes and materials which will offer the greatest potential for ascertaining integrated devices for assembly into the next level of interconnect. During Phase 2, the most promising candidates will be further developed, analyzed and characterized and verified through hardware assembly and testing.

AF90-088. TITLE: Optical Analog to Digital (A/D) Conversion

OBJECTIVE: To examine novel optical parallel sampling architectures for analog to digital conversion.

DESCRIPTION: Analog to digital converters currently under development operate at 1-2 gigahertz sample rates for 2-4 bit words. Various problems arise due to the speed limitation of current devices. Systems using high speed transducers, such as RADAR, require an analog interface between the sensor and the digital processor in order to reduce the data rate to within the range of the A/D converter. Analog processing is much less flexible than digital because parameters and processing procedures cannot be altered as readily. Also the limited dynamic range of present A/Ds makes them sensitive to noise interference. Issues such as how to do optical thresholding, quantization, and encoding will all be addressed. Optical A/D converters have potential for 10 bit conversion at 30 gigahertz. Phase I will result in novel optical architectures meeting program goals. Phase II will further develop promising architectures indicated in Phase I to working demonstrations.

AF90-089. TITLE: Concepts, Models, and Techniques for Advanced Multifunctional Optoelectronic Devices

OBJECTIVE: To develop enabling technologies for integration of diverse electronic/optoelectronic functions on a single semiconductor chip.

DESCRIPTION: Advanced device concepts and models, along with demonstrations of key materials growth and device fabrication techniques, are required for enhancement of research efforts in the material synthesis and device development aspects of advanced, electronic and optoelectronic integrated circuits. Emphasis will be placed on the development and demonstration of critical concepts, modeling tools, heteroepitaxial growth techniques and processing technologies required for synthesizing multifunctional integrated circuits incorporating both electronic and optronic devices. Semiconductor material systems of interest range from the group IV semiconductors to III-V and II-VI compounds and includes alloy/superlattice and heterojunctions thereof. Phase I activity will include initial feasibility demonstration of the enabling task to be investigated. Phase II will consist of the final development of the concept, modeling tool, process technique or apparatus required for integrating or transitioning the enabling technology into the existing electronic/ optoelectronic technology base.

AF90-090. TITLE: Process Modeling of Microwave Heterojunction Transistors

OBJECTIVE: To develop interactive process models that effectively describe monolithic microwave integrated circuit heterojunction transistors.

DESCRIPTION: Significant effort is presently devoted to the development and refinement of computer-aided design (CAD) techniques for gallium arsenide (GaAs) monolithic microwave integrated circuits (MMIC). The bulk of the work centers on developing field-effect transistor (FET) small signal and large signal models, circuit simulators, and layout tools. Work is underway on developing GaAs FET process models that couple with the circuit CAD tools. The process model allows the detailed evaluation and optimization of the specific device fabrication sequence to achieve improved performance and higher fabrication yields. When integrated with other MMIC CAD tools, the process model becomes a very effective design tool. The objective of the subject effort is to develop similar process models for microwave heterojunction transistors such as the heterojunction bipolar transistor. Emphasis will be placed on developing a modeling program that can accurately and quickly simulate a full set of heterojunction device characteristics on workstations or personal computers in a matter of minutes starting with the process specifications. The developed program must have the capability to be easily coupled to MMIC simulators. Phase I shall consist of the feasibility demonstration and delivery of a preliminary modeling program. In Phase II the modeling program will be refined with a full set of parameters and verified by comparison with measured device results.

AF90-091. TITLE: In situ Sensors for Semiconductor Processing

OBJECTIVE: To develop new, innovative techniques and devices for in situ sensors and real time process controls.

DESCRIPTION: Low cost, fabrication facilities for semiconductor devices needed by the Air Force, Army and Navy are increasingly dependent on real time process controls for first pass success in fabricating small lots of very complex devices cost effectively. Advanced semiconductor device fabrication facilities for application specific integrated circuits and many special purpose devices in silicon, gallium arsenide, mercury cadmium telluride and other semiconductor materials are rapidly moving towards the use of single wafer processing facilities using all dry, plasma processes for deposition, etching, resist development, etc. In many cases special sensors are needed to control critical plasma parameters, the rate of the process, or to detect end points accurately. Various types of electrical and optical measurements have been made at RF, microwave, and optical wavelengths using spectrophotometric, interferometric, holographic, fluorescent and other techniques for extracting the critical information. As more complex devices and processes are developed, realtime, in situ sensors and process controls become even more critical for cost effective manufacturing. Phase I of this program shall consist of a six (6) month feasibility study for new in situ sensors. New semiconductor processes should be surveyed to determine critical process steps limited by sensor availability. New, innovative ideas for sensors to acquire the needed data should be analyzed theoretically to determine the feasibility of this approach. Critical experimental measurements to prove feasibility of the idea should be performed. A report documenting these ideas and experiments should be prepared together with designs for a full scale demonstration. Phase II of this effort shall consist of additional work to perform the full scale demonstration of the technique, such that the limits of performance, operating parameters and benefits of the technique can be demonstrated.

AF90-092. TITLE: Novel Laser Host Materials

OBJECTIVE: Develop new host/lasant combinations with improved performance or which operate in new spectral regions.

DESCRIPTION: A few solid-state, continuously tunable laser materials such as titanium-sapphire, alexandrite, and cobalt:magnesium fluoride have been successfully demonstrated. However, these materials do not cover all wavelength bands of interest. Also, improved operating efficiency is often needed for various applications. Novel concepts for new laser materials are needed to develop the next generation of frequency agile laser sources. Phase I will involve growth or fabrication of the new laser material with demonstration of lasing. In Phase II the new material will be optimized and characterized for laser performance with the goal of a laser or material which could be easily developed into a commercially available product.

AF90-093. TITLE: Low Profile Capacitance Strain Measurement System for High Temperature Materials

OBJECTIVE: Develop an accurate/repeatable capacitance strain measurement system for high temperature structural materials at temperatures over 2000° F.

DESCRIPTION: Develop a reliable capacitance strain measurement system to evaluate materials for critical high temperature structural applications for both ground thermostructural testing and flight operations of advanced structures for aeronautical space applications. The capacitance strain sensor must be of low profile, directly attachable to the structural material and provide accurate and repeatable apparent strain compensation without the need of preheating of the sensor installation. Phase I activity will demonstrate the repeatability of apparent strain by a strain sensor during transient thermostructural heating. Phase II activities will consist of refinement of the strain sensor apparent strain compensation for accuracy and repeatability for selected high temperature materials, plus modularizing the transducer signal conditioning equipment.

AF90-094. TITLE: Design Guidelines for Multivariable Flight Control

OBJECTIVE: To develop guidelines for application of multivariable control design techniques to aerospace systems.

DESCRIPTION: In the past, many flight vehicles with multiple-inputs, and multiple-outputs (multivariable) have been considered as single-input, single-output (SISO) systems for the purpose of control law design. As the complexity of these multivariable systems has increased, modeling them as SISO systems has become less valid. In spite of its decreasing validity, the SISO assumption is still often used in flight control design. This is due, in part, to a lack of design guidance for applying multivariable techniques. Recent developments in multivariable control have made it worthwhile to reconsider the possibility of applying multivariable techniques to real flight systems. The objective of Phase I research is to determine measures of goodness to evaluate control law designs. In other words, when a flight control system is designed using multivariable control theory, how should the designer determine whether or not the design is good? For SISO systems, the answer to this question is well defined by existing standards and military specifications. Such information is not available for multivariable systems. The emphasis of this phase will be to select a specific control task (such as landing, takeoff, up and away, etc.) and identify and justify a catalog of characteristics to check in a multivariable control system design to evaluate it. These characteristics should reflect the desirable flying qualities for the selected control task. Phase II activities will extend this catalog to other tasks, develop admissible ranges of the characteristics for the various tasks, and validate the ranges through simulation.

AF90-095. TITLE: Stability Theory for Hypersonic Boundary Layers

OBJECTIVE: Analyze stability of hypersonic boundary layers to improve analytical representation of boundary-layer disturbance history for transition prediction methods.

DESCRIPTION: An Air Force goal in the area of boundary-layer transition is to have the capability to make a confident prediction of the location of boundary-layer transition on any hypersonic aerospace vehicle while operating within its planned flight conditions. One basic need in the accomplishment of this goal is the development of a theory which is capable of describing the pertinent instability phenomena and provide the basis for the numerical representation of the boundary-layer disturbance history up close to the point of transition. Present analysis capability for hypersonic boundary layers is limited to simple boundary layers in a perfect gas. There is a need to extend the analysis capability to more complex flow fields and include high temperature gas dynamic effects. For example, the effects of nosetip bluntness, three-dimensional flow fields, pressure gradients, and high temperature effects (including nonequilibrium effects) need to be addressed. Also, nonlinear aspects of hypersonic boundary-layer stability need to be considered. Advancements in stability analysis in all of the above areas are considered beyond the scope of a single study. A specific aspect of hypersonic boundary-layer stability is to be selected for investigation. Phase I will select a specific aspect of hypersonic boundary-layer stability to be investigated and demonstrate the methods and approach for addressing the problem. Phase II will be the detailed stability analysis and include comparisons with experimental data where possible.

AF90-096. TITLE: Thermal Protection Technologies for Hypersonic Crew Escape Systems

OBJECTIVE: To develop thermal protection concepts composed of lightweight materials suitable for use in hypervelocity emergency crew escape systems.

DESCRIPTION: Crew escape systems for a hypervelocity vehicle must be designed with adequate thermal protection to ensure that maximum structural temperatures stay below the allowable for that material, and that heat transmitted to the crew environment comply with human tolerance considerations. New material systems and structures have been synthesized that offer solutions to the problems of lightweight, high temperature heat shield construction. One such new material system consists of chemical vapor infiltration and deposition on porous carbon by refractory metals and their compounds with oxygen, nitrogen, carbon, and boron. This class of material structural systems can exhibit low thermal conductance, high temperature tolerance, and structural strength/stiffness. Other reticulated ceramic foams systems have also been reported. Temperatures approaching 7000^{o} F should be possible by using Hafnium Carbide for example. One barrier to the development of emergency crew escape systems for future hypersonic, space capable aerospace vehicles is the excessive weight associated with the required thermal protection/heat shield provisions. There is interest in evaluating the potential of new material systems to slash the weight penalties of hypersonic vehicle escape systems. In Phase I, a preliminary redesign of the Apollo (vehicle and mission) heat shield using new materials systems is required with a goal of cutting associated heat shield system weight by at least 50%. Realistic fabrication and structural attachment approaches should be proposed and feasibility of these and weight goal attained evaluated by analysis and other means. Coupon samples of representative materials should be fabricated and delivered. In Phase II, a larger subscale portion of a heat shield for a hypersonic, space capable capsule to be defined later should be constructed and subjected to mechanical and thermal testing in simulated typical environments.

AF90-097. TITLE: Design Criteria for Multidisciplinary Optimization

OBJECTIVE: Develop design criteria for multidisciplinary optimization of airframe structures including materials, loads, stability/durability, damage tolerance, static/dynamic aeroelasticity, and aircraft controls.

DESCRIPTION: Most modern design optimization systems depend on the sensitivity analysis of the interacting disciplines. Accurate definition of the design criteria is the key for reliable sensitivity analysis which in turn assures predicted performance. The disciplines that participate in the airframe preliminary design are material properties, loads, fatigue, fracture, impact damage, static and dynamic aeroelasticity, and aircraft controls. Phase I activity includes identification of data requirements for the development of such design criteria in the disciplines mentioned. This will lead to Phase II activities where the contractor actually develops prototype design criteria addressing at least three of the above disciplines.

AF90-098. TITLE: On-Line Adaptive Networks Applied to Aircraft Control

OBJECTIVE: Develop algorithms allowing on line adaptation of polynomial network controllers which solve an aircraft control problem.

DESCRIPTION: Adaptive Networks have proven valuable as controllers of nonlinear systems for real-time applications due to their low on-line computational burden. The major problems associated with network controllers is in the off-line computations required during synthesis resulting in controllers which are not truly "on-line adaptive". The two types of adaptation to system variation to be considered are 1) those which vary gradually or smoothly (as in change in flight condition) and 2) those which vary abruptly (as in the case of battle damage). The effort should investigate methods of employing unsupervised learning to reduce on-line computation burden and recover performance. The problem to be addressed will be controller design for a nonlinear aircraft model and/or an AeroServoElastic aircraft problem. Phase I should address the on-line adaptation methods to support network controller tuning and integration of those methods into existing network synthesis algorithms in solving a subset of the problem chosen. Phase II will continue to apply the adaptive controller in solving a larger more complex problem and evaluate results.

AF90-099. TITLE: Postprocessing for Computational Fluid Dynamics (CFD) Methods

OBJECTIVE: Enhance the understanding of CFD results and facilitate comparisons with experimental data.

DESCRIPTION: Modern CFD routines have the ability to produce vast amounts of flow results. Several methods exist for displaying these results on terminals, workstations, etc. However, these methods display the results at computational points, lines, planes, or surfaces (i.e., along grid lines) rather than physical locations. Engineering experience and intuition would be better served if the information was displayed along physical locations (constant span stations, fuselage stations, etc.). Also, most experimental data exists at physical coordinates making comparisons with computational results difficult or impossible. In Phase I, the contractor shall research possible techniques to determine and display the CFD results at user specified physical locations. The procedure shall work with single- and multiple-block CFD solutions, and with both structured and unstructured grids. The required postprocessing equipment is a Silicon Graphics, Inc. IRIS workstation. The procedure shall be capable of using the full graphics capability of the IRIS in producing plots of scalar and vector variables, contour plots, vector plots, and particle traces. The contractor shall provide accuracy and computer resource estimates for the proposed method. Phase II would proceed with development and demonstration of the method for a range of CFD solutions. Additional enhancements, such as particle tracing where the tracing rate is scaled by local velocity, may be included in a Phase II effort.

AF90-100. TITLE: Aircraft Tire/Wheel Interface-Load Distribution Measurement

OBJECTIVE: Develop unique measurement test methodologies that allow accurate measurement of load distribution at the tire/wheel interface.

DESCRIPTION: One of the most common failure locations for an aircraft wheel are in the flange and beadseat areas. In order to understand the stress distribution in the wheel beadseat, it is very desirable to measure the load distribution at this interface. Due to the extremely tight fit of the tire on the wheel flange and sensor size limitations, common sensors (strain gages, force transducers, photographic film) have been used with very limited success during quasi-static and dynamic load and speed tests. It is also desirable to apply these sensors at this interface without modifying the tire/wheel interface by, for example, removing tire and/or wheel material at the sensor location. However, if material removal becomes necessary, the measured load distribution values must not be adversely affected. Dynamic tests may include contained air pressures up to 300 pounds per square inch, vertical/drag and side loads up to 50,000 pounds, and speeds up to 50 miles per hour. The Phase I effort should demonstrate the feasibility of accurate, durable sensors and unique test methodologies for measuring the load distribution at the tire/wheel interface during dynamic wheel tests. The Phase II effort should include the prototype development and application of these unique, accurate, durable sensors/test methodologies during dynamic wheel testing of aircraft wheels.

AF90-101. TITLE: Fluctuating Pressure Loads Definition for Hypersonic Vehicle Structures

OBJECTIVE: Develop acoustic load prediction methods for oscillating shock behavior with supersonic/hypersonic flow over vehicle configurations.

DESCRIPTION: Hypersonic vehicle configurations including blended wing body shapes can produce extremely high fluctuating pressure loads or acoustic loads due to oscillating shock behavior encountered in flight. Shock interactions can result from compression corners due to ramps, axial corners, bow shock boundary-layer interactions, and coupling effects. These noise sources can increase the acoustic load predictions by a factor of 10 or more. The acoustic loads are significant in the design of the structure to resist sonic fatigue damage. The loads from these noise sources are higher than other noise sources which must be defined more accurately for proper design. Existing prediction techniques are based on experimental data in limited flight regimes. There is a lack of data for shock boundary-layer interaction at Mach numbers (M) around and above three. Also, there is a lack of data for axial offset shock generators, axial corners, and coupling effects. There is a lack of knowledge in the three-dimensional shock interaction effects. Extrapolation of the existing data base to Mach numbers above three is very uncertain. The program involves extending fluctuating pressure load prediction methods to the supersonic and hypersonic speed regimes for vehicles with ramps and corners. Phase I activity will center on the definition of the basic prediction methods available utilizing existing data. Phase II will involve definition of three dimensional shock wave-boundary layer interaction effects through wind tunnel testing to empirically refine/improve the prediction methods. Wind tunnels capable of Mach 3.0 and 6.0 at high Reynolds numbers, wind tunnel models consisting of a flat plate with ramps and a

corner flow mode, instrumentation, data reduction, and data analysis equipment will be available to assist in the Phase II investigations.

AF90-102. TITLE: Model-Bourne Data Management System

OBJECTIVE: Enhance the quality/quantity of experimental aeromechanic data acquired from hypersonic test facilities to reduce cost/shorten analysis time.

DESCRIPTION: Data acquisition techniques have changed only slightly in the last quarter century. They require facility dependent hardware applied to pre-defined test strategies within the facility. The cost in test time alone of this philosophy is unacceptable. The lack of productivity caused by test data delays of months is unacceptable. This project will take advantage of modern electronic and micromechanistic devices to replace an entire control room of outmoded electronics with a model-bourne system. The system will feature an order of magnitude improvement in the number of sensors available to the experimentalist from 100 to 1,000. It will dramatically reduce test entry times by conducting concurrent multifunction testing and adaptively re-focus the test matrix through integrated and real-time data analyses (based on microprocessor technology) which will drive the tunnel test matrix through algorithms and acquire the data for analysis. Finally, it will allow the acquisition of reduced engineering aeromechanic data within days of the test - not months as currently encountered. Several of these features have already been demonstrated in a less capable prototype system developed by the Flight Dynamics Laboratory (FDL) and operated at the Arnold Engineering Development Center (AEDC). The new features envisioned in this device reflect our projections of actual operating experience and hard engineer assessments of computer and electronic capabilities now available. Phase I activity will consist of design and prototype construction of a candidate system. Phase II activity will be installation of the system in a wind tunnel model and completion of a wind tunnel test program.

AF90-103. TITLE: Performance Assessment and Analysis of Rod End Bearing Systems

OBJECTIVE: To develop a wear prediction model for aircraft actuator rod end bearings subject to cyclic loading conditions.

DESCRIPTION: Actuator rod end bearings represent a high incidence frequency reliability problem area which is common to many different subsystems. Advanced analysis methods are required to accurately assess the wear properties limited service life of aircraft rod end bearings when subjected to complex loading profiles. The current spectrum of bearing and bearing liner materials react in unexpected ways when subjected to the cyclic loading conditions found in today's aircraft. Phase I activity will define the approach and examine the feasibility of developing an adequate analytical model to predict bearing life. Phase II activities will be the development and validation through testing and prior experimental data of the analytical model proposed under Phase I.

AF90-104. TITLE: Airborne Graphics Generation Technology Issues

OBJECTIVE: Investigate issues relevant to the generation of display graphics in an airborne environment.

DESCRIPTION: The following programs are of specific interest:

a. Programmable Hierarchical Interactive Graphics Standard (PHIGS) is rapidly becoming the standard software for graphics primitives for display generation. As we invest in the hardware technology to move advanced graphics generation and displays into the airborne environment, we need to investigate the necessary mechanism for real-time generation and mapping of graphics primitives, onto these architectures, using the PHIGS standard. Ada is the language of choice for all DoD applications for airborne systems. In order to be compatible with the next generation Avionics Architecture, graphics display generation must reside under a distributed Ada software architecture and the necessary software must be developed to allow the graphics generation under an Ada environment. Phase I would demonstrate the feasibility of a single primitive with Phase II exploring all primitives with the necessary Ada interfaces.

b. The purpose of this effort is to define a digital interface from the graphics processor to the display. Liquid Crystal display technology looks very promising for avionics displays of the future. These displays are digitally

addressable and currently electronics are required to convert analog signals to digital for display. The current and future graphics processor is a digital processor with the output converted to analog for transmission to the display electronics. We could achieve a higher bandwidth for transmission as well as higher display resolution with fewer electronics if we developed a digital interface between the graphics processor and the display surface. Phase I will begin to investigate the feasibility for a digital display interface with Phase II exploring the required mechanism. The ability to also handle analog signals will be required.

AF90-105. TITLE: Unique Light Source for Full Color, Dot Matrix Cockpit Displays

OBJECTIVE: Perform investigations/experiments that define new illumination sources as a backlight for light-valve type, dot-matrix displays.

DESCRIPTION: The primary elements of advanced, flat-panel, color-display instruments for aircraft cockpits function as light-valves. These valves are electronically activated to block or pass light. With groupings of the three primary colors (red, green, blue) superimposed over the valves, and with their orderly arrangement in columns and rows, an appropriate activation of these light-valves produces desired images on the related flat-panel surface...along with the desired color. A broad spectrum illumination source behind the display surface provides the necessary backlight. These light-valves are very reliable. Present light sources, however, lack the desired reliability; therefore, the display instrument, as a whole, has a reliability that is paced by the light source's longevity. Also, since the light source is operating continuously, considerable heat is generated internal to the display assembly; this further contributes to unreliability. Such heat levels are also influenced by the amount of light required to cope with the ambient light levels (10 K ft candles) encountered in canopy-covered fighter aircraft cockpits, and by the operating efficiency of the light source. During dusk and night operations, these light sources are dimmed accordingly. Phase I of this effort will explore the potentials of defining a new light source that is uniquely suited for the preceding display instrument application. Phase II will pursue the fabrication and characterization of samples of the new light source concept and establish a database for transitioning to quantity fabrication.

AF90-106. TITLE: Autostereoscopic Three-Dimensional (3-D) Cockpit Display

OBJECTIVE: Develop/demonstrate a 3-D cockpit display with high brightness stereoscopic 3-D images without wearing viewing aids (autostereoscopic).

DESCRIPTION: Future military cockpits will rely on computer generated electrooptic displays to present information to the pilot. Recent studies have indicated significant performance and situational awareness advantages may be gained by displaying some information to the pilot using stereoscopic 3-D versus two-dimensional (2-D) display formats. However, current stereoscopic 3-D display systems require the user to wear viewing aids (glasses) to see the images in 3-D, and the displays are not bright enough for cockpit applications. Advanced autostereoscopic display technologies are needed to eliminate the requirement for user viewing aids. Ability to display high brightness, full color images in both stereoscopic 3-D and 2-D formats is required. Due to the high ambient conditions in cockpits, a maximum display brightness of at least 150 fottlamberts in color is desired. Minimum display unit depth and video display capability are also desireable. Phase I activity will include development and demonstration of feasibility for the proposed display design. Phase II will include final design, actual prototype display construction, and testing/performance validation of the autostereoscopic 3-D display system.

AF90-107. TITLE: Manufacturing as a Natural Adaptive System

OBJECTIVE: Develop approaches to machine learning to establish fundamental laws of manufacturing and to improve the activities of design, planning, scheduling, control and configuration of manufacturing systems.

DESCRIPTION: Manufacturing systems must learn from experience. Manufacturing is a natural adaptive system, like that of a biological being which undergoes change through genetic transformation. The problem is it takes a lifetime to master the art (product design, plant operation, field support, etc.) of the manufacturing. Those who have become masters-of-the-art did so by developing manmade laws or heuristics using a most remarkable process - the uniquely human ability of synthesis. There is a need to both capture this knowledge and represent it for use by computers to assist

and to accelerate the generalization and codification of new knowledge. The key to the success of machine learning as applied to manufacturing is on-line interaction with the environment. More specifically, such a capability must be interfaced to existing systems for acquisition, analysis and experimentation by a controlled means to affect the behavior or operation of manufacturing systems in situ. The Phase I goal is to demonstrate a working discovery system, and Phase II is to apply a discovery system to a manufacturing problem domain.

AF90-108. TITLE: Computer Aided Abstract Reasoning for Conceptual Design

OBJECTIVE: Establish an understanding of the fundamental issues in using a computer as an intelligent background for that part of the design process commonly referred to as conceptual design.

DESCRIPTION: Computers have found widespread acceptance in analysis and rendering applications in design. The common thread among these applications is the model. In mechanical design, the designer assimilates knowledge about the task (functional specifications) and the world (experience) and produces a model (the conceptual design), which is successively refined and improved until the model satisfies all the requirements of the functional specifications and the global constraints imposed by the world (detailed design). While tremendous contributions have been made using computers to help designers optimize detailed, concrete models, their usefulness in aiding designers in creating models has been limited, particularly in the area of mechanical design. This is because model creation requires the ability to reason abstractly, something uniquely human, and because computers have been traditionally used to manipulate details rather than ideas. Manipulating ideas is the crux of the problem in conceptual design. For example, in optimizing a model, a designer may need to decide what size fastener to use to obtain the most economically functional fixed fastener for a component. In contrast, when creating the model, the designer might have to decide whether to use fasteners or some other method of force transmission or component mating. These are vastly different problems. Note that the latter subsumes the former. The conclusion to be drawn is that the amount and content of information to be considered in conceptual design is orders of magnitude greater than that of detailed design, and perhaps most importantly, includes all levels of abstraction. The purpose of this SBIR topic is to begin to explore the requirements of knowledge representation for conceptual design with the ultimate goal of bringing the synergistic power of man and machine together as early as possible in the design process. Phase I goal is to identify the issues pertaining to information processing and knowledge representation for conceptual design. Phase II goal will be a working demonstration prototype of a knowledge representation system for use in conceptual design.

AF90-109. TITLE: Biotechnology for Aerospace Materials Requirements

OBJECTIVE: Utilize biotechnology for aerospace materials requirements in order to obtain improved materials design concepts, useful materials with structural complexity not otherwise obtainable, and lower methods of materials preparation or removal.

DESCRIPTION: The Air Force is interested in research and development directed toward the following potential applications of biotechnology to aerospace materials requirements: 1) Modeling the chemical or morphological design of natural systems with structural applications such as fiber reinforced composites which might provide optimization of strength, stiffness, toughness, and weight, and subsequent reproduction of the designs using high temperature resistant chemistry. 2) Utilization of materials with chemical and morphological structures of complexity obtainable practically only from natural sources for aerospace applications requiring specific properties. Examples would include carbon matrix composite precursors with high char yields, ceramic precursors, and materials with nonlinear optical or electromagnetic properties. 3) Biological preparation methods for aerospace materials, which might include the biosynthesis of chemical intermediates for matrix resins for organic matrix resin composites, ceramic materials, lubricants, elastomeric materials, electrooptical materials, etc. This area also might include bioleaching or bioaccumulation for obtaining or purifying rare metals for aerospace applications. 4) The use of biodegradative methods for the removal of materials such as sealants and paint or other coatings from aircraft, or for integrated circuit etching. Phase I would address application requirements and goals as well as initial formulation, fabrication, and evaluation required for proof of concept. Phase II would perform enhanced development for optimization followed by trade and design studies for future efforts. Either process or design concepts should lead to a marketable product for Phase III.

AF90-110. TITLE: Advanced Processing for Thermoplastic Matrix Composite Materials

OBJECTIVE: To develop a process model for aerospace graphite fiber reinforced/semicrystalline thermoplastic matrix composites that incorporates the viscoelastic mechanical behavior and the crystallization kinetics of the matrix polymer.

DESCRIPTION: Advanced semicrystalline thermoplastic composite (SXTPC) matrix polymers offer superior mechanical and solvent resistance properties as compared to amorphous systems. However, during the processing of the semicrystalline polymers up to 25 percent volume changes may occur between the processing conditions and typical use conditions. This large volume change in the matrix relative to the volume change of the reinforcing fiber is believed to be responsible for the high levels of residual stresses in the resulting laminates. These stresses cause reduced laminate strength and deviations from net shape processing. Innovative approaches to processing of SXTPC are sought that would result in controllable levels of residual stress. Phase I of this program would assess the relative contributions to the level of residual stress of factors such as crystallization kinetics, crystal morphology, volume relaxation, stress relaxation, and the thermal expansion mismatch between matrix and fiber. Phase II would involve development of a process model and control strategy that incorporates the significant factors identified in Phase I.

AF90-111. TITLE: New High Performance Polymers

OBJECTIVE: To investigate the synthesis, characterization, morphology processing and properties of new polymer systems to provide performance advantages over state-of-the-art materials.

DESCRIPTION: Investigations are sought to discover new polymeric materials with potential for the development of improved structural materials, nonlinear optical materials or conductive materials. Polymer systems with exceptionally high use temperatures and reasonably low processing temperature requirements are of primary interest. Areas of emphasis include investigations of a) synthesis routes and methods to improve processing of rigid-rod polymer molecular composites which give rise to very thermally stable (600°-700° F use temperatures) structural materials under reasonable processing conditions and without the evolution of impractical quantities of volatiles; b) theoretical chemistry to provide fundamental understanding of the molecular requirements for achieving nonlinear optical or conductive properties in organic and semiorganic polymer systems; c) processing, morphology and mechanics of rigid-rod polymers to discover approaches for achieving superior compressive strengths; and d) polymer structure-property correlations to elucidate processing options for achieving desired morphologies and mechanical properties. The establishment of viable approaches to obtaining improved nonmetallic materials are sought in Phase I efforts which can be pursued in Phase II follow-on efforts.

AF90-112. TITLE: High Temperature Structural Materials for Advanced Air Force Systems

OBJECTIVE: To develop and characterize advanced high temperature structural materials and to model forming processes.

DESCRIPTION: New approaches are requested to develop and characterize advanced high temperature structural ceramic composites (2500° F to 4000° F, excluding carbon-carbon composites) and intermetallic materials and composites (2000° F to 3000° F, excluding titanium aluminides), and to model forming processes for advanced structural materials. For ceramic composites, research may include a) new, unique ceramic reinforcement/matrix systems and coatings; b) reinforcement/matrix interactions during processing or use; c) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain; etc.) as a function of temperature and loading history; and d) analytical modeling of composite behavior. For intermetallic materials and composites, research may include a) new or novel methods for synthesis of intermetallic materials with emphasis on achieving theoretical density, low defect content, and synthesis temperatures comparable with the use temperatures; b) methods for identifying, synthesizing, characterizing, and modeling intermetallic composites; and c) methods of fabricating composites to provide chemistry control on a submicron scale while maintaining the ability to vary and control the final microstructural scale. For modeling of forming processes research may include a) modeling of the unit forming process; b) modeling of the material behavior in response to the demands of the unit process; c) modeling of the interface between the work piece and the die mold; and d) novel methods for obtaining physical property data and constitutive equations for insertion into the models. Phase I shall focus on the critical issues which, when solved, will provide proof of concept. Phase II shall be structured to develop and refine those feasible concepts to

the point where an assessment could be made of ultimate potential to help meet Air Force advanced materials needs. The demarcation between Phase I and Phase II should be clear.

AF90-113. TITLE: Improved Nondestructive Evaluation

OBJECTIVE: Identify and evaluate new nondestructive evaluation techniques for advanced aerospace applications.

DESCRIPTION: Advanced, innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection and characterization of flaws in airframe and engine materials including metals and metal-matrix and ceramic-matrix composites, and for use in the real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed for the detection and characterization of bulk and surface defects in both metallic and nonmetallic structures, for the evaluation of the integrity of bondlines in structures containing adhesive and metal-metal bonds, for the determination of the condition of matrix and reinforcing substructures in advanced composite structures, for the quality of high-temperature material coatings, and for the inspection and evaluation of electronic device materials and components. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and field inspections or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the potential for ultimate use in realistic manufacturing or in-service environments. Phase I of this program would address the initial formulation, fabrication, and evaluation of specific NDE techniques for demonstration of proof of concept. Phase II would perform enhanced development for optimization of the techniques investigated in Phase I followed by trade and design studies for future efforts.

AF90-114. TITLE: High Performance Light Metal Alloys and Metal Matrix

OBJECTIVE: Develop improved light metal alloys based on the aluminum, beryllium, titanium, and magnesium systems.

DESCRIPTION: Unique approaches which result in new aluminum, beryllium (Be), magnesium (Mg) and titanium alloys are required to support the technology/ system requirements identified in the Air Force Systems Command Forecast II study. Incorporated are ultra high temperature aluminum alloys to replace titanium for applications to 900^{o} F, and ultra high temperature titanium alloys to replace superalloy applications to 1800^{o} F. Environmentally stable, ultralight magnesium and beryllium alloys are also desired. Included is the response of all alloys to secondary processing. Titanium alloy requirements are directed for improvements in three areas: temperature stability to 1800^{o} F, strength to 210 ksi, and high modulus/density ratio. Research is now needed to explore property improvements, especially in the corrosion resistance of Mg alloys. Improvements in strength, stiffness, and a reduction in density may be possible using novel alloying additions. Metal matrix composites (MMC) offer considerable promise for aerospace applications because of their strength to density ratio and potential use at high temperatures. Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Matrix materials considered should take advantage of unique property improvements available through MMC. Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would optimize chemistry and processing and also produce larger amounts of material for a full spectrum of mechanical property evaluation. It would also include preliminary evaluation of trade and design studies to give an early indication of future application potential.

AF90-115. TITLE: High Temperature Superconducting Materials

OBJECTIVE: Development of high temperature superconducting thin film materials that can be used for sensing and modifying electromagnetic radiation.

DESCRIPTION: High temperature superconducting ceramic (HTSC) materials offer a variety of application opportunities. Detection of infrared (IR) radiation can potentially be improved through the use of these HTSC materials. For example, sensitivity, operating temperature, and signal processing speed are functions that need to be increased over present technology. The properties of the materials must be established and detection techniques evaluated (e.g., bolometers and Josephson junctions) in order to fully assess their value in electromagnetic sensing. Modeling of the

superconducting mechanisms, development of unique thin film deposition and processing methods which produce films with the required properties, and optoelectronic response and temperature dependent noise measurements are examples of topics considered appropriate for this program area. Phase I would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would perform enhanced development for optimization followed by tradeoff and design studies for future efforts.

AF90-116. TITLE: Nonlinear Optical Materials

OBJECTIVE: To demonstrate approaches for obtaining materials with large nonlinear optical coefficients in useful configurations.

DESCRIPTION: Nonlinear optical materials are required for a variety of potential Air Force applications including optical signal processing (switches, modulators, and guided wave devices) and a new laser source (optical parametric oscillators and harmonic generators). Approaches applicable to inorganic and organic materials will be given consideration both in thin films and bulk media. Nonlinear optical devices may be examined for the purpose of evaluating and demonstrating the properties of the material(s). Phase I of this program would address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II would perform optimization of the material(s) in order to promote rapid development.

AF90-117. TITLE: Repair of Plated-Through Holes (PTHs) in Multilayer Printed Wiring Boards (PWBs)

OBJECTIVE: Develop a repair procedure for cracked PTHs in loaded PWBs.

DESCRIPTION: Multilayer boards are extremely expensive to manufacture. The conductive integrity of the holes is extremely important since the reliability of the circuits is dependent on the plated-through holes being defect free. Accordingly, multilayer boards are normally subjected to a rigorous testing procedure after manufacture to determine if they function properly. On occasion, manufacturing defects may occur with a defective hole or holes being present. It is normally not practical to reprocess a multilayer board where such defect exists. More importantly, once a board has had the various electronic components mounted, it is impossible to reprocess the board through conventional means. Because of the critical nature of the reliability of such boards, it has been necessary to scrap the boards. In addition to the existence of occasional manufacturing defects, damage to the board can occur after the board has been put into use. As with defectively manufactured printed circuit boards, those boards damaged during use or after installation are normally scrapped, because no practical or dependable solution for repairing plated-through holes has been known and, in particular, no method has been known to repair the plated-through holes in a dependable manner. Accordingly, an important need exists for a way of repairing defective plated-through holes in multilayer printed circuit boards in which the printed circuit board can be repaired to a condition that satisfies original manufacturing specifications and in which the original electrical and structural integrity of the board are achieved so that defects resulting from either manufacture or damage are corrected. Phase I goal is to set up a system, while Phase II goal is to repair multilayer boards.

AF90-118. TITLE: Light Curing Fuel Tank Repair Sealant

OBJECTIVE: To investigate and develop light curing sealants for repairing aircraft integral fuel tanks.

DESCRIPTION: Fuel tank sealants are normally of the polysulfide type and are cured under room temperature conditions although heat up to 140^{o} F can be applied to accelerate cure. The fastest curing sealants require in the range of three hours to become tack-free and the sealant must be tack-free before fuel can be added to the tanks. Repairs of fuel tanks are slowed because of the waiting for the sealant to cure. Cure is further slowed when the sealant has to be applied and cured at low temperatures. There are products available which can be cured in less than a minute by the use of visible or ultraviolet light. An example is dental fillings. The material used for dental fillings would not be suitable because it is too rigid but it is certainly conceivable that an elastomeric, fuel resistant, high adhesion sealant could be light cured. Such a product would greatly reduce the time required for making integral fuel tank repairs at normal temperatures. It is believed it would greatly improve the low temperature cure problem. It is also conceivable that such a product could be used in production sealing since aircraft manufacturers would like to be able

to keep chips out of freshly applied sealant and would like to be able to move parts in the factory without waiting for sealant cure. This is concerned mainly with fuel tank sealing, but a light curing sealant could also be used for other type sealing such as cabin pressurization, potting, and firewall. Phase I will show proof of concept. That is, whether a fuel resistant sealant material can be found in thicknesses of approximately 1/8" by the use of ultraviolet light. Phase II will develop the actual sealant compound with appropriate materials properties for tensile strength, elongation, hardness, peel strength, resistance to heat and fuel and low temperature flexibility. The material shall be packaged in a suitable container for Air Force fuel system repair personnel.

AF90-119. TITLE: Concurrent Engineering

OBJECTIVE: Develop a methodology leading to optimal design of electronics products considering all aspects of the product life cycle.

DESCRIPTION: Concurrent Engineering is the integrated design of the product, manufacturing, and support processes together with emphasis on efficiency, improved quality, and reduced costs. The method developed needs to allow the interaction of constraints which arise from the various design disciplines. The information available from the numerous domain experts must be unified during the design phase. The Air Force has a particular interest in improving the product life cycle of multilayer interconnect structures used in advanced electronic systems. Current electronic design and assembly practice emphasize electrical characteristics as related to performance and trivialize mechanical stress/strains, material properties, and manufacturing process improvements. A need exists to characterize temperature dependent material properties of the conductors and insulators used in a multilayer electronic interconnect structure. Three areas of particular interest include: 1) use Concurrent Engineering techniques to interactively tradeoff system parameters (e.g., performance, cost, reliability), technical parameters (e.g., electrical, mechanical, thermal, chemical properties), materials and processes; 2) define an information architecture to facilitate interactive communication between disciplines during the electronic design phase; and 3) identify technologies applicable to the development and integration of support tools for design and decision support systems. Phase I will address application requirements and goals as well as the formulation, fabrication, and evaluation of specific subjects necessary for proof-of-concept. Phase II will develop and demonstrate a candidate concurrent engineering methodology applied to electronic product design. Establish the database required for modeling the mechanical and thermal behavior of complex interconnect structures.

AF90-120. TITLE: Machine Tool Products and Processes

OBJECTIVE: To improve domestic machine tool builder manufacturing capabilities and introduce new technologies into machine tool products.

DESCRIPTION: New and creative solutions to problems facing the machine tool industry are sought. The primary aim of this effort is to investigate and develop innovative approaches to advanced machine tool products and to the manufacturing activities employed to produce machine tools. New ideas for machine tools and industrial production equipment addressing virtually any manufacturing operation will be considered. Creative ideas for improving, integrating or combining any processes used in the design, planning, production or test of machine tools are considered of equal importance with new machine tool products. The end objective of this effort is successful competition with nondomestic suppliers as to product performance, quality, reliability, delivery time, price and product support. Activities required to develop and test any specific approach will be dictated by the product or process being addressed, but the following specific requirements apply where appropriate: a) identify potentially applicable DoD production needs for new products, as well as nondefense needs, and quantitatively address the ability of new products to meet those needs; b) perform conceptual design, analysis and proof-of-concept experimentation; c) complete engineering design and analysis, prototyping and prototype testing; and d) production planning and implementation. The Phase I product will result in a preliminary design. The Phase II product will be a prototype.

AF90-121. TITLE: Electronic Packaging and Interconnect Multichip Package Automated Assembly Yield and Cost Verses Complexity

OBJECTIVE: Improved yield and cost of automated assembly, test and production of complex, dense multichip packages.

DESCRIPTION: Current automated assembly, test and manufacturing of electronics deals primarily with the assembly of single chip packaged devices onto printed wiring boards and to a lesser extent with the assembly of bare integrated circuits onto ceramic substrates representative of the classical hybrid electronics industry. Future military electronics will require the automated assembly, test and production of bare integrated circuits at much greater densities and complexities than state-of-the-art hybrids. These future assemblies must be dense to meet performance requirements; and the systems designer will want the assemblies to be as large (complex) as possible. Manufacturing assembly processing, test, rework, associated equipments, and cost will determine the complexity that is affordable for a life cycle cost point of view. Phase I will establish the impact-payoff of the proposed manufacturing process, assembly equipment development or modification, test or rework methodology-approach. This assessment will greatly influence the efficacy of proceeding with the Phase II development of the approach for transition to the military electronic equipment manufacturers. A very desirable aspect of the proposed approach is that it also will have payoff for high end commercial electronic equipment.

AF90-122. TITLE: Space Power Energy Conversion and Thermal Management Systems

OBJECTIVE: To develop survivable, lightweight spacecraft power and thermal technology for military satellite applications at the 5-100 kw level.

DESCRIPTION: Development of one or more of the following technologies is needed: a) lightweight solar array electrochemical energy storage and thermal control technology for long life (5-10 yrs) in a high particulate radiation environment; b) technologies to provide protection from weapon effects from nuclear, laser, and other weapon threats; c) high efficiency (30+%) radiation resistant solar cell technology for high temperature (600° C) exposure of planar and concentrator arrays; d) autonomous system operation; e) thermionic converter technology with emitters for thermionic fuel elements which avoid distortion due to fuel swelling; f) a reliable way to regulate cesium pressure in the TI interelectrode gap over the life of the system; g) address system problems such as mission ending single point failures and the effects of redundancy and key component reliability on overall system reliability; h) cryogen and thermal energy storage; i) rotating heat transfer joint; j) deployable radiators; and k) high energy density (greater than 110 wh/kg) rechargeable electrochemical energy storage. Phase I products will consist of analyses, design studies, experimental verification, and preliminary proof of feasibility demonstrations. Phase II products will include prototypical device performance verification, detailed phenomena characterization and performance optimization studies and analyses.

AF90-123. TITLE: Pulsed Power for Airborne/Spaceborne Applications

OBJECTIVE: To develop pulsed power component technology for airborne/spaceborne applications.

DESCRIPTION: Development of one or more of the following advanced pulsed power component technologies is needed for future airborne/spaceborne high power applications: a) advanced lightweight power sources with power densities less than 0.02 kilograms/kilowatt; b) capacitive energy storage devices with energy densities approaching or exceeding 3 kilojoules/kilogram, output voltage of greater than 10 kilovolts, response time of less than 10 nanoseconds, and lifetimes of greater than 10 million pulses per device; c) inductive energy storage devices with energy densities approaching or exceeding 100 kilojoules/kilograms; d) repetitive opening switches capable of hundreds to thousands of cycles when interrupting 2-4 megamperes at several hundred volts; e) closing switches for repetitive switching of average currents of 10-100 amperes at voltages of 100-500 kilovolts; f) advanced lightweight pulse forming networks for peak power pulses at tens to hundreds of gigawatts with rise times of tenths of nanoseconds, pulse widths of 10-1000 nanoseconds and repetition rates of 10 hertz to 10 kilohertz; g) high current density pulse conductors that are lightweight with high tensile strength and are suitable for airborne and spaceborne operating environments; h) advanced lightweight, high voltage, high temperature, radiation tolerant insulation suitable for airborne or spaceborne operating environments; i) high temperature, high dielectric strength, low dissipation factor, radiation tolerant power semiconductor devices with a maximum junction temperature exceeding 500 degrees Kelvin and the ability to switch tens/hundreds/thousands of amperes at 5-20 kilovolts per device; j) high permeability, ultralow loss ferromagnetic materials for application in passive and active magnetic systems; k) development of control algorithms and philosophies for the autonomous or quasi-autonomous operation of high power systems in conjunction with their power source for a variety of pulsed loads such as microwave sources and lasers; l) power sources for RF generators; m) high power density

sources including batteries, fuel cells, turbogenerators, and thermionic energy conversion systems; and n) superconductivity as applied to pulsed power componentry. Phase I goals include study results, analytical derivations and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF90-124. TITLE: Strategic and Tactical Missile Power

OBJECTIVE: To develop novel, high payoff power system technologies for strategic and tactical missile as well as silo applications.

DESCRIPTION: The battery/fuel cell power source goals/desired characteristics are: a) strategic and tactical onboard power: peak power 22 kw/kg in a pulsed mode, active lifetimes from 1 - 60 minutes; shelf life of 25 years without maintenance; 1 second delay or less from initiation to full load; operation over altitude range from sea level to 150 km; operation over temperature range from -54° C to +74° C without power from an external heat source; gravimetric energy density from 25 wh/kg for one-minute lifetimes to over 220 wh/kg for 60-minute lifetimes; volumetric energy densities from 0.1 wh/cc for one-minute lifetimes to over 1 wh/cc for 60-minute lifetimes; size average power range from 0.1 to 10 kw; b) silo power source: 15 years' inactive lifetime; active lifetimes up to 10,000 hours; 900 wh/kg or greater; 1.5 wh/cc or greater thermal efficiency of 90%; 500 kg or greater modules; c) silo energy storage: 15 years' lifetime; round-trip energy efficiency 80%; 220 wh/kg; 1 kw/kg peak power capability; 1000 discharges/charges; 0.6 wh/cc; minimum self discharge rate of 10,000 hours; size 50 kwh or larger. Phase I products will consist of analyses, design studies, experimental verification, and preliminary proof of feasibility demonstrations. Phase II products will include prototypical device performance verification, detailed phenomena characterization and performance optimization studies and analyses.

AF90-125. TITLE: Aircraft Power and Power Electronics

OBJECTIVE: Develop electrical, mechanical, thermal, fluid, and energy storage systems and component power technologies and develop power electronic devices and systems for space and aircraft applications.

DESCRIPTION: Development of one or more of the following advanced power and power electronics technologies for future aircraft: a) cold weather (-55° C) energy storage technology (batteries, capacitors); b) highly reliable, fault tolerant electrical power generation and distribution technology; c) solid state power controllers; d) high temperature (200 - 1000° C) electrical power and distribution components; e) high temperature (greater than 300° C) magnetic materials; f) lightweight shafts, gearing clutches, housings, and gearboxes with special emphasis on advanced materials; g) high performance small turbine technology; h) 270 VDC or 20 kHz electrical power generation and distribution technology; i) hot aircraft surfaces and secondary power components thermal control; j) high temperature, radiation hardened power semiconductor devices; k) advanced converter and inverter topologies for spacecraft and aircraft applications; l) advanced motor and motor drive technology for aircraft actuators, fuel pumps and environmental control systems; m) "smart power" electronic technology for aircraft and spacecraft; and n) high temperature (greater than 500° C) components, fluids, and seals for hydraulic systems. Phase I goals include study results, analytical derivations and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations.

AF90-126. TITLE: Computer Aided Structural and Life Analysis of Turbine Engine Components

OBJECTIVE: To develop methods for structural analysis and life prediction of high performance gas turbine engine components; and to develop computer graphics that simplify model development and results interpretation.

DESCRIPTION: Advanced analysis methods are needed to accurately assess the stress, strain, dynamic response, and life of high performance turbine engine components. Emphasis is placed on simplifying model development and results interpretation, while maintaining accuracy. Components of interest include compressors, turbines, nozzles, ducts, and cases. Typical materials for these components would include organic matrix composites, metal matrix composites, ceramic matrix composites, and titanium aluminides. Phase I activity will include demonstration of feasibility through comparison of analysis results with experimental results, and with analysis results from other sources. Phase II

activity will include: expansion of code to full capability, development of pre- and postprocessing capability, porting to government computers, and training of government engineers. Possible Phase III activities include further expansion of capabilities, further validation of materials data base, and transition of code from assessment tool to design tool.

AF90-127. TITLE: Weaving and Braiding Techniques for Turbine Engine Composite Components

OBJECTIVE: To investigate the automation of the fabrication of continuous fiber reinforced composite components for future advanced gas turbine engines.

DESCRIPTION: Continuous fiber reinforced composite materials offer properties which enable the designers of gas turbine engines to develop lightweight, high performance engine components. The purpose of this effort is to investigate the application of special weaving or braiding techniques to the automation of the fabrication of composite components for advanced engines. Current fabrication methods, other than filament winding, rely heavily on hand lay-up techniques. This leads not only to high fabrication costs, but also to problems with repeatability and quality assurance. Future, highly structurally efficient components will require three-dimensional fiber reinforcement to achieve the high stress levels. This Phase I effort will investigate the feasibility of automating the fabrication of near net shape components, while allowing total freedom of fiber orientation and geometry. These latter qualities will allow the true tailoring of the material's, and hence the component's, mechanical properties. A follow-on Phase II effort will build and test the automated fabrication technique designed during the Phase I activities.

AF90-128. TITLE: Multifunctional Additives for High Temperature Fuel

OBJECTIVE: Develop additives for JP-8 fuel which increases thermal oxidative stability of the fuel by at least 50° C, improve lubricity and preserve other performance qualities.

DESCRIPTION: Military aviation turbine fuels such as JP-8 contain additives to protect against ice formation, improve storage stability, improve the lubricity of the fuel, and prevent electrostatic charge hazards. These additives can interact with one another to cause problems. Aviation turbine fuel and ramjet fuel additives that combine several functions are needed. Of special interest are additives that provide long term ambient storage protection and high temperature (400-600° F) stability and lubricity without degrading system performance and durability. Phase I should result in the demonstration of an additive that will increase the thermal stability of jet fuel by 50° F and impart sufficient lubricity to the fuel. Phase II should result in an additive that increases fuel thermal stability by 100° F, imparts adequate lubricity to the fuel at elevated temperatures, and extends the storage life of the fuel to at least ten years.

AF90-129. TITLE: Solid Lubricants and Their Distribution for Advanced Aircraft Gas Turbines

OBJECTIVE: To develop a powder solid lubricant system (including onboard storage, distribution, control, and reclamation) having potential for use in advanced gas turbines.

DESCRIPTION: Future aircraft turbine engines being developed in support of the Integrated High Performance Turbine Engine Technology initiative will gain much of their performance from higher cycle temperatures. Current liquids, used to lubricate bearings and other components, will not be able to survive the cycle imposed temperatures. Protection of the liquid lubricant will incur severe aircraft performance penalties. One potential solution to this temperature problem is to use a solid lubricant (e.g., powdered MoS_2) to minimize bearing friction and wear. That solution requires a distribution and control system to be incorporated into the engine and/or aircraft. Phase I of this effort shall result in the definition of system concepts for lubrication of turbine engine components with low coefficient of friction solid materials. The materials and system concepts shall have potential for use in advanced gas turbine engines over their full operating envelope (e.g., negative-g operation). The system shall provide for onboard storage, distribution, control, and (if appropriate) reclamation/scavenge for recirculation. Materials/concepts posing a hazard to the engine, environment and/or personnel are not acceptable. Phase II of this effort shall result in the design, fabrication and evaluation of the system having the most potential for satisfying overall requirements. It is expected

the evaluation would include demonstration of the system with several solid lubricants under simulated engine operating conditions. This effort should have Phase III potential in that the system could be supplied to various engine contractors having need of this technology.

AF90-130. TITLE: Lubrication of High Temperature Bearing Surfaces by Vapor Deposition

OBJECTIVE: To develop a system for vapor depositing suitable lubricants on bearing and/or bearing raceway surfaces for application in high temperature, advanced gas turbine engines.

DESCRIPTION: Lubrication of bearings in high temperature, advanced gas turbines will be difficult with conventional liquid or powder lubricant systems. Preliminary data suggest that a vapor deposition system may be superior in weight, lubricant performance, and delivery ease. Emphasis shall be placed on determining suitability of lubricant delivery and tribological performance over a temperature range of approximately -50 to 500° C. System size and weight shall be considered so as to minimize impact on advanced gas turbine engine design. Phase I activity shall include development and demonstration in a laboratory environment of a feasible lubricant and lubricant delivery system suitable for high temperature advanced turbine engines. This will lead to Phase II activities of bearing rig and possible full scale simulator demonstration of the system. This effort has Phase III potential for engine manufacturers to use the system for lubrication of high temperature bearing systems.

AF90-131. TITLE: Surface Deposit Analyzer

OBJECTIVE: An instrument for identifying, measuring, and characterizing surface deposits formed by the thermal decomposition of jet fuels is desired.

DESCRIPTION: When hydrocarbon fuels flow over hot surfaces, they tend to degrade thermally and create surface deposits that interfere with heat transfer and, in some critical subassemblies, with mechanical tolerances. These deposits are usually carbonaceous materials, or lacquer-type polymers on their way to carbon, but are generally poorly understood and characterized. The rate and extent of deposit formation depend strongly on both the precise chemical composition of the fuel, the environmental temperature profile, residence time, the presence of oxygen and trace components, and the nature and morphology of the surface. A method is desired that will permit monitoring the growth of such deposits as they are formed, beginning in the submicron thickness regime, in order to understand the relative significance of those chemical, physical, and mechanical parameters. The Phase I product would be the demonstration of a prototype laboratory-scale device capable of either intrusive or nonintrusive operation. This program has the potential for development of a commercially applicable device, useful in either research or quality assurance applications, in Phase II.

AF90-132. TITLE: Air Breathing Propulsion Using Antimatter

OBJECTIVE: To determine if antimatter could be used as the power source for manned or unmanned air breathing vehicles such as missiles, single stage to orbit vehicles, etc.

DESCRIPTION: Since the existence of antimatter has been determined, and the production and containment of antimatter has no near term solution, its application to air breathing propulsion should be determined in advance of a possible breakthrough. This study would be concerned with the development of a vehicle concept that would make use of this power source. The main concerns for this study would be the estimation of thrust levels available and whether they would be usable in an atmospheric vehicle. Also, such questions as would the vehicle be manned, what would be the size and weight of such a vehicle (based on extrapolated data from current concepts), what safety and operations problems would such a vehicle cause? Phase I activity will include a literature search, development of concept vehicle(s), as well as, a parametric study that would provide size, weight and performance estimates of the vehicle concept(s). This would provide a basis for Phase II activities, which would include the refinement of the concept vehicle(s) and their expected performance.

AF90-133. TITLE: Nonintrusive Velocity Measurements of Supersonic Combustion

OBJECTIVE: Development of instrumentation suitable to measure velocity of a supersonic combustion air stream in a test cell environment.

DESCRIPTION: In a supersonic combustion ramjet (scramjet), nonintrusive instrumentation is necessary to avoid disturbing that which is being measured. Determination of the inlet and exit stream thrust to a combustor will define the performance. Measurement of the airstream velocity will permit determination of stream thrust as the other parameters for stream thrust can be determined with conventional means. The challenge is to develop a method that will measure scramjet combustor velocity in a test cell environment, which can be quite different than a laboratory environment. The instrument must be able to hold calibration and obtain useful data for the test run duration. The operation of such a system should be development to a point where extensive pretest and post test preparation is not required. Seeding with external particles in the airstream to measure velocity is not desirable. The scramjet fuels to be considered are hydrocarbons and hydrogen. Delivery of an actual working system compatible with the test cells of the Aero Propulsion and Power Laboratory would be a final deliverable item. The goal of Phase I is to demonstrate in a laboratory test the concept to be developed for the test cell environment. Phase II goal is to develop and demonstrate a system capable of measuring the velocity in a test cell environment.

AF90-134. TITLE: High Energy Radiation Discrimination for Long-Wavelength Infrared Detector Arrays

OBJECTIVE: Demonstrate long-wavelength infrared detector arrays exhibiting near undegraded performance in high energy radiation environments.

DESCRIPTION: New long-wavelength infrared (8 to 35 microns or a subset thereof) detector array technology is solicited which exhibits state-of-the-art performance in low or moderate optical space backgrounds (1E9 to 1E14 photons/cm2sec), and which can discriminate between high-energy radiation (e.g., gamma radiation) and infrared radiation. Detector arrays which are located in space are subject to unwanted high energy radiation arising from charged particles in the earth's radiation belts, cosmic particles, and gamma radiation from various sources. In addition, the density of some of these radiation types can be greatly enhanced through both natural and man-made events. Infrared detector arrays which can discriminate against or essentially ignore the high-energy radiation while maintaining nearly undergraded infrared detector performance are desired. Potential approaches may include, but are not limited to the following: 1) new materials, 2) novel device architectures, and 3) on array optical lenses/condensers. Phase I will demonstrate a proof-of-concept. Phase II will further refine the design, fabricate, and demonstrate a prototype device array. Particular attention will be given to completely novel approaches which are based on sound physical principles.

AF90-135. TITLE: High Throughput Detector and Hybrid Array Production Testing

OBJECTIVE: Demonstrate improved, automated test equipment for testing large numbers of infrared detector and hybrid arrays.

DESCRIPTION: Over the next few years, several government programs will produce hundreds or thousands of infrared focal plane arrays. A major cost driver for these programs is the cryogenic testing of the detector arrays or the hybridized (detectors mated with suitable readouts) focal plane arrays. Currently, testing is done with single arrays mounted individually in customized dewars. The development of innovative, automated test equipment is solicited which is capable of testing multiple, low-noise (on the order of 100 noise electrons per sample) detector or hybrid arrays operating at low temperatures (as low as 10 degrees Kelvin). Sample times on individual detector pixels of less than 100 microseconds are required, as is low optical background capability. Test capabilities must include responsivity and NEI/D* (Dstar) for several operating conditions (device operating temperature, background flux, bias voltage, integration time, etc.,) and compatibility with many different readout array types. Phase I will demonstrate new design concepts for critical engineering tasks: low noise electrical contacts, multiple array handling, array temperature control, and infrared (optical) background control. Phase II will build and demonstrate models of the critical components, in preparation for fabrication and demonstration of an automated cryogenic test station in Phase III.

AF90-136. TITLE: Innovative Concepts for Space Control

OBJECTIVE: To develop new approaches (integrative methods and modeling tools) to perform the space control mission.

DESCRIPTION: Space control is the assured use of space by U.S. and friendly forces and the denial of space to hostile forces when directed. Space control functions include destruction or denial of enemy space capabilities, protection of U.S. space capabilities, space surveillance and the associated command and control nodes. Innovative approaches are sought to enhance U.S. capabilities in these areas. Methods should model the time and spatial dimension so that variation of operational concepts and tactics can be explored. Possible approaches include data flow diagrams and petri nets. Concepts should focus on the system architecture level. Phase I will define the method and demonstrate significant characteristics and improvements in the state-of-the-art by limited test cases. Phase II will continue the development through a full model of space force macro system performance.

AF90-137. TITLE: Innovative Concepts for Force Support from Space

OBJECTIVE: To identify new and/or improved methods of supporting military forces from space.

DESCRIPTION: Space systems provide critical support for operational military forces, including ground, sea and air. The key support functions include navigation, communications, meteorology and surveillance. The Air Force seeks innovative improvements in these particular capabilities as well as innovative new methods and capabilities to support worldwide military operations. This support may involve current systems or new system types. Changes to current support types might be accomplished with new approaches, or the application of new technologies. New support types should be described in sufficient detail to permit evaluation. An example of new technology might include improvements, changes or modifications to computer data links which would ultimately improve military capabilities. To better support terrestrial forces, innovative, small, inexpensive, user friendly equipment is required. Phase I will define the concept and describe the feasibility of developing force support from space. Phase II will develop a laboratory model, validate the technology and demonstrate in the laboratory the concepts proposed in Phase I.

AF90-138. TITLE: Innovative Applications of Emerging and Mature Technologies for Air Force Space Capabilities

OBJECTIVE: To identify innovative applications of new technologies for military space missions

DESCRIPTION: New innovative space applications for emerging technologies are needed for the 21st century. Research and development technologies are discouraged. New technology areas of particular interest include low thrust electric propulsion, high power density (greater than 10 kilowatts/cc), solid core, gas cooled fission propulsion reactors; and nonpropulsive space transportation. Phase I will define the concept and establish the technology and methodology requirements to validate and demonstrate the Phase I proposal. Phase II will develop, validate and demonstrate the Phase I proposal. Concept feasibility is the product of Phase II.

AF90-139. TITLE: Innovative Concepts for Improved Space Object Surveillance and Classification

OBJECTIVE: To develop new technologies and innovative applications of existing technologies to improve space object surveillance and classification.

DESCRIPTION: New technologies and innovative applications of existing technologies need to be investigated to improve space object surveillance classification. Classification should include a determination of the mission and potential hostile intent of space objects. Topics of particular interest include, but are not limited to the following: a) nuclear event detection; b) improved resolution and cloud penetration techniques for ground based systems; and c) radar and laser techniques for classification of spacebased systems. Phase I will define the concepts and establish the technology and methodology requirements to validate the concept. The contractor shall provide a rough estimate of anticipated improvements over the existing systems, as well as projected cost savings. Phase II will develop, validate and demonstrate Phase I. Proof-of-concept feasibility is the product of Phase II.

AF90-140. TITLE: Stabilized Sensor Platform for Manned Space Observations

OBJECTIVE: To develop a compact, flexible two gimbal stabilized sensor platform for manned observations of the earth or sky from space.

DESCRIPTION: Observations from space, using an optical sensor having sufficient magnification to recognize terrestrial objects, requires a sensor platform having the capability to assist the observer in finding and then tracking these objects from an orbiting space ship (presently the NASA Space transportation System). This platform must be capable of being mounted in the Space Transportation System overhead window during flight and of being stored in a crew compartment locker when not in use. Sensors, such as a high magnification optical telescope, should be easily attached and stabilized. The platform should be capable of accepting object position parameters and automatically tracking a point on the ground while that point is within sight of the instruments. Because of the small size required, and the weightless environment encountered in space, innovative techniques should be utilized, such as magnetically floated gimbal bearings. The offeror should also consider designing the system so that its inputs could be from another pointing system mounted in the Space Transportation System cargo bay. Phase II will build a prototype unit capable of being tested in space.

AF90-141. TITLE: Respiratory Protection Device

OBJECTIVE: Develop a lightweight respiratory protection device suitable for use in atmospheres contaminated with low concentrations of rocket propellant vapors.

DESCRIPTION: A lightweight comfortable device is needed for respiratory protection of personnel working in areas contaminated with low concentrations of rocket propellants. Hydrazines are widely used as rocket propulsion fuels in space launch operations. Because they are extremely toxic compounds, categorized as suspected human carcinogens, personnel must be protected from exposure to even very low levels. The threshold limit values (TLVs) of the three amine fuels, N_2H_4 (Hydrazine), MMH (Monomethyl hydrazine), and UDMH (Unsymmetrical Dimethyl hydrazine), for eight hours a day, five days a week are 0.1, 0.2, and 0.5 ppm (parts per million) respectively. Protection against rocket propulsion oxidizer vapors, primarily nitrogen dioxide, is also a concern. Nitrogen dioxide is a respiratory irritant with a work place TLV of 3 ppm. Because it would be very disruptive to evacuate personnel from nearby work stations every time a propellant activity takes place at a nearby launch support site, a device is needed that provides required respiratory protection for personnel working in contaminated environments having propellant vapor concentrations as high as several hundred ppm. Protection time is a minimum of four hours of exposure and preferably eight. The remaining protection capacity must be readily available to the wearer. The device should be lightweight and comfortable to wear. It should protect the eyes, nose, and mouth. It should be inexpensive to produce and maintain. Phase I shall be a concept feasibility design and building of a prototype for further development under Phase II. Phase II will consist of device performance improvement through continued development, testing, and modification. The proposal must show demonstrated potential for development into a viable device having field applications.

AF90-142. TITLE: System to Measure Currently Unfulfilled/Partially Satisfied Environmental Data Parameters

OBJECTIVE: Develop an optimum system prototype to measure unsatisfied or partially satisfied environmental data parameters.

DESCRIPTION: This effort should concentrate on the environmental data parameters detailed in Joint Chiefs of Staff Memorandum, MJCS 154-86, Meteorological Requirements for Defense Environmental Satellites, 1 Aug 86. The 43 MJCS 154-86 parameters include clouds, wind, moisture profiles, electron density profiles, and visibility. More than one parameter may be investigated in the proposed effort. Phase I should address a conceptual design development or analysis of currently available technology for an optimum data collection system. The system should be aimed at satisfying currently unfulfilled or partially satisfied MJCS 154-86 requirements. The Phase I design should consider satisfying as many related parameters as possible in a single cost effective system. Pros and cons of the proposed system should also be addressed (including impact to spacecraft and ground segments). Power, weight, cost, and

state-of-technology constraints should be considerations. Active or passive sensing techniques may be investigated. Phase II shall include further development of the Phase I concept into development of a prototype (working laboratory model) of the optimized system.

AF90-143. TITLE: Improved Lens Polishing and Coating Techniques for Zinc Selenide Optical Components

OBJECTIVE: To develop better methods of polishing and coating zinc selenide optical elements in order to reduce the amount of scattered light.

DESCRIPTION: Zinc selenide is a relatively soft optical material. As a result, standard polishing techniques do not produce very smooth surfaces. These smooth surfaces are required in order to minimize the amount of scattered light at the surfaces of the zinc selenide optical elements. The goal would be to develop surface finishes that would allow the zinc selenide to be used in optical systems that operate with the sun close to the field of view. An improvement in scattering by a factor of 3 or 4 is desired. Coatings for optical elements are needed to permit desired target energy to pass through while rejecting out of band backgrounds such as solar energy and other unwanted bright sources. The required coatings must have very steep cut on and cut off wavelengths and, therefore, require very many layers. These coatings must have very low scattering properties when applied to the zinc selenide optical elements for the reasons discussed in the above paragraphs. Existing coating materials and/or techniques for zinc selenide scatter too much light. New techniques and/or materials are desired which can reduce the amount of scattered light by a factor of 3 or 4. The Phase I effort will be to develop the proof-of-concept approach. The Phase II effort will be the design of the system using the approach developed in Phase I. Particular attention will be given to revolutionary approaches.

AF89-144. TITLE: Retrodirective Flight Test Article Instrumentation Antenna

OBJECTIVE: To develop small light weight antennas which direct gain in the direction of desired incoming signal.

DESCRIPTION: National Test Ranges such as the Western Space and Missile Center (WSMC) use radio frequency (RF) links to provide command, control, and position monitoring of articles undergoing flight testing. More data could be collected from flight tests if better antennas were available. Omnidirectional antenna coverage is needed. The antennas should not introduce amplitude or phase modulation. Additional challenges include small size (to fit on objects 1/2-10 ft in diameter), low weight (typically 3 ozs-22 lbs), high efficiency (>50%), minimum aerodynamic effects (drag 0.19-1.25 lbs per kg), ability to withstand high temperatures (300°-3000° F), ability to withstand high vibration levels (16-125 g) and capability for both transmit and receive. Initial development should concentrate on S-band for telemetry and command relay via satellite. Other areas of interest are C-band for radar and L-band for GPS. Future systems will use X-band, K-band and Extremely High Frequencies (EHF). A retrodirective antenna automatically directing the transmit energy to the proper direction would reduce the required on-board transmitter power. Likewise, the retrodirective antenna would maximize receiver antenna gain in the direction of the desired incoming signals. The retrodirective antenna will be useful for such programs as the National Aerospace Plane (NASP) and Hypersonic Glide Vehicle. In this application, command data would be linked down to the test article antenna and narrowband telemetry containing test measurements would be uplinked via satellite through the retrodirective antenna. Such retrodirective antennas have not been developed yet. Innovative approaches are sought. Phase I should develop one or more alternatives to achieving retrodirective antennas as described in the preceding paragraphs. Phase II should result in a deliverable prototype retrodirective antenna for testing and characterization. Phase I should be in sufficient detail to allow the feasibility of producing a suitable prototype antenna to be accurately assessed. There are several possible commercial applications for retrodirective antennas. These include mobile and airborne long distance telecommunications and high fidelity mobile radio.

AF90-145. TITLE: Space Launch Complex Waste Water Treatment Plan

OBJECTIVE: Develop a method to treat toxic waste water generated by space launch complexes.

DESCRIPTION: During space launch operations, large amounts of water are sprayed on areas of the launch pad to prevent blast damage. After use, this waste water is channeled into storage ponds where, in the past, it was treated to neutralize any toxic agents and released into the environment. Recently however, the treatment methods were found to

be inadequate to meet environmental regulations and release of the water was prohibited. The current practice is to transport it to a large pond for long-term storage. Even this ponds capacity may not be adequate to support all launch operations, and rain water further complicates the problem. The Air Force is therefore soliciting innovative approaches for the permanent disposal of this water. Phase I will develop proof-of-concept for a new method to treat the water so that it may be safely released to the environment. This plan should be based upon water samples taken from the ponds and must conform to all environmental laws applicable to the treatment, transportation and storage of toxic liquids. Phase II will develop detailed engineering to implement the water treatment techniques at the space launch complexes. The water capacity required for launch operations should be considered as well as the physical dimensions and accessibility of the storage ponds.

AF90-146. TITLE: High Power Microwave Detector

OBJECTIVE: Design, fabricate and test a High Power Microwave (HPM) receiver to detect range radar emissions.

DESCRIPTION: The recent attention to RF power issues at Vandenberg AFB has resulted in increased awareness of potential damage to spacecraft electronic systems. A simple receiver should be developed to provide a monitoring capability to detect the occurrence of high power microwave illumination. Support systems at satellite launch facilities may illuminate satellites with high microwave energy prior to and during launch operations. For example, tracking radars, located close to launch sites, use large antennas and high peak power transmitters to achieve the sensitivity to track satellites as they proceed to orbital altitudes. These support systems can exceed the field strength value specified by MIL-STD 461B for satellite electronic systems at the short range between the support system and the launch site. An innovative design will result in a receiver that can be triggered by an RF impulse similar to a smoke detector. The detector should be as simple and portable as possible because monitoring sites may be remote and power sources may not be available. Some possible uses for the HPM detector include inside transporters during satellite transport to launch base; at off site processing facilities (factories) prior to integration of the satellite and launch vehicle; and at the launch base, both at the pad and at off-line processing facilities. Eastern Test Range is also interested in detector development. Some commercial applications may be as a detector in ordnance factories or storage areas; in factories that produce sensitive micro circuits; and any other industry where electronic devices may be damaged by large emitters. At Vandenberg, data from the detector will be used to correlate vehicle failures with excessive RF power levels. Therefore, if a failure occurs, data from the detector will confirm or eliminate excessive RF levels as a potential cause.

SPECIFICATION:

1. FREQUENCY BAND: 1 GHz-10 GHz, hemispheric coverage.
2. MODULATION: Pulse or CW. Minimum pulse width - 0.1 microseconds.
3. RESPONSE: Single radar pulse.
4. DETECTION LEVELS: 1.0 V/m, 5.0 V/m, 10.0 V/m, 50.0 V/m.
5. RECORDING: At least 30 minute recording capability.
6. POWER SOURCE: Battery or 110 V AC line.

AF90-147. TITLE: Innovative Concepts for Structural Dynamics and Control Space Experiments

OBJECTIVE: Design structural dynamics and control research space experiments.

DESCRIPTION: Several proposed Air Force missions call for large precision space structures. These structures present new challenges in the areas of structures, dynamics and control. Over the past decade, extensive research has been conducted in methodologies associated with the control of large precision structures. To address the need for validation of these methodologies, several ground demonstration facilities have been developed. These ground facilities are limited in their ability to mimic space environmental conditions which affect structural behavior. Space experiments which complement the ground demonstration facilities are needed. Innovative structural dynamics and control space experimental designs are solicited to address the limitations of ground demonstration facilities. Shuttle based, free flying, and piggyback concepts will all be considered. Experiments should provide data related to the dynamic behavior of structures in the space environment. Effects of microgravity and material degradation are of particular interest. Also, as a minimun, experiments should provide transient response of some test article to various

disturbances. Platforms which can easily be adapted to support a variety of experiments will receive greatest consideration. In Phase I, the contractor will identify and evaluate experiment conceptual designs and the means available for putting a space experiment into space. In Phase II, a detailed design of the most promising concept will be generated, and hardware will be purchased or fabricated and assembled.

AF90-148. TITLE: Innovative Models of Propellant Combustion

OBJECTIVE: To develop and verify innovative models of various aspects of the combustion process.

DESCRIPTION: There are several areas in the combustion process that strongly need to have models developed or improved. The first area is droplet formation, breakup and coalescence. These play a critical role in many propulsion and spacecraft problem areas. Accurate predictive models of droplet behavior are not available, especially when one of the propellants is in the super critical state. A second area in which a significant improvement to existing models could be made is in the detailed spatial and temporal modeling of the gas phase reaction zone associated with burning heterogeneous solid propellant. Most of the models that currently exist, use global reaction models rather than the full set of reactions that may occur. With the increases in computing power that have occurred in recent years and considering the added information that the full set of rate equations will provide, it is time and appropriate that this important step be made. Finally, combustion process models are very limited in the physics that they include, as well as the validity of the results they provide. Models which include a more realistic analysis of the combustion process could lead to a greater understanding of this process and improve our ability to predict and control combustion. Innovative new models might include detailed diffusion and finite rate kinetics, time dependent surface geometry variation and heat transfer analysis, surface melt effects, and stochastic analysis of the interaction of multiple flames produced from multiple surface sources. Phase I of the project will involve the development of the model while Phase II will validate the model by comparing the predictions with experimental data.

AF90-149. TITLE: Advanced Turbomachinery Systems and Components

OBJECTIVE: Develop lightweight, highly reliable dynamic space power and thermal management system components.

DESCRIPTION: The Air Force solicits innovative concepts that provide substantial improvements in rotating components for application to dynamic power and thermal management systems. Areas of particular interest include: 1) novel thermodynamic cycles, 2) highly reliable lightweight pumps, 3) self healing or integrated bearings and seals, and 4) high efficiency cryorefrigerators. Current thermodynamic cycles are substantially below the predicted Carnot efficiencies. New or hybrid thermodynamic cycles with cycle efficiencies in excess of 40% offer the potential for both power generation and thermal management system mass savings. Besides a device specific power greater than 40 w/kg and insensitivity to energy source (nuclear reactor or solar collector), scalability to greater than 50 kw and low cost are of prime concern. Long life lightweight pumps with assured reliability are required. Both rotating and passive pump concepts are solicited. The ability to autonomously detect incipient failure and reliably self-heal bearings or seals would eliminate the need for multiple redundant components or systems for required reliability. Components which more highly integrate bearings or seals into their designs could also result in increased reliability and reduced mass. The development of higher efficiency cryorefrigerators significantly impact the development of lighter weight spacecraft with enhanced operational capability by both reducing the cryorefrigerator mass and, more importantly, reducing the required electrical power to operate the refrigerator. Based on his expertise, an offeror may submit a proposal for any of the identified areas of interest. For each effort, Phase I should produce a complete analysis of the concept's feasibility; limited laboratory testing, if required; a prediction of performmance characteristics; and a design of a proof-of-principle model. The Phase I proposal should include a preliminary feasibility analysis as part of the concept justification. In Phase II, appropriate scale models will be fabricated and tested under simulated operational conditions to verify performance estimates. A detailed technology development plan shall also be prepared during Phase II.

AF90-150. TITLE: Technology for Storage, Handling, or Use of Antimatter

OBJECTIVE: Develop technology in the area of 1) analysis of matter by matter-antimatter annihilation radiation; 2) prediction of its products and effects; or 3) safe long-term, high density storage systems for antimatter.

DESCRIPTION: Antimatter is composed of quantum mechanical particles which have reverse properties of their normal matter counterparts. When antimatter and matter are allowed to interact, the entire mass of both is converted into energetic radiation, mostly charged pions and gamma rays in the near field. This property of antimatter has led to concepts for the use of stored antimatter as an analytic radiation source in the near term, and as an energy source for rocket propellant in the far term. Proposals are sought to design and demonstrate an element of the technology needed to use antimatter which: 1) can be developed within the funding and time limitations of an SBIR procurement, and 2) can be demonstrated using an appropriate form of normal matter (a normal matter analog) to simulate antimatter. Examples of the technologies sought include: 1) wide angle, high resolution X-ray fluorescence, annihilation gamma ray, or charge pion detector arrays to locate and characterize annihilation site within normal matter; 2) storage systems for charged or neutral solid antihydrogen; 3)computer models and software for predicting annihilation products and their effects; and 4) other innovative technologies which review of the literature indicate are required for use of antimatter in astronautics related areas. Phase I of this effort shall consist of a design for the proposed technology element. In Phase II, the selected item shall be built and demonstrated with a normal matter analog. Designs shall consider (as applicable): 1)radiological safety with respect to annihilation rates; 2) vacuum requirements; 3) temperature requirements (solid antihydrogen storage will probably require a 1 Kelvin radiative heat sink); 4) proposed uses of the technology, and 5) other appropriate constraints.

AF90-151. TITLE: Innovative Concepts for Ground Testing Spacecraft Structures

OBJECTIVE: Develop innovative techniques, equipment or facilities for testing large precision space structures.

DESCRIPTION: Several proposed Air Force missions call for large precision space structures. These structures will be larger than anything flown before. The combination of large size and low structural mass will make these structures very flexible. Many of these structures will not have sufficient strength to support their own weight when on the earth's surface. Those capable of withstanding gravitational loads will behave differently on the earth's surface than when on orbit because of those loads. Their large size will require these structures to collapse for launch then deploy once on orbit, undergoing radical changes in geometry and dimension in the process. Some proposed systems are actually composed of several interconnected, articulated structures. Spacecraft which utilize these types of structures present new challenges in the area of ground testing. Innovative concepts are solicited which address the problem of ground testing large precision space structures. Concepts related to techniques, equipment or facilities are sought. Ground tests of interest include modal testing, structural performance validation, and deployment. The Phase I contractor will define approach and perform trade studies against other existing approaches to evaluate feasibility, payoffs, and penalties associated with the concept. In Phase II, the contractor will refine the concept based on Phase I findings, then proceed as appropriate for the concept proposed. Techniques and equipment will be developed and implemented in a structural dynamics and control tested to evaluate the performance of the concept. Detailed designs will be generated for facility proposals.

AF90-152. TITLE: Innovative Pumping Concept for Supporting Ammonia Arcjet Propulsion

OBJECTIVE: Develop new and innovative techniques providing high throughput vacuum capability required for ammonia arcjet research.

DESCRIPTION: A new technique is required to provide high throughput, high vacuum pumping capability needed to provide 1E-4 Torr vacuums with arcjet propellant flow rates of 0.25 to 1.0 grams per second for 10 to 100 minutes. The technique must be able to withstand the 30 to 100 kilowatt exhaust plume of the thruster with degradation. No such facility or technique currently exists in the United States. The technique must also be amenable to cost effective retrofitting to existing vacuum facilities. Approaches using one or more of the following techniques are suggested: 1) mechanically scraped cryopumps, 2) titanium getter pumping, and 3) ion pumping. Concepts need not be limited to these suggestions. Phase I will develop the technique and perform a proof-of-concept test using an ammonia arcjet. Phase II will be the design, fabrication, and installation into a government vacuum facility of a full-sized engineering version of the new pumping concept. Particular attention will be given to revolutionary approaches based on sound scientific principles.

AF90-153. TITLE: Electrochemical Energy Storage

OBJECTIVE: Develop lightweight, high power electrochemical energy storage systems for satellites.

DESCRIPTION: Most Air Force satellite missions use photovoltaic arrays to generate required electrical power. These systems require some sort of electrical storage system to allow for operation during orbital eclipses. Current electrochemical energy storage technology cannot provide more than a few kilowatts of power without significant mass penalties. In accordance with Project Forecast II PT-05, innovative proposals for lightweight, high power electrochemical energy storage systems (fuel cells and batteries) are solicited. Proposals should include a preliminary feasibility analysis as part of a concept justification. For fuel cell systems, research needs to be performed in areas of high performance electrolytes. Maximizing the amperage generated per unit area of electrolyte is desirable for systems having separate fuel cell and electrolyzer stacks. For a fuel cell stack itself, minimizing the mass per unit area of electrolyzer is desirable for producing a high energy density system design. Electrolyzers suitable for extended use on orbit also need to be developed. Another possibility is the development of a bifunctional electrolyte, allowing the functions of the fuel cell and electrolyzer to be combined into a single hardware stack. Advanced fuel cell concepts using reactants other than hydrogen and oxygen have high potential payoffs. Other electrochemical energy storage concepts in the field of rechargeable batteries can also provide very high energy densities. The primary technical issues associated with satellite rechargeable batteries are related to design engineering: constructing hardware from theoretical designs, consistently obtaining deep depths of discharge from test cells, and verifying long lifetime operation at high performance levels. Desired energy storage system performance parameters are: 20 to 50 kw of power delivered, usable energy density greater than 100 whr/kg, and orbital life greater than 5 years. Technical issues to be considered include thermal and fluid management (if any); and reliable operation under various charge/ discharge cycle conditions. Phase I should produce a complete system feasibility analysis, a prediction of performance characteristics, and a proof-of-principle design. In Phase II, small scale models will be fabricated and tested under simulated operational conditions.

AF90-154. TITLE: 2.10 Micron Doppler Lidar Detection System

OBJECTIVE: To study detection techniques for a 2.10 micron coherent Doppler and backscatter lidar system.

DESCRIPTION: The Geophysics Laboratory (GL) is pursuing the development of lidar sensors for use in both ground and spacebased applications. There is currently strong interest in the development of near IR lidar systems which could obtain both aerosol backscatter and Doppler information from space. The objective of this effort is to study detection techniques for a 2.10 micron coherent Doppler and backscatter lidar system to be used in ground-based proof-of-concept studies. This would include the selection of candidate detectors, use of single mode fiber optic photomixing techniques, and the review of designs for a signal acquisition system to handle the detected signal. If the Phase I results warrant it, the Phase II effort would include fabrication and testing of a prototype system with the laser transmitter and receiver optics provided by GL as Government furnished equipment. The system would be integrated into an existing mobile lidar laboratory containing a Raman lidar and a coherent CO_2 backscatter/Doppler lidar system. The 2.10 micron lidar would share the MicroVAX II computer, displays, scanners, and other hardware used by the existing systems. Details of the mobile laboratory and the 2.10 micron laser would be made available to the successful awardee.

AF90-155. TITLE: Knowledge Based Seismic Event Automatic Association and Location Estimation

OBJECTIVE: Development of advanced, knowledge based techniques for the association and location of seismic events.

DESCRIPTION: Successful monitoring and verification of compliance with nuclear test ban treaties requires the Air Force to effectively integrate a complex set of resources including signal collection, processing, and analysis. The product of this effort is forwarded to the highest levels of the Government including the National Security Council and the White House. The generation of accurate, and reliable information is of paramount importance. The process of nuclear test ban treaty monitoring involves the collection of raw signal data; reduction of these data by analysis and processing; and the fusion of the results with other intelligence information. The Air Force's ability to meet current test ban treaty monitoring requirements is critically dependent on the second of these activities: the analysis and processing of the signal data. The objective of this activity is to a) detect and extract information on the seismic signals of interest; b) to associate this information with specific events; and c) to characterize the events in the

context of nuclear test monitoring and verification requirements. Limitations in existing association and location algorithms restrict the number of detections that can realistically be processed, and reduce our capabilities to meet monitoring requirements. This restriction is largely imposed by the inability of the current architectures to quickly analyze and eliminate most of the possible association combinations resulting from large numbers of seismic arrival detections. This limitation could be overcome through the application of effective control "knowledge" and modification of current algorithm architecture. Success in this area would significantly increase the capability of the Air Force to meet durrent and future monitoring requirements. Phase I: The contractor will study current association and location algorithms and evaluate where processing and control knowledge could be employed to reduce the number of association combinations processed. The contractor will prepare a design for a proposed "knowledge based architecture" and demonstrate, through prototype development, at least three examples of how and to what degree the application of these techniques can improve the algorithm performance. The preliminary design and results of the prototype processing will be delivered at the end of Phase I. Phase II: The contractor will prepare a final design and develop an advanced, knowledge based prototype system for association and location of seismic events. The prototype will be tested at the contractor's facility and be demonstrated on 24 hours of real data to be provided by the government. The hardware for implementation of the prototype system will be approved by the government prior to commencing development. The completed system must operate at least ten (10) times faster than real time on the test database provided.

AF90-156. TITLE: Surrogate Cloud Information From Satellite

OBJECTIVE: To provide from environmental satellite data the specialized information needed to specify the degradation in radiance intensity affected by cirrus clouds.

DESCRIPTION: In order to specify the attenuation of radiation which passes through clouds, and in particularly cirrus clouds, a considerable amount of bulk and microphysical cloud data is needed, e.g., particle sizes, condensed water content, physical thickness, radiative properties, etc. Since these specialized data can only be obtained from in situ measurements and well-calibrated remote sensors (e.g., lidar), such information is not available on a global, continuous (day-and-night) basis. Nevertheless, requirements exist for specifying cirrus cloud attenuation on this scale. The satellite platform affords coverage needed but no methodology presently available allows satellite radiometric and sounder data to be used as surrogate for the specialized cloud data. The objective of this proposal is to develop techniques which will provide the cloud information required for an accurate assessment of radiance degradation under typical cirrus cloud conditions, given only satellite data. Evaluation of the errors resulting from substituting satellite data for more direct cloud measurements must be made. The wavelengths for which attenuation is of interest are the upper half of the visible spectrum and the infrared atmospheric windows out to 14 microns. The techniques must be based on radiation theory and the analysis of multiplatform, coincident measurements. Precedence should be given to data from the Defense Meteorological Satellite Program (DMSP) sensors. Any DMSP data required will be provided as Government Furnished Equipment (GFE). All other data sets are the responsibility of the contractor to obtain. The Phase I six month report should consist of the pertinent radiation theory, an appropriate cloud discrimination scheme, an annotated compendium of germane data sets and a detailed work plan and milestone chart for the rest of the effort. The end product of Phase II will be a well documented methodology, in equation form and in appropriate computer code, having as input a very effective satellite retrieval algorithm for cirrus clouds and as output the bulk and microphysical cloud information needed to specify attenuation in the required wavelength bands.

AF90-157. TITLE: Ionospheric Tomography System

OBJECTIVE: Develop a system for constructing two-dimensional ionospheric electron density profiles using tomographical techniques.

DESCRIPTION: Many modern military space systems involving communications, radar or precise positioning, require knowledge of the ionospheric environment. Advanced radar sensors require corrections for both range and range rate errors, particularly when tracking objects as they pass through the ionosphere. Large gradients in electron density can limit signal returns from OTH radars at times when the ionospheric trough region is deep. The tomography technique, applied to the ionosphere, has the potential of yielding near real-time two-dimensional electron density profiles versus height and latitude over a wide range of latitudes at low cost. The tomography technique works by making integrated measurements of electron content at a number of sites along a latitude chain, and applying mathematical algorithms to construct two dimensional electron density profiles versus latitude. The overall system

design requires cost effective, dual frequency, electron content receivers, a method of communicating data from each receiving location to a central location in near real time, and the development of efficient algorithms for reconstruction of equivalent electron density profiles along the direction of the station chain. In Phase I, system design tradeoffs would be examined, including potential methods of obtaining electron content data and performing computations at a central site. Tradeoffs also would be computed on desired profile height and horizontal resolution versus number of stations, communication and computational assets and time required. A possible Phase II demonstration of the concept would be made near existing ionospheric diagnostic facilities located in an ionospheric region where large gradients in the ionosphere normally occur.

AF90-158. TITLE: Instrumentation to Measure Low Electron Densities in Laboratory Vacuum Chambers

OBJECTIVE: Develop technique to measure temporal and spatial properties of low electron densities in vacuum chambers.

DESCRIPTION: Laboratory chambers are being used to experimentally investigate high power microwave breakdown of the air. It is important to measure long lifetime electron densities in the chamber experiments. Current state-of-the-art techniques can measure densities down only to the order of 10^9 electron/cm^3. Projected requirements for the apparatus are: ability to measure electron densities down to the order of 10^4 per cm^3, in plasmas of thickness of the order of 4 cm and diameter of the order of 20 cm, with time resolution of the order of 10 microseconds or better, in tank pressures of from 0.01 to 3 Torr. In Phase I, we expect that the feasibility of building such an instrument will be evaluated and that a preliminary design will be prepared. In Phase II, a prototype instrument will be constructed and tested, and if successful, will be used in future chamber experiments on AIM lifetimes.

AF90-159. Title: Variable Polarization Lidar Optics System

OBJECTIVE: To provide an existing lidar with an adjustable polarization optics system for cloud studies.

DESCRIPTION: The Air Force ABLE (Atmospheric Backscatter Lidar Experiment) lidar system utilizes a frequency doubled and tripled Nd:YAG laser transmitter and a half-meter telescope receiver to make backscatter measurements at 355 and 532 nanometers. This lidar system has successfully performed in both ground-based and balloon-borne experiments. In the Rayleigh/Mie backscatter mode, the ABLE system has measured atmospheric neutral density and aerosol profiles from 30 km to the ground. In the Raman backscatter mode, N_2, CO_2, and H_2O boundary-layer profiles have been measured. Although capable of cloud detection, the lidar is unable to make any assessment of cloud composition. A conventional lidar of the ABLE type transmits a linearly polarized laser pulse and measures the backscatter from atmospheric constituents including aerosols and clouds. The backscattered radiation is assumed to be linearly polarized in the same manner as the laser pulse, but this has not been experimentally confirmed for various meteorological cases. A polarization uncertainty can degrade the measurement and compromise the accuracy of lidar data analysis. Under certain atmospheric conditions, such as ice crystal formation, the backscatter is expected to be polarization dependent. A lidar polarization system implemented in both the transmitter and receiver optics to permit selectable polarized illumination of clouds and polarization shift analysis of the backscatter, is to be developed. Phase I will consist of a feasibility study and the development of a preliminary design of the lidar polarizer. Phase II will require the fabrication of the polarizer followed by integration and testing with the ABLE lidar system in preparation for field operations during various meteorological conditions. This will be an important enhancement of the ABLE system at a time of increased interest in cloud studies, especially visible and subvisual cirrus.

AF90-160. TITLE: Phased Array Telescope Image Processing

OBJECTIVE: Develop an algorithm to measure misalignments in an phased array telescope using image plane information.

DESCRIPTION: The phased array imaging telescope concept has advantages over traditional single telescope systems for space applications where very large apertures are required for high resolution. Primary mirrors may be relatively small, lightweight, easy to fabricate and test. The system may be launched in pieces, but with individual subtelescopes fully assembled and aligned. The phased array telescope must be designed so that the subtelescope positions with respect to each other are not critical. A servo system then adjusts the smaller beam combining optics so that the array achieves the resolution of a single very large telescope. This requires that two conditions be met

simultaneously over the telescope's entire field of view. First, the images must be superimposed with an accuracy of much less than the required resolution of telescope array. Second, the images from each telescope must be phased to the others to an accuracy of much less than a wavelength. The first phased array imaging telescope is now in operation at the Weapons Laboratory. A sensor system estimates pupil geometry errors from phase and tilt measurements on a local alignment beam which is scanned over the telescope's field of view. The phase and tilt control loops requires a bandwidth of about 50 Hertz because the tolerances on phase and tilt are very tight. The lateral pupil geometry loops operate at a bandwidth of less than one Hertz because pupil geometry tolerances are much looser. The system works but has two problems. First, the sensor optics are very complex because they have to measure piston errors over many points in the field of view. Second, the sensor is subject to bias errors since it is strictly a local measurement and does not utilize any information from the object being imaged by the telescope. The Air Force is looking for innovative concepts to measure telescope misalignments by processing the image of an extended object at the telescope array's focal plane. If this algorithm is fast enough, it could replace all of our local sensor systems. If it is relatively slow, the traditional local alignment sensor could be retained to control the arrays on axis phase and tilt at high bandwidth. Since this new focal plane sensor would operate on the image of the actual object being viewed, it could also remove any bias errors in the local phase and tilt loops. In Phase I the contractor should develop a concept for measuring phased array misalignments by analyzing the image of an extended object at the phased array telescope's combined focal plane. The contractor should perform initial algorithm tests with simple images using a computer simulation of a phased array telescope. At the end of Phase I, the contractor should deliver a final report. In Phase II, the contractor should refine his algorithm with a simulated phased array telescope using realistic images and a more accurate telescope simulation. At the end of Phase II, the contractor should deliver a final report and software suitable for demonstration by the Air Force.

AF90-161. TITLE: Nonlinear Optical Target Recognition

OBJECTIVE: Develop nonlinear optical techniques to recognize patterns within images.

DESCRIPTION: The Air Force needs to recognize and select targets within optical images. Prior pattern recognition systems required complicated computer algorithms using artificial intelligence. Electronic neural networks and associative memories have been used to decrease the complexity of computerized pattern recognition algorithms, but they remain complicated and inflexible. Recently, all optical neural networks and associative memories have been developed using nonlinear optical processes. These processes eliminate the requirement for computer algorithms, and do all image processing in parallel, rather than serially. This topic solicits innovative approaches for nonlinear optical pattern recognition systems. The required outcome of Phase I is a conceptual model and detailed engineering design of a nonlinear optical imaging neural network or associative memory. The product of Phase II will be a robust, adaptable image processing system, which may involve a hybrid of computer and nonlinear optical techniques, and which recognizes selected objects in images.

AF90-162. TITLE: Modular, High Efficiency, High Temperature Energy Conversion Systems

OBJECTIVE: Develop modular (redundant), high efficiency, high temperature energy conversions systems for spacecraft applications.

DESCRIPTION: Redundant, high temperature, high efficiency power systems offer many advantages to Air Force spacecraft, such as reduced mass, reduced area, and enhanced survivability. In Phase I, the contractor shall produce the conceptual design of one or more power conversion systems with as many of the following features as possible: 1) modularity (allow the use of multiple redundant units); 2) high efficiency; 3) high temperature (particularly on the heat rejection side of the cycle), 4) interface flexibility indirectly coupled with a wide range of heat sources, including nuclear: and 5) a variety of heat transport systems - conductive, radiative, heat pipe, and/or pumped loop (liquid, gas, and/or two phase); 6) low specific mass (kg/kwe); 7) producibility (avoid expensive, scarce, or hard to produce materials, if possible). In Phase I, the contractor shall design a basic module to produce 1000 watts (electric). For each candidate power system, in Phase I, the contractor shall identify thermodynamic characteristics, materials of construction, interface requirements, development status, life limiting mechanisms, and scaling implications (to 10 kwe and 100 kwe units) of the technology. In Phase II, the contractor shall develop a working prototype of the converter as a proof-of-principle device. In addition, system studies shall be performed to determine the performance of the technology in comparison with established conversion systems. In Phase III, the prototype could

be further developed to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost, and manufacturability. Potential applications of the power conversion technology developed by this effort include primary and secondary space and terrestrial power systems.

AF90-163. TITLE: Anechoic Chamber Performance in the Near Field of High Power Antennas

OBJECTIVE: Develop a personal computer based expert system for calculation of anechoic chamber performance.

DESCRIPTION: Susceptibility/vulnerability testing of military systems to irradiation by high power microwaves requires a controlled electromagnetic environment. A typical environment consists of a conducting faraday cage which is lined with varying heights of microwave absorber. Although the absorber generally reduces wall reflections, its effectiveness is highly dependent on the angle of incidence and the frequency of the incident wave. Angles of incidence are in turn highly dependent on the pattern of the radiating antenna and its proximity to the object under test and walls. A key goal of anechoic chamber design is to irradiate the object under test exclusively with energy launched directly by the source antenna, even though multiple reflections between imperfectly absorptive walls, the conducting test object, and the antenna itself, always occur. A second consideration in chamber operation is to utilize antenna and source geometries which simulate free field, plane wave conditions. However, often antenna near field conditions prevail at the location of the test object, because the distance from antenna to test object is limited. Thus, uniformity of HPM illumination over the surface of the test object is adversely affected both by near field antenna effects as well as by waves partially reflected from anechoic chamber walls. A need exists for a personal computer based, innovative expert system to aid in the planning, execution, and interpretation of high power microwave effects testing. The expert system embodied in software should allow calculation of all relevant electromagnetic quantities at any point exterior to the test object when the antenna geometry and operating mode, radiated power spectrum, approximate test object shape, and spatial distribution of wall absorber are given. Of particular interest is the variation in power density over the surface of the test object. The expert system should be able to carry out near field calculations for a wide variety of antenna types and should adequately treat, as a minimum, the effects described above. Phase I work should explore potential novel, computationally efficient techniques for calculation of the spatial distribution of power density and other electromagnetic quantities in the presence of multiple reflecting surfaces as described above. Novel methods for near field calculations of a wide variety of HPM antennas should be included as a subset of the proposed expert system. Phase II work will involve implementation of the methods proposed in Phase I research on a personal computer to produce the expert system. This expert system will be a flexible tool in evaluating the new effectiveness of the antenna/anechoic chamber combination for HPM effects testing.

AF90-164. TITLE: Advanced Suspension/Isolation System

OBJECTIVE: Develop a system for supporting the weight of a simulated/actual beam director in a 1-G environment.

DESCRIPTION: Pointing and tracking experiments with a large beam director require a means for supporting its weight while accurately simulating the unconstrained boundary conditions of space. A system is needed which can produce rigid body suspension frequencies on the order of 0.1-.2 Hz for payloads in the range of 6000-12000 lbs supported by 3-4 devices with nominally equal loading, i.e. 2000-3000 lbs per device. The payload must be free to translate through amplitudes of several inches in all three directions and to undergo rotations of several degrees about all three axes. The suspension device must support the payload from underneath in order to minimize headroom requirements and thus be usable in an ordinary (low bay) laboratory facility. Suspension must be accomplished with minimal added mass and minimal nonlinear constraint due to friction. The moving structure of the suspension devices must be compact, stiff and well damped such that they add no objectionable vibration modes of their own. Phase I would investigate active and passive technologies for the suspension devices, including construction of a subscale proof-of-concept demonstrator. The Phase II objective would be the design, construction and testing of a set of full scale devices plus the associated system controller.

AF90-165. TITLE: Optical Parametric Oscillator (OPO) with a Diode Laser Pump Source

OBJECTIVE: Develop and demonstrate a tunable OPO using a diode laser as the pumping source.

DESCRIPTION: Recent developments in semiconductor laser diode technology have taken the power output of these devices from the milliwatt into the watt regime. At these power levels, many Air Force applications, such as Infrared Counter Measures (IRCM) and optical communications exist for such a compact, robust light source. These applications, however, require sources which are wavelength tunable or, at least, operate at a nonabsorbing wavelength in the atmosphere. The current semiconductor materials suitable for diode lasers do not contain bandgaps which allow this. A solution to this problem is to use an Optical Parametric Oscillator (OPO) with the diode laser as the pumping source. The output of this device would be tunable through either temperature or incidence angle control of the nonlinear crystal. Although OPOs have been demonstrated with several other laser sources, none have been demonstrated with diode lasers. Reasons for this are: 1) High intensities (MW/cm^2 range) are required for the nonlinear process of the OPO to occur. The output power of a single diode laser is typically in the mw range. 2) Since the OPO intensity requirements cannot be met with single devices, diode arrays must be used. OPOs also require a clean, nearly diffraction limited beam over the nonlinear interaction length. The output of such arrays only approaches the diffraction limit when coherence of the entire array is achieved. 3) The beam must be focused to a very small spot to achieve the required OPO intensity level. Focusing the beam this tightly shortens its Rayleigh Range and, therefore, the effective interaction length. This impacts the overall gain of the OPO since it is a function of the intensity length product. However, possibilities exist to develop an OPO in nonlinear fibers or waveguides, both of which presently exist. Phase I of this program is to design an OPO which is driven by a diode laser source. The nonlinear crystal requirements to be used per diode type (i.e., 0.7-0.9 um AlGaAs or 1.2-1.6 um InGaAsP) will be determined. Examples of such requirements are the transparency wavelength range and the phase matching wavelength range. Once these parameters have been determined, the appropriate nonlinear materials will be researched and the proper material or set of materials determined. Also included in Phase I will be the design of the OPO cavity and any required optics. Phase II should apply the designs of Phase I and physically develop an OPO driven by a laser diode source. This development is to include quantification of such figures of merit for an OPO as intensity threshold of the nonlinear process, gain of the device, conversion efficiency from the source wavelength to the desired wavelength and temperature and/or angle tuning parameters of the device. Such an OPO device will be deliverable at the end of the Phase II period. The technology developed is directly associated with initiatives established under Project Forecast II. Commercial applications which will result from a successful Phase II effort are wavelength tunable or wavelength agile laser sources for infrared countermeasure systems and optical communication systems.

AF90-166. TITLE: Large-Scale Scientific Programming in a Supercomputer Based Object Oriented Environment (OOP)

OBJECTIVE: Develop techniques for increasing the reliability and reusability of large modeling/simulation computer programs.

DESCRIPTION: In pursuit of optimum productivity, a researcher should remain focused on the potential solution(s) to a problem. In the supercomputing environment though, current programming tools (Fortran C, etc.) do not provide a high enough level of abstraction for this to be possible. They require that the researcher also be concerned with low level implementation details. These high performance systems also lack any vehicle, other than, and often unruly, relocatable libraries, which favor code reuse. Accordingly, a significant number of new programming efforts involve rewriting code which, usually unbeknownst to the author, already exists elsewhere in the system. In the last few years, a revolutionary new programming methodology has begun to emerge. Entitled Object Oriented Programming (OOP), this approach effectively addresses the above problems via a shifting of emphasis from the code supplier to the code consumer. Many OOP environments are available on small to medium sized computers; however there is apparently no evidence that any such environment has ever been utilized in the development of software on a supercomputer. Phase I work should therefore explore the feasibility of using C++ (a popular OOP extension to the C language), on a Cray supercomputer, as a tool for the modeling of problems in areas such as computational fluid dynamics, quantum chemistry, and plasma physics. Phase II should conclude with an actual demonstration on a Cray based C++ environment, used as a substantial player in the construction of a simulation code for a representative problem.

AF90-167. TITLE: Ballistic Missile Research

OBJECTIVE: Develop new concepts and innovations for ICBM systems and/or subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of ICBM systems/subsystems research, development and acquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific ICBM topics. This general area covers the full spectrum of Air Force ICBM missions (i.e., basing, propulsion, guidance and control, defense penetration, target kill, etc). Emphasis is placed on potential long-term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. This could include studies of heavy weather and cirrus clouds over target areas. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, innovative R&D organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF90-168. TITLE: Alternate Laser Initiated Detonator (LID) Designs

OBJECTIVE: Demonstrate improved LID safety and inspectability while maintaining current form, fit and function constraints.

DESCRIPTION: Present LID designs do not allow for in situ inspection of the detonator charge. There is no means of determining if the explosive charge has seen any laser energy without physically destroying the LID configuration. In addition, this requires removal and shipment back to the manufacturer. An approach whereby nondestructive physical examination or diagnostic instrumentation feedback allows verification of whether or not laser energy has impinged on the detonator charge is preferred. The current LID design is initiated using a 1.06 micrometer light pulse emitted from a laser through a 400 micron fiber optic cable. These LIDs have a 10 millijoule all fire threshold (and a 1 millijoule no fire) and must produce a minimum 15 millimeter dent in a steel plate of Rockwell B hardness between 84 and 90. Safety improvements are desired from a thermal "cook off" standpoint. A "thermal fuse" or similar approach whereby the detonator material is rendered benign when a specified temperature is reached is desirable. The primary benefit here would be during a confined fire scenario. Current explosive material candidates are Petraerythirte Tetranitrate (PETN) and 2-(5 Cyanotetrazolato) Pentaaminecobalt (III) Perchlorate (CP). Alternate materials should be considered and investigated. The desired output of Phase I is to successfully conduct an assessment of alternate explosive materials including limited testing on the two preferred candidates. Phase II will carry both LID materials through stringent environmental testing and result in a Level III engineering design drawing package of the preferred design.

AF90-169. TITLE: Development of a Standard Propellant to Liner Peel Test Method

OBJECTIVE: Develop a standard propellant to liner peel test method and an analysis technique for peel failure.

DESCRIPTION: Propellant to liner failures in solid rockets can result in catastrophic failures of the motor. In a case like this, the propellant would "un-zip" from the liner and the propellant burning area would increase to the point that the additional chamber pressure developed would blow the motor apart. Major solid rocket motor manufacturers have developed a peel test to evaluate the integrity of the bond and track bond quality. However, there is no standard method of testing or analyzing the results of these peel tests. An acceptable peel value for one process may not be acceptable on another, even if both are manufactured in the same plant. Furthermore, there is no way of knowing how much margin of safety exists with each peel test. A method should be developed to not only standardize the peel test technique, but to also interpret the results in a quantitative way that will be meaningful to the design engineers of the rocket motor. Phase I will research the current methods used for testing peel and will examine ways to quantify peel. Phase II will develop and standardize the chosen test technique.

AF90-170. TITLE: Abrasive Water Jet Machining/Diffusion Bonding of ICBM Isogrid Structures

OBJECTIVE: To develop a process for cost effective production of Missile Isogrid Structures.

DESCRIPTION: Current Isogrid manufacturing processes are prohibitively expensive as a result of extremely long cycle times and untenable scrap rates. Isogrids are used in BSD's Peacekeeper and Small ICBM development and SSD's Expendable Launch Vehicles, but because of cost, have been dropped from the Small ICBM production program. Proposed concept is expected to produce a short cycle time, economical, high quality isogrid structure in time for Small ICBM

production. The proposed concept should use existing technologies (Waterjet machining and diffusion bonding techniques) as a basis for the new production process. A phase I would look at different concepts and determine the machinery, facilities, etc., required. A phase II would be to validate the process.

AF90-171. TITLE: Noncontact Small Diameter Bore Gauge

OBJECTIVE: Develop mechanized device that measures small bore diameter, taper, out of round to 10^{-6} inch.

DESCRIPTION: Current Peacekeeper and Small ICBM guidance systems require tolerances on SFIR and TGG bores of 5 x 10^{-6} inches. Honeywell is measuring these bores with a manually loaded air gauge. It is possible for the operator to damage the bore while trying to measure it. The part must then be reworked or scrapped. A mechanically loaded noncontact small diameter bore gauge based on Heterodyne Laser Interferometry would save many manhours, reduce the scrap rate on very expensive parts, and give more accurate measurements on bore, taper, out of round and surface finish. A Phase I would look at all possible designs for the device and determine the parts needed. A phase II would down select the designs to one or two promising designs, manufacture the design(s) and test and validate the design(s).

AF90-172. TITLE: Automatic Manufacture of Very Small Electric Hand Wound Motors

OBJECTIVE: To improve the manufacture and decrease the price of hand-wound electric motors with automation.

DESCRIPTION: The existing method of manufacturing small electric motors for the Peacekeeper and Small ICBM is expensive and not repeatable. Manual processes are time consuming and not subject to good process control. However, the size of the motors or windings being made are such that automated processes have not been developed. There should be a way to automate this process. A phase I would look at various concepts to automate the process and determine the required machinery, facilities, etc., for the most promising concepts. A phase II would be to validate the concept.

AF90-173. TITLE: Nondestructive Tests and Evaluation (NDT&E) Techniques for Solid Rocket Motors

OBJECTIVE: Develop innovative concepts for the nondestructive test and evaluation of solid rocket motors.

DESCRIPTION: The following programs are of interest:

a. Develop portable NDT&E tools employing ultrasonics and other techniques for defect evaluation. NDT&E techniques are needed for investigating defects in solid rocket motors, nozzles, cones and other propulsion components during manufacture, acceptance, static and dynamic testing, shipping and handling, and in the field. Several techniques are in use which require extensive handling of heavy articles at certain facilities. There is a need for the development of portable techniques that are nonhazardous and simple to use that would allow for more rapid and convenient evaluations. Of particular interest for evaluation would be internal surface defects that may be found in large rocket motors such as case/insulation debonds, propellant/liner/insulation debonds, propellant voids and carbon nozzle defects. Phase I would be to evaluate and validate various concepts. Phase II would be to manufacture, test and validate in the field the most promising concept found in Phase I.

b. Develop analytical models for defect/effect evaluation. Current methods for such evaluations are based on somewhat subjective assessments, experience of specific people and limited test. These evaluation techniques and the resultant database are expected to become less useful with time because of rapid changes in materials designs and manufacturing techniques and retirement of experienced evaluators. Current methods therefore need to be augmented with suitable engineering analyses and test methods that can take advantage of automated data acquisition, material modeling and computerized data evaluation. This effort is aimed at the development of automated engineering evaluation methodology. An evaluation of available performance codes and the definition of other analytical models for predicting structural and ballistic performance of propulsion systems accounting for the effects of defects is required. This effort includes investigation of methods of characterizing material properties with degradations due to defects. Phase II effort will develop computer codes for modeling material properties.

c. Detection and evaluation of critical kissing debonds in solid rocket motors. Innovative research is needed in the development of NDT&E techniques that have the potential for detecting kissing debonds in solid rocket motors such a Minuteman, Peacekeeper, SICBM and any future ICBM systems. In particular, techniques are needed for the detection and characterization of kissing debonds in motor cases, propellant/liner/insulation, nozzles and cones. Current defect detection methods are not totally satisfactory in meeting the requirements of being able to detect all the different types of defects capable of existing in all solid rocket motors. Existing NDT techniques like x-ray call for tangential inspections of the cone at intervals ranging from 10-60 degrees, along with a limited number of through body shots. The degree of success of these techniques vary somewhat in that the procedures only allow a very small percentage of the test item to be inspected. Also, in the areas that are inspected by x-ray, debonds/delaminations can only be detected if the gap is 10 mils or greater, which is the spacial resolution achievable with the best quality film. Debonds or delaminations with gaps less than this will likely not be detected. Since no techniques have demonstrated the ability to detect a debond or delamination when no gap or a kissing debond is present, development in this area is clearly needed. In Phase I, various techniques will be evaluated/demonstrated for detection capabilities. Phase II would test the most promising techniques found in Phase I using lab samples, analogs and actual motors and motor components. Phase II would also provide automated computerized interfaces and defects modeling for the technique chosen.

AF90-174. TITLE: Information States, Paths and Timelines for Strategic Offense/Defense Integration

OBJECTIVE: Define the conceptual approaches and the associated technology development needed to enhance ICBM mission performance.

DESCRIPTION: The presence of a U.S. strategic defense presents new opportunities and states of information to an offensive planner in conditions of strategic and tactical warning. This effort will synthesize the ongoing DoD efforts in the integration of strategic offense and defense to identify new technology efforts which can enhance the achievement of ICBM missions. Utilizing information found within the Battle Management/Command, Control, and Communications (BM/C^3) system architecture with which both the offense and defense must interact, this effort will consider new and innovative approaches which address ICBM missions *without relying solely and autonomously on the* booster and its payload to accomplish these missions. Consideration of external updates during prelaunch, boost, post boost and reentry will be considered to identify high leverage technology approaches which maximize ICBM mission effectiveness given the availability, delivery and synthesis of information from the BM/C^3 system.

AF90-175. TITLE: Diamond Technology for Intercontinental Missile (ICM) Applications

OBJECTIVE: Develop various diamond technologies such as bulk diamonds, diamond coatings and films for future ICM applications.

DESCRIPTION: Diamond technology has many potential applications for ICM offensive/defensive systems. Before these applications can be realized, certain technical issues have to be resolved. The following areas are of particular concern:

a. Determine the feasibility and utilization of bulk diamonds for multispectral discrimination. Bulk diamonds have the potential properties to change the focal points of UV and IR wavelengths enabling the potential of multispectral imaging utilizing thin detector layers behind a bulk diamond optical window. The goal of Phase I is to determine the design of such a device. Phase II would be to construct and demonstrate such a device.

b. Determine the feasibility and utilization of diamond coatings for sensors/windows. Diamond coatings have a potential to be utilized for sensor windows and/or for the sensors themselves. Phase I of this effort would be to solve the technical issues involved in utilizing diamond coatings for this purpose. Phase II objectives would demonstrate the solutions of Phase I and applications.

c. Develop the technology for diamond film growth on advanced substrates. Diamond film growth has many potential uses, yet the high temperatures and pressures for diamond film growth adversely affects the substrate. Phase I of this effort would be to identify solutions to this technology issue, with Phase II leading to the demonstration of the solution and applications.

AF90-176. TITLE: ICBM Guidance Technologies

OBJECTIVE: Develop improved ICBM guidance component technologies.

DESCRIPTION:

a. Current ICBM inertial measurement units (IMUs) require very expensive accelerometers to meet both accuracy and hardness requirements. There is a need to meet velocity measurement requirements at substantially lower life cycle cost. A low cost accelerometer of velocity update subsystem needs to be able to perform in either a strapdown or fully-gimballed mode. Results of Phase I should be a conceptual definition of the proposed accelerometer or update subsystem. Phase II should develop the idea to a point where a prototype can be delivered to the government for independent test and evaluation.

b. The radiation environment postulated for an evader maneuvering reentry vehicle (EMaRV) mission is among the most severe for any military electronics application. Because of the environment, conventional approaches to electronics, such as dielectrically isolated bipolar and CMOS, are of limited usefulness. One of the mechanisms of performance degradation under nuclear radiation is loss of carrier mobility in the doped semiconductor. Because of this problem majority carrier devices such as JFETs perform better than bipolar devices. Presently, approaches being studied include the use of III-V Compounds for semiconductor device construction. The successful offeror will develop models and approaches for constructing devices in Phase I of the effort and culminate Phase II with a demonstration device, preferably a linear device, that will be radiation tested to evaluate the success of the program.

AF90-177. TITLE: Strategic Relocatable Target (SRT) Sensor Technologies

OBJECTIVE: Investigate the feasibility of various SRT sensors for application to ICBMs.

DESCRIPTION:

a. Conduct an investigation of proposed processing speed for Synthetic Aperture Radar (SAR) image processing. Typical methods of creating SAR imagery involve large volumes of data handling, storage, and transmission. ICBM platforms most likely will have penalties in volume and weight and also compressed time lines. Therefore, alternative methods of creating SAR imagery should be investigated. SAR related areas that would be suitable for a Phase I investigation include the following: 1) An investigation of algorithms for creating a SAR image from radar data (I/O channels). This may involve the generation of synthesized SAR data for testing purposes; 2) An investigation of proposed computer architectures and a tradeoff study on their possible performance for SAR imagery; 3) An analysis of figures of merit to describe such SAR imagery and its generation via these algorithms and computer architectures. These figures of merit should include processing time, complexity and amount of IC circuitry required, image quality in terms of image features and spatial resolution, and other technical factors. The Phase I results should provide an analysis of the suitability of the selected figures of merit. It would be useful to have, from the Phase I results, a detailed plan for acquiring data on these figures of merit, such as could be achieved in Phase II. The output of Phase II should be numerical data on the selected and comprehensive SAR imagery figures of merit.

b. Perform an analytical study on the potential utility of state-of-the-art forward Looking InfraRed (FLIR) systems for ICBM platform applications. An examination of the potential assets and problems in converting a state-of-the-art FLIR system for imaging ground areas from an ICBM platform is needed. The intent is to investigate the ICBM-system unique problems of such an imaging system. These will include IR semiconductor sensitive mosaic arrays, very hot surface (ablative) temperature effects, optics requirements for small diameter apertures, detector cooling, etc. The high relative velocities between the ICBM platform and the ground area will pose severe constraints requiring imaginative solutions. The Phase I efforts should propose and provide analysis of possible solutions for these problem areas. The Phase II effort would involve scaled testing of subsystems and concepts needed to explore feasibility of a FLIR on an ICBM platform.

c. Conduct a study of the feasibility of implementing laser radar on an ICBM platform for target detection ground mapping applications. This proposed sensor system analysis task should address the current capabilities of laser radar

systems. With these identified, it should project technology developments in this field, including transmitted power, prime power development for small platforms, instrument packaging, etc. The processing requirements for laser radar image formation should be examined. Of particular interest would be the identification of critical areas for development and the formulation of critical hardware experiments. Tradeoff studies to support the selection of these critical areas for development are needed for Phase I. The Phase II effort would involve the execution of a plan to evaluate a small scale laser radar critical hardware experiment.

AF90-178. TITLE: ICBM Power Technologies

OBJECTIVE: Develop innovative concepts for reliable and efficient supplies of electrical power for ICBM applications.

DESCRIPTION: The power requirements of ICBM weapon systems are very stringent and different from other applications. Innovative techniques are necessary to meet demanding power density, energy density, reliability, and lifetime requirements.

a. Develop and demonstrate power sources for any of the following general ICBM application areas: 1) Basing/Survival Power: This area calls for large, multikilowatt power rates for periods of days to weeks. These power systems must be rechargeable/replenishable and endure dozens to hundreds of cycles over a lifetime of a decade. 2) Boost Flight Power: Immediately before and during ICBM booster flight, onboard systems will require power in the kilowatt range for up to one hour. These power systems will be used only once but must survive long term storage up to a decade, be compact, have high reliability, and start quickly. 3) Reentry Vehicle Power: Reentry vehicles (RV) have nearly the same power requirements as boosters except they must be smaller and lighter. They typically have a 10 to 100 watt load until the near the end of their trajectory when they must sustain pulsed loads into the multikilowatt range for several minutes.

b. Develop and demonstrate a rechargeable RV power source for test purposes. Test vehicles frequently undergo months of testing before launch to ensure that all systems are functioning properly. A rechargeable power system that can meet both the mission requirements and endure 10-15 cycles with an integral state-of-charge readout would facilitate full scale tests of an RV after mating to the launch system. The energy density should be in the following ranges: Wh/Kg = 100-120 and Wh/L = 180.

c. Develop and demonstrate a higher voltage cathode design and cathode cell chemistry for thermal batteries. Advanced ICBM systems could benefit greatly from thermal batteries with higher cell voltages. Current lithium-iron-disulfide cells generally operate in the 1.6-2.0 volt range, requiring 15 to 18 cells for a 30 volt battery. A new chemistry that provided a loaded cell voltage of 2.8-3.0 volts would require as few as 10 cells for a 30 volt battery.

AF-179. TITLE: ICBM Penetration Aid Technologies

OBJECTIVE: Develop hardware and analysis capabilities to support penetration aid technologies.

DESCRIPTION:

a. Develop an ablative pyrotechnic heatshield material to enhance visible and IR optical signatures. It is possible in the future that the Soviet Anti Ballistic Missile (ABM) defense system will have the capability to detect and discriminate incoming Reentry Vehicles (RVs) with the use of optics to augment their existing radar systems. During reentry into the atmosphere, the optical signatures from the two different sized vehicles (decoys & RVs) differ by several magnitudes. By developing an ablative heatshield with pyrotechnic materials for the decoy, matching of the RV can be accomplished. The desired end product of Phase I is an initial development of an ablative material which can potentially be used as a heatshield. Concept should be defined and feasibility determined. Phase II will include advanced development of material, and ground tests to include arc jet ablation tests and ballistic range tests at Arnold Engineering Development Center (AEDC), Arnold AFB TN.

b. Develop new methodologies for RCS, IR and visible optical wake/plume signature prediction capability. The offerers are expected to be familiar with the Ballistic System Division (BSD) mission and generally the capabilities of threat radars and optical sensors to detect and analyze wake signatures. Current specific threat information will be

available after contract award. The codes developed should provide for the effects of various wake additives on conical ballistic Reentry Vehicles (RVs). Material reaction chemistry will be provided for certain test cases.

c. Develop new methodologies for RCS prediction of bodies with protuberances and electrically nonhomogenous materials. Improvements and upgrades on state-of-the-art computer codes in the areas of robustness, versatility, speed, and accuracy are expected. The offerers are expected to be familiar with the BSD mission and generally the capabilities of large Anti Ballistic Missile (ABM) radars. Current specific threat information will be available after contract award. The codes developed should be applicable to both conical ballistic Reentry Vehicles (RVs) and shaped bodies such as Maneuvering Reentry Vehicles (MaRVs) and Hypersonic Glide Vehicles (HGVs).

d. Develop new methodologies for incorporating RF antennas into RVs and penetration aids. Penetration against evolving defense systems requires more design consideration for control of RCS characteristics of reentry bodies while incorporating RF transmission and receive capability. Currently, dielectric surface discontinuities for antenna windows are distinctive scattering centers. Techniques should be investigated that incorporate actively controlled dielectric properties to match surface impedance for nonactive antenna elements while allowing low loss transmissivity when required. Materials considered must be compatible with reentry environments. Techniques using distributed arrays over the RV skin should be considered. Phase I shall identify promising technologies and demonstrate by analysis, application to RV and penetration aid design. Phase II shall include more detailed feasibility investigations and selected validation testing.

AF-180. TITLE: ICBM Reentry Vehicle Technologies

OBJECTIVE: Develop innovative concepts and approaches to improve RV aerodynamic capability in hypersonic flow and in light weather effects.

DESCRIPTION:

a. Develop a database of the particle size distributions in various types of weather with particular emphasis on high altitude, cirrus (light weather). The types of data availability and quality of these data should be assessed. These data should be examined to correlate particle size with liquid water content for various types of hydrometeors (ice, small snow, large snow, rain). From this an updated particle size distribution versus altitude should be generated for various cloud types, particularly for high altitude cirrus. Special attention should be paid to data taken over land and over water to insure that differences are accounted for. These updated particle distribution data will be used in support of future reentry vehicle flight tests.

b. Develop algorithms to predict the aerodynamics and aerothermodynamics of ballistic reentry vehicles (BRV), maneuvering reentry vehicles (MaRV), and decoys including the influence of real gas versus ideal gas. Emphasis is to be placed on heatshield/nosetip ablation, surface blowing, and thermal and chemical equilibrium and nonequilibrium phenomenon. Specifically the interest is focused on the location of center of pressure for predicting the trim angles of attack for MaRVs. The heatshield ablation can be large where the conventional boundary layer theory or even Parabolized Navier Stokes (PNS) methods become invalid, requiring global iteration PNS or time dependent Navier Stokes methods. The heatshield thermal conduction and ablation are an integral part of the problem and will yield part of the surface boundary conditions (i.e., surface blowing, surface temperature, etc.). Innovative algorithms with minimal numerical viscosity and damping are sought. The numerical grid generation scheme is an important part of the formulation and the methodology should handle BRV/MaRV/decoy geometries of interest to Ballistic System Division (BSD). The Phase I effort should demonstrate solutions for a basic RV/decoy at zero angle of attack. The Phase II effort should extend this formulation to 3-D and would include software and users manual delivery with proven BSD supplied test cases.

c. Antenna windows of reentry vehicles and the adjacent heatshield currently have a different ablation rate. This difference further augments the overall uneven ablation wear and causes various problems with the performance of the vehicle. An innovative concept is needed to 1) develop sensors to measure recession in ground and flight tests and 2) develop a mechanical design to reduce the uneven ablation. These concepts must be nonintrusive to electromagnetic transmission/reception.

AF90-181. TITLE: ICBM Command, Control, Communications and Intelligence C^3I Technologies

OBJECTIVE: Develop improved C^3I technology and Battle Management for ICBM forces.

DESCRIPTION:

a. Develop and investigate innovative concepts for 1) ICBM launchers, both mobile and fixed; 2) launch control centers located in ground mobile units and manned or unmanned aircraft; and 3) satellite relays. Goals for the communication system include continuous connectivity during peacetime and throughout the attack and postattack phases of conflict, defeat of hostile jammers and direction finding equipment and operation through difficult weather and nuclear war environments. New challenges could include higher data rates for rapid retargeting, near real-time reconnaissance, and compressed timeline attack and scenarios. Innovative architectures and enabling technologies are needed for significant performance improvements. Proposals should present promising innovative architecture and technology options and alternatives for analysis in Phase I. Phase I should include an estimate of preferred option payoffs. Phase II should include more detailed feasibility investigations, quantitative descriptions of the preferred architectures or technology and concept demonstrations.

b. Future ICBM operational environments which include force reductions, special payloads capable of attacking mobile or deeply buried targets, defense and attack of spaced based assets and collocation of reconstitutable reconnaissance assets with ICBM forces are to be considered. Collocation of some C^3 Battle Management assets with ICBM forces could be needed for survivability, rapid response or control. Innovative concepts, architectures and technologies are needed to respond effectively to these new conditions. Specific areas that could be selected for investigation include: 1) peacetime reconnaissance and tracking of mobile enemy targets; 2) rapid force retargeting; 3) near real-time assessment of attacking enemy forces, including expected impact points and penetration aids discrimination; 4) rapid post attack target damage level assessment for retargeting; 5) reconstitution of C^3I assets lost in initial attack; and 6) ground and in-flight survivability. The proposal should present innovative architectural approaches and technology for consideration in Phase I. Phase I will consist of development and preliminary evaluation of concepts/options and an estimate of payoffs. Phase II will validate effectiveness by analysis, test or computer demonstration of preferred architecture or technology options.

AF90-182. TITLE: ICBM Advanced Basing Structures Response Technologies

OBJECTIVE: Develop analytical models to evaluate multiple load and high strain response of basing structures to nuclear attack.

DESCRIPTION:

a. Current basing upgrade systems and future systems must be able to survive close-in, multiple nuclear blast load environments. These systems include facility structures emplaced in soil or rock and metallic launcher shell structures protected from direct airblast. The response of these buried ICBM structures and their attenuating or protective systems to multiple blast loads and upstream induced ground shocks is not well understood. Innovative simplified analytic response modeling and parametric studies of representative structures and systems is required to understand the phenomena and define test requirements. Follow-on Phase II efforts may involve definition of simple experiment scale tests to validate or evaluate the analytical data.

b. Advanced facilities structures, typically involving reinforced concrete cylinders in the high hardness environment, must be able to carry ultimate loads in the high strain regime. These structures tend to undergo strain softening in this regime. The load carrying capability of structure with the behavior is not well understood. Analytical modeling research on strain softening should focus on basic cylindrical structure loaded with distributed and concentrated loads with different schemes of load paths. Follow-on Phase II efforts may involve evaluation of this behavior experimentally or a detailed analytical validation of concepts.

AF90-183. TITLE: ICBM Testing Technologies

OBJECTIVE: Develop innovative testing methods to accurately simulate and measure reentry vehicle environments in ground test facilities.

DESCRIPTION:

a. Develop model seeding techniques appropriate for ballistic range simulation of reentry vehicle wakes. The offeror should be familiar with wake electron seeding levels and methods employed by ballistic ranges in the past. One or more seeding designs would be developed during Phase I and actual range testing/validation could be conducted during Phase II. Emphasis would be on accurate simulation of wake electron distributions while minimizing introduction of contaminate materials.

b. Design and develop a multielement probe rake and pressure retrieval hardware capable of measuring data which can be used to calculate arc jet exit conditions. The probe rake elements should be able to measure local freestream total pressure, static pressure, total temperature, and freestream flow angles. The probe rake should be able to map these flow quantities over the entire arc jet exit plane. The probe rake should have a data retrieval rate for pressure and temperature data such that the probe can be quickly swept across the arc jet exit plane to reduce probe cooling requirements. It may require water cooling. The probe rake would have to survive repeated tests in the HR, HX, and H1 arc jet facilities at Arnold Engineering Development Center (AEDC). The probe data should be in a form that mass average flow quantities of total pressure and static pressure can be calculated for comparison to derived arc jet results. The probe should be able to map out flow field vorticity. Phase 1 results should include a low-risk test plan with at least two candidate probe designs. Data reduction procedures for mass averaged flow quantities should also be part of the Phase I results. The probe and data acquisition hardware should be developed closely with AEDC to guarantee its general usefulness on BSD arc tests. Phase II results will include fabrication of probe and data acquisition hardware and software. The test plan given in Phase II will be executed and probe data results will be reduced and reported. Part of Phase II results will be software capable of calculating mass averaged flow quantities with the probe results. Part of Phase II results may require probe calibrations in an appropriate calibration facility.

AF90-184. TITLE: Life Sciences Basic Research

OBJECTIVE: To provide fundamental data in toxicology, neurobiology, sensory information processing, and cognitive sciences.

DESCRIPTION: Basic research in five areas is supported:

Toxicology: Emphasis is on fundamental mechanisms that organisms use to respond to toxic chemical exposure, especially chemicals to which Air Force personnel are exposed. Primary objectives are to identify early indicators of toxic insult, to elucidate the mechanism of action of toxic chemicals, and to enhance natural detoxification of environmental chemicals through conversion of toxic agents into nontoxic metabolites.

Neuroscience: Fundamental studies of the neurobiology of learning and memory, attention, biological rhythms, fatigue, stress, and arousal are one area of emphasis. Proposals for neurobiological research in which behavior is not studied explicitly but which would clearly further the understanding of behavior are accepted. Neurobiological research on visual and auditory information processing and higher cognitive functions and studies that bring together information about cellular and neural circuit functions with information from studies of artificial intelligence are also supported. The relationship between neural architectures and formal computations that might underlie goal directed behavior, learning, memory, and pattern recognition is emphasized.

Vision: Psychophysical research is supported leading to the discovery and quantitative modeling of featural processing mechanisms underlying visual recognition. Contrast detection and discrimination, motion, eye movement, color, and spatial orientation are examples.

Audition: Psychophysical research is supported on the perception of complex sounds in normal human adults. The mechanisms underlying recognition, pitch, localization, speech and spatial orientation are examples.

Cognition: Research is supported on cognitive aspects of perception, attention, working memory, spatial processing, long-term memory representation, natural reasoning, problem solving, and stressed decision making (under time pressure).

AF90-185. TITLE: Quantum Structures and Devices

OBJECTIVE: Improve capabilities of high resolution radar systems and high capacity communication systems.

DESCRIPTION: Recent advances in materials processing and fabrication techniques have made it possible to produce device structures with characteristic dimensions down to a few atomic layers. New classes of devices are emerging or being conceived. Many of these manifest quantum mechanical effects such as tunneling (two- and three-terminal resonant tunneling structures), quantum phase interference (Aharonov-Bohn effect) or coherence (Bloch oscillators). Proposals are invited addressing processing, fabrication, characterization and modeling of quantum devices. It is important that fundamental issues be addressed while concentrating on devices with realistic potential for DoD applications. Particularly relevant are devices with possible high frequency or high speed applications. In modeling efforts, proposals are encouraged that incorporate self-consistency and dissipation as well as realistic boundary conditions.

AF90-186. TITLE: Development and Application of New Theories and Concepts Relating to Structures

OBJECTIVE: Improve structural efficiency and durability.

DESCRIPTION: We are particularly interested in the role of nonlinearity in structural response and in the ability to control the behavior by active and passive means. The dynamic response to external stimuli such as aerodynamics, gust and impact loads and complex interactions with fluids and control subsystems are of major interest. We seek the capability for accurate modeling of thermal diffusion through multilayer, actively cooled structures including consideration of aerothermodynamic heating and surface reactions in hypersonic flight. Studies of dynamics and stability of deployment and assembly of structures in orbit and of interactions between sloshing fuel and structural dynamics of orbiting satellites are also of interest. We support development of advanced constitutive theories capable of modeling the behavior of advanced materials such as polymeric, ceramic, metal matrix and carbon-carbon composites. Consistency between micro- and macro-structural viewpoints and accommodation of progressive damage are desirable attributes in this regard. Special emphasis is placed on innovative interdisciplinary approaches combining materials science and solid mechanics and aimed at establishing quantitatively the connection between the microstructure and the mechanical material behavior. Emphasis is also placed on damage growth predictions and physically identifiable and measurable damage metrics. Probability aspects of damage growth and failure are pursued by considering the development of damage states as a stochastic process. A significant portion of this research addresses composite materials for propulsion and hypervelocity flight structures, including airframe composite laminates; solid rocket fuel particulate composites; and very high temperature ceramic and carbon-carbon composites. Research areas include micromechanically based, constitutive modeling of soil, concrete and rock; in situ measurement of soil properties; identification of the mechanics of soil stabilization; investigation of blast induced soil liquefaction; study of the strength and fracture characteristics of geological materials; modeling of the response of jointed and monolithic rock formations; identification of damage mechanisms in cement materials; investigation of structural systems for expedient facilities; study the nonlinear structural response to dynamic loading; and investigation of structure-media interaction.

AF90-187. TITLE: Multifunctional Nonmetallic Materials Processing and Characterization

OBJECTIVE: To develop new nonmetallic material concepts for unique combinations of electrooptical and nonlinear optical, electromagnetic and structural properties

DESCRIPTION: Advances in ceramics, glasses and polymers are expected to come from the control of features at the 100 A to 1000 level (ultrastructure) via chemical synthesis and processing methods. These materials may take the form of ultrastructural level structures and composites which will perform a combination of active and passive functions. Processing includes new and improved materials based on the methods of organic, inorganic and organometallic chemistry as well as sol-gel, graphite-template chemistry, micromorphology processing, transformation processing, intercalation

chemistry, emulsion chemistry and other innovative processes. Imaginative combinations of these processes are of interest for materials with nonlinear optical, magnetic, superconducting and/or semiconducting properties and phenomena and structural integrity. Subpicosecond, nonresonant or near resonant low power optical polymers, organics and inorganics or combinations thereof or unique materials concepts for high critical temperature superconduction are specifically required. Molecular composites, which would include the analogs of macroscopic composites, biological and natural systems as well as new synthetic combinations, are of interest. Device applications should be considered, particularly where the ultrastructured material will serve as a self-contained functional entity. New organic and inorganic polymers as well as oxides and nonoxide nonmetallics are needed for these multifunctional ultrastructures. New mechanisms and reactions are considered important components of nonmetallic materials processing and synthesis. Phase I must provide sufficient material for proof-of-principle. Phase II must make available both well characterized material and processing know-how for high volume, high yield.

AF90-188. TITLE: Atmospheric Science Modeling Technology

OBJECTIVE: To stimulate the development of new experimental and/or numerical methods for modeling atmospheric processes.

DESCRIPTION: Advances in capabilities for more accurate specification and prediction of the state of the atmosphere depend to a large extent on the fundamental understanding of underlying physical processes. There are so many variables in the real atmosphere that isolating various causes/effects of these physical processes often becomes difficult to nearly impossible in the natural environment. Development of physical laboratory models and/or computer models will enable controlled simulation of individual processes to uncover the mysteries of their basic evolution. This effort seeks to enhance scientific research activities in the area of simulating lesser understood atmospheric processes. Areas of interest include, but are not limited to, gravity waves, lee waves, turbulence, convection, latent heating/cooling, and boundary-layer fluxes. The Phase I effort should provide a review of various concepts and design the options for the proposed model(s). In Phase II the model(s) will be built and tested against observed atmospheric phenomena.

AF90-189. TITLE: Development of New Scientific Research Instrumentation for Electronics

OBJECTIVE: To stimulate the development of new scientific instruments for laboratory and industrial applications.

DESCRIPTION: Progress in fundamental research often depends on use or invention of new diagnostic techniques which can provide better insight into the fundamental processes or phenomena under study. Development of improved and novel scientific instrumentation will enable researchers to make more useful measurements per unit time, to make measurements to a greater degree of accuracy and to make measurements in places and under conditions not now possible. It may also permit quality instruments to cost less and be more reliable. This effort seeks to improve the basic function of scientific instruments, and to reduce the cost and improve the reliability of instruments which would enhance the scientific productivity of this country. Areas of interest include, but are not limited to, laser combustion diagnostic testing, vision testing equipment, advanced biogenetic tests for toxicity, new mathematical algorithms allowing improved computer program performance, optical information processing, accelerator mass spectroscopy, aerodynamic flow measurement devices, and improved material and process diagnostic systems. Of particular interest are all types of novel instrumentation for characterizing the electrical, optical, thermal, acoustical, mechanical, and structural properties of electronic materials and devices with emphasis on semiconductor, superconductor, insulator, and metallic contacting materials. Of additional interest are novel approaches to instrumentation capable of measuring the electrical and optical performance characteristics of thin film electronic and optoelectronic devices and integrated circuits. Novel instrumentation for improved process control of lithography, wet or dry etching, metallization, and other steps in the fabrication of thin film electronic and optoelectronic devices, including circuits, is of interest. The Phase I effort should provide a review of various concepts and design options for the proposed type of scientific instrumentation. The Phase II effort would then develop a prototype or prototypes of the best-concept design alternatives, leading to Phase III commercialization of the instrument. Evaluation of proposals will include the following factors: 1) potential value to the Air Force Research Program, 2) potential for transition to Air Force Laboratories, and 3) potential to aid the scientific community.

AF90-190. TITLE: Routing and Scheduling on Microcomputers

OBJECTIVE: Develop algorithms and models for improved routing and scheduling.

DESCRIPTION: Military organizations, such as the Air Force, are faced with a large number of vehicle routing and scheduling problems. These range from the scheduling of pickers and placers in a warehouse, to the scheduling and distribution of resources in a manufacturing facility, to the scheduling of transportation assets for mobilization. Recent progress in mathematical optimization and in the development of practical and effective heuristics has made the near optimal solution of some of these problems possible on easily affordable microcomputers. We seek to extend and develop the capability of such algorithms for the solution of real problems. Proposers should not limit themselves to extensions of conventional methodology. Topics such as 1) use of networks of microcomputers to solve problems that would be impractical on a single machine, 2) determination and management of information that now can be continuously and automatically generated concerning parameters of the logistics system under study, and 3) aids to assist the logistics analyst in model or algorithm selection are all of interest.

AF90-191. TITLE: Novel Electron Beam Driven Sources of Millimeter-Wave Radiation

OBJECTIVE: To advance the state-of-the-art in compact, efficient, high power microwave and mm-wave vacuum electronics.

DESCRIPTION: The Air Force is the nation's single largest customer for vacuum electronic microwave devices. In spite of the popularity of solid-state devices, there are numerous applications in communication, radar, and electronic warfare whose power requirements exceed the capabilities of available semiconductors. Some DoD requirements are putting increasing pressure on industry to produce microwave tubes which are more compact, lighter in weight, more efficient, and of greater reliability. In addition, future applications are expected to require tube output at higher and higher frequencies. The shorter the wavelength of radiation desired, the more intricate and expensive are the required fast wave tube structures. New tube concepts and geometries are needed to meet these future needs. In addition, the physics involved with beam-plasma interactions offer alternative mm-wave device concepts that require exploration. Phase I efforts should provide a solid theoretical foundation for the new mm-wave amplifier or oscillator concept. Preliminary device design should be addressed. Phase II should result in the design and construction of an actual prototype device along with preliminary performance optimization studies. Phase III should see the commercialization of the device concept.

AF90-192. TITLE: Emerging Technologies Resulting in Lighter Aircraft, Increased Engine Performance (ISP) and Improved Design Tools

OBJECTIVE: Improvements in aircraft structure, scramjet, and aerodynamic design technologies.

DESCRIPTION: The National Aero-Space Plane is providing a quantum jump in aerospace technologies by investigating new and innovative solutions. Its goal is a Mach 25 air-breathing scramjet vehicle capable of single stage to orbit. Emerging technologies providing significant performance improvements for the aircraft will be considered. Phase I must show experience and understanding of the relative importance of the technologies. It also must provide detailed drawings, specifications, and test procedures for the proposed technologies. Phase II requires prototype and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased liabilities.

AF90-193. TITLE: Development of High Temperature (T>/- 3000^{0} F) Heat-Pipe Wing Leading Edge

OBJECTIVE: Develop a high temperature heat-pipe wing leading edge to reduce leading edge size and mass and eliminate the need for active cooling.

DESCRIPTION: Current heat-pipe wing leading edge designs are limited by a maximum reuse temperature of most refractory metals of 2500^{0} F based on coating and structural limitations. This limits the total heat rejection capability of such a wing leading edge design. Increasing the operating temperature, by use of higher temperature structural materials such as carbon-carbon or sic-sic, can greatly reduce the size and mass of the leading edge, and eliminate the need for active cooling. In addition, reliability and fail-safe features may also be consistent with such design improvements.

The Phase I efforts should address a particular design for heating representative of a National Aero-Space Plane type vehicle and should include the fabrication and testing of at least one flat individual c o/heat-pipe. The Phase II effort should address the fabrication, development, and testing of a spanwise section of the wing, including an array of heat pipes.

AF90-194. TITLE: Advanced Algorithms for Hypersonic Flows

OBJECTIVE: Develop innovative algorithms that will increase the accuracy and efficiency of computer codes used in the analysis and understanding of hypersonic flow physics.

DESCRIPTION: For the past decade and a half most algorithm development for computational fluid dynamics in the aerodynamics field has focused on the transonic regime. Many of the now standard algorithms have great difficulty in coping with the more challenging physics of hypersonic flow such as strong shocks, real gas effects, and chemical reactions. Innovative algorithms for this field which either solve existing problems more efficiently or solve previously intractable problems are greatly needed. These algorithms must be suitable for modern vector or parallel computers. The applications of interest are: 1) steady-state external flow about high-speed vehicles; 2) steady-state internal flows, such as inlets and combustors; 3) high-order algorithms for performing unsteady simulations of transition and turbulence; and 4) high-order algorithms for computing shock/boundary layer and shock/turbulence interactions.

AF90-195. TITLE: Innovative High Temperature Nonintrusive Diagnostic Instruments for Reactive Flow Field Measurements

OBJECTIVE: Prototype instruments capable of operating within a hypersonic combustor with test results demonstrating their sensitivity and accuracy.

DESCRIPTION: Innovative, nonintrusive diagnostic instruments and techniques are required for experiments with high temperature (1800-5000° R) combustor flow fields. The instrumentation must be capable of working in flow fields with hydrogen and air combustion. Phase I should demonstrate knowledge of existing measurement techniques and provide detailed drawings of proposed new or improved instruments. Phase II must build and test prototype instruments.

AF90-196. TITLE: Ceramic Fibers and Coatings

OBJECTIVE: To provide ceramic fibers with improved high temperature (1800 - 2000° F) properties and innovative techniques to uniformly coat these fibers.

DESCRIPTION: The capabilities of current fibers and fiber coatings limit the application temperature and environmental durability of ceramic or metal matrix composites. Innovative approaches are needed in developing ceramic fibers with improved high temperature (1800-2000° F) strength, and to import toughening. The small diameter tow-based fibers are reactive at elevated temperatures and could lose their mechanical properties as a result. The coating development for these fibers should include various reaction barrier/compliant layer materials.

AF90-197. TITLE: Oxidation Protection Coating for Titanium Aluminides

OBJECTIVE: To develop innovative techniques to apply oxidation protection coatings to titanium aluminides and their composites.

DESCRIBTION: Various high strength titanium aluminides and their composites have been developed for potential use in hypersonic vehicles. This task is to develop and evaluate innovative techniques to provide oxidation protection coatings for titanium aluminides and their composites at elevated temperatures (1800 - 1000° F). The coatings must be tested in an appropriate environment for 200 cycles from room temperature to 1800° F.

AF90-198. TITLE: Hydrogen Effects in XD Titanium Aluminides

OBJECTIVE: To study the mechanisms and determine the effects of hydrogen in XD titanium aluminides.

DESCRIPTION: The XD (Exothermic Dispersion) process was developed by Martin Marietta Research Laboratory. It leads to the formation of a fine, uniform distribution of stable dispersoids in a material. The process has been applied to titanium aluminides and other materials. This task is to study the mechanism and determine the effects of hydrogen on the mechanical properties, fracture properties, and fatigue properties of the XD titanium aluminides. Both low pressure and high pressure effects at various temperatures need to be delineated.

AF90-199. TITLE: Nondestructive Inspection Methodology for Thin Oxidation Resistant Carbon-Carbon Composites

OBJECTIVE: To provide nondestructive inspection (NDI) methodology for field inspection for oxidation resistant carbon-carbon composites.

DESCRIPTION: The thin oxidation resistant carbon-carbon composites have been developed for use as airframe hot structure on advanced hypersonic vehicles. An NDI methodology is needed for measuring sealant depletion, coating thinning, and substrate loss from oxidation resistant cabon-carbon composites in a field situation with the component being interrogated while on the vehicle. The methodology should also be applicable to detection of cracks during the manufacturing process and establishment of rejection criteria.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Program Management Office. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/PM/SBIR
Attention: Dr Bud Durand
1400 Wilson Boulevard
Arlington, VA 22209-2308

The proposals will be processed in the Program Management Office and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 61 technical topics to which small business may respond. A list of the topics is included below, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. DARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior. Each proposal submitted to DARPA must have a topic number and can only respond to one topic.

DARPA has prepared a checklist to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or handcarrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1990 Phase I SBIR

Check List

1) Proposal Format

- a. Cover Sheet - Apendix A (identify topic number) ____
- b. Project Summary - Appendix B ____
- c. Identification and Significance of Problem or Opportunity ____
- d. Phase I Technical Objectives ____
- e. Phase I Work Plan ____
- f. Related Work ____
- g. Relationship with Future Research and Development ____
- h. Post Potential Applications ____
- i. Key Personnel ____
- j. Facilities/Equipment ____
- k. Consultants ____
- l. Prior, Current or Pending Support ____
- m. Cost Proposal ____

2) Bindings

- a. Staple proposals in upper left hand corner. ____
- b. Do not use a cover. ____
- c. Do not use special bindings. ____

3) Page Limitation

- a. Total for each proposal 25 pages inclusive of cost proposal (Appendix C) and resumes. ____
- b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ____

4) Submission Requirement

- a. For DARPA you must submit 4 copies plus the original signature copy (total 5) for each proposal to be considered. ____
- b. In addition you must submit two copies of Appendix A and Appendix B only, for each proposal submission. ____

5) Proposal Acknowledgement

- a. Include Reference B. ____
- b. Include Self Addressed, Stamped, Envelope. ____

INDEX

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

FY 1990 Small Business Innovation Research Topics

DARPA 90-001	Electromechanical Power Supplies for Low Power Electronic Systems
DARPA 90-002	Re-Examination of Analog Computing Techniques and Applications
DARPA 90-003	Low Volume, High Efficiency Power Sources for Small Satellites
DARPA 90-004	Novel Propulsion Systems For Small Satellites
DARPA 90-005	Innovative Thermal Control Concepts for Small Satellites
DARPA 90-006	Miniaturized DC to DC Converters for Small Satellites
DARPA 90-007	Novel, Low Energy Orbital Transfer Concepts for Small Satellites
DARPA 90-008	Novel Blue/Green Laser and Filter Technology for Tactical Airborne Laser Communications
DARPA 90-009	Interferometric Fiber Optic Gyro Manufacturability
DARPA 90-010	Low Observable Technology for Infrared, Acoustic, and Visible Signature Suppression on Aircraft
DARPA 90-011	Passive (Non-Radio Frequency, Non-Electro Optic) Sensors for Application to Low Observable Aircraft
DARPA 90-012	Relocatable Target Sensor Technology
DARPA 90-013	Innovative Sensors for Target Acquisition and Tracking, for Use On Hypersonic Weapons
DARPA 90-014	Remotely Piloted Vehicle Technology
DARPA 90-015	New Optical Materials on Which to Base Development of Solid State Lasers in the Mid-Infrared
DARPA 90-016	Innovative Methods for Protecting Mid-Infrared Sensors from Attack by Lasers
DARPA 90-017	Innovative Methods for Protecting Electro-Optic and Infrared Sensors from Attack by High Power Microwave Energy
DARPA 90-018	Simple and Inexpensive Means of Detecting Laser Illumination of Tactical Platforms
DARPA 90-019	Innovative Concepts to Test the Efficacy of Directed Energy Weapons (Laser, Microwaves, Particle Beams) by Simulation/Wargaming
DARPA 90-020	Novel Ways to Monitor/Verify Use of Directed Energy Weapons Which May Be Restricted by Future Treaties

DARPA 90-021	New Approaches in the Design of Very Compact, Wideband, High Power, Microwave Antennas
DARPA 90-022	Innovative Technologies for the Production of High Current (10 kA), High Repetition Rate (10 kHz) Cathodes
DARPA 90-023	New Ideas for High Power (10-100 MW), High Repetition Rate (10 MHz) Switches
DARPA 90-024	Diamond Films for Wear/Erosion Resistance
DARPA 90-025	Supercritical Fluid Process Technology
DARPA 90-026	Mathematical Modeling of Fluid Flow in Chemical Vapor Deposition and Plasma Reactors
DARPA 90-027	Applications of Wavelet Theory in Modeling Functions of Defense Systems
DARPA 90-028	In-Situ Process Sensors for Real-Time Microcircuit Manufacturing Control
DARPA 90-029	Traveling Heater Method Growth of Bulk Compound Semiconductor Alloy Crystals
DARPA 90-030	Self-Assembling Microstructures
DARPA 90-031	Artificial Neural Network Technology
DARPA 90-032	Electronic Ceramics for Novel Devices and High-Speed Packages
DARPA 90-033	Large Diameter III-V Crystal Growth
DARPA 90-034	Lightweight Payloads for High-Altitude Balloons
DARPA 90-035	Integration of Low-Cost Sensors with Fiber-Optic Links
DARPA 90-036	Development of Computer Aided Design Models for Microwave and Millimeter Wave Devices and Circuits
DARPA 90-037	Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques
DARPA 90-038	Implementation of New Gallium Arsenide Growth Technique (Vertical Float Zone) Developed at Naval Research Laboratory
DARPA 90-039	Developing Mach Operating System Family Modules
DARPA 90-040	Advanced Manufacturing Techniques for Flat Panel Displays
DARPA 90-041	Advanced Optical Techniques Extending Use of Optical Tools Below 0.5 Micrometer Geometry Constraints
DARPA 90-042	Low Cost, High Throughput Test Methods for Analog Semiconductors
DARPA 90-043	Dry Etching for III-V and II-VI Semiconductors
DARPA 90-044	Non-Invasive Characteristics Techniques for In-Process Control of II-VI Compound Material Growth Systems

DARPA 90-045	Anti-Reproduction Document Coating
DARPA 90-046	Experimental Determination of Differences in Seismic Coupling of Explosions Detonated in Different, Hard, Brittle Rocks
DARPA 90-047	Experimental Determination of the Excitation of Seismic Regional Phases as a Function of Explosion Source Depth
DARPA 90-048	Applications of Acoustic Charge Transport Technology
DARPA 90-049	New Ideas for Unconventional Sensors for Ground Targets and Helicopters
DARPA 90-050	Thin Films with Electrically Controllable Reflectivity/Transmitivity to Visual or Infrared
DARPA 90-051	New Wide-Area Mine Concepts/Munitions
DARPA 90-052	The Use of Active Materials to Enhance Fragment-Impact Initiation of Explosives
DARPA 90-053	Innovative Application of Binary Phasegrating Optics
DARPA 90-054	Innovative Uncooled, Infrared Imaging Techniques That Minimize the Thermal Isolation Effect of the Focal Plane Array
DARPA 90-055	Integrated Earphone, Night Vision Goggles and Burst Communications in Helment for Low Probability of Detection and Intercept for Small Units
DARPA 90-056	Novel Configurations of Electromagnetic Launchers and Their Associated Power Supplies
DARPA 90-057	Innovative and Novel Means of Attacking Tactical Armored Vehicles by Reducing Their Firepower, Mobility, Armor, Crew Capability, etc.
DARPA 90-058	Speech Recognition Modules
DARPA 90-059	Generic Reasoning Modules
DARPA 90-060	Knowledge-Based Replanning In Resource Constrained Domains
DARPA 90-061	Distributed Artificial Intelligence /Databases for Command and Control

DARPA 90-001 Title: Electromechanical Power Supplies for Low Power Electronic Systems.

Category: Exploratory Development

Objective: A "wind-up" battery.

Description:

General - DARPA is interested in innovative concepts to eliminate chemical batteries for low power manpack electronics equipment. Current and foreseeable systems need many pounds of batteries for extended field operations without resupply. The DARPA sponsored mini Global Positioning System receiver uses approximately 25 watt-minutes per navigation fix. This level of stored energy could be accumulated over a period of time by extracting power from normal activities, or the energy could be stored by a manually wound spring device to be released on demand over a relatively short period of time. Systems that are compact, rugged, convenient, and reliable are preferred. Scaleability to larger sizes or the ability to connect multiple devices together to provide higher power levels are also desirable characteristics.

Phase I - Prototype devices demonstrating 4 watts of output at 12 volts for 5 minutes.

Phase II - Rugged field test units with demonstrated reliability.

DARPA 90-002 Title: Re-Examination of Analog Computing Techniques and Applications.

Category: Exploratory Development

Objective: To develop an analog or hybrid computer that solves a useful military problem and offers significant advantages in speed, size or power over an all digital implementation.

Description:

General - In the face of demands for digital processing speeds in the gigaflop range (and higher) analog computing has generally been ignored as an alternative for rapid solution of interesting and useful problems. In keeping with the philosophy that new technology may allow implementations of old concepts that meet modern needs, DARPA encourages a relook at analog computation as an alternative to digital processing for selected problems.

Phase I - Innovative applications of analog computation are sought along with new approaches which cast classes of difficult modern computational problems in an analog form. Include a feasibility demonstration of solving an interesting problem by analog methods.

Phase II - Prototype hardware for a specific application.

DARPA 90-003 Title: Low Volume, High Efficiency Power Sources for Small Satellites.

Category: Exploratory Development

Objective: The analysis and design of candidate space-qualified electrical power sources for small spacecraft that have a low volume and high efficiency compared to current space electrical power sources.

Description:

General - All spacecraft require some type of electrical power source to operate the spacecraft systems. Spacecraft electrical power needs range from continuous/steady low power levels up to burst/high power levels. Small spacecraft may require tens of watts up to a few kilowatts of power depending on the application. Current spacecraft electrical sources are solar panels and batteries. These systems are presently small scale versions of electrical power source designs created for much larger spacecraft. Designs optimized for small satellites are needed.

Phase I - Identify candidate electrical power sources that promise significant improvements in system volume and efficiency when compared to current designs. Identify and categorize applicable components and architecture, define areas for subsequent trade-off studies, and produce development schedules and risk assessments of various systems.

Phase II - Perform trade-off studies and system architecture analysis of candidate systems that can be space-qualified and optimized for small satellite operations. Areas of concern here are: survivability in the space environment, mission requirements and duty cycles, fabrication and testing issues, and development risk. The outcome of Phase II will be the selection of a design deserving of future development and prototype manufacture.

DARPA 90-004 Title: Novel Propulsion Systems for Small Satellites.

Category: Basic Research

Objective: To identify and assess the feasibility of novel propulsion systems for small satellites. The results will indicate the level of effort needed for future development of candidate systems.

Description:

General - Most spacecraft, large or small, require some type of propulsion system. Propulsion systems are used for orbit change maneuvers, large orbit transfer maneuvers, and altitude control. Because of the inherent volume and mass constraints of small satellites, existing conventional propulsion systems are of modest performance. New propulsion systems need to be identified that will increase the capabilities of small satellites.

Phase I - Identify candidate concepts for use as propulsion systems on small satellites. The alternative concepts will be characterized and trade-off and analysis areas for Phase II will be identified.

Phase II - Perform trade-off and performance analysis of the candidate propulsion concepts. This may include mechanical performance, mission profile compatibility, development needs and risks, and definition of technology advances to be realized. This effort will produce concept assessments and plans for possible future development.

DARPA 90-005 Title: Innovative Thermal Control Concepts for Small Satellites.

Category: Exploratory Development

Objective: To develop and evaluate the performance of candidate innovative thermal control systems for small satellites.

Description:

General - An inherent problem with small satellites is the lack of surface area that can serve as thermal radiators for the heat generated by on-board systems. The present situation restricts the power levels of small satellites to the order of hundreds of watts. This prevents small space platforms from being used for such missions as high capacity communications. Thermal control concepts that will allow small satellites to deal with higher power load heating will permit the use of this class of satellite in new areas.

Phase I - Identify alternative approaches to controlling thermal loads on spacecraft and those systems generating the most heat. Plans for developing the alternatives will be generated during this time.

Phase II - Develop at least some of the Phase I approaches identified. This development work could include computer simulations, bench tests, control system demonstrations, and environmental testing. The result of this phase will be a realistic knowledge of the effectiveness of the alternatives.

DARPA 90-006 Title: Miniaturized DC to DC Converters for Small Satellites.

Category: Engineering Development

Objective: To develop and construct a prototype DC to DC converter that incorporates features to reduce size and weight and to improve conversion efficiency.

Description:

General - Most spacecraft employ DC to DC converters to convert electrical power obtained by solar panels to the proper characteristics for use by other spacecraft systems including charging storage batteries. DC to DC converters are also used to dispense storage battery electrical power to other systems when needed. Present space qualified DC to DC converter designs are a mass and volume

burden to small spacecraft, an effect not of concern to large satellites. Therefore, small satellite systems can derive significant benefit from any advances that can reduce the mass and volume of DC to DC converters.

Phase I - Identify electrical components that can contribute to the reduction of size and volume of some qualified DC to DC converters; operate in a microgravity, vacuum environment; demonstrate conversion stability over a wide range of temperatures; resist radiation; and have conversion efficiency and demonstrate low volume and mass compared to existing systems. Phase I efforts will also identify design trade-off areas, operational environment constraints and a Phase II development and production schedule and risk assessment.

Phase II - Perform component and design architecture trade-off studies and producton and testing of prototype DC to DC converter. Testing of the prototype will include environmental testing in a ground based space chamber.

DARPA 90-007 Title: Novel, Low Energy Orbital Transfer Concepts for Small Satellites.

Category: Basic Research

Objective: To identify and understand new novel concepts for low energy orbital transfer of small satellites.

Description:

General - There is a need to learn about and understand new methods of performing low energy orbit transfers of small satellites. Such concepts could extend the on-orbit life of small satellites and enhance overall mission utility.

Phase I - Identify alternative concepts for performing low energy orbit transfer maneuvers and analysis and performance criteria for subsequent efforts.

Phase II - Evaluate the performance, advantages and disadvantages of the candidate alternative concepts. The result of this effort will be an understanding of the development's efforts and value of these concepts.

DARPA 90-008 Title: Novel Blue-Green Laser and Filter Technologies for Tactical Airborne Laser Communications.

Category: Exploratory Development

Objective: To develop novel blue/green (B/G) lasers and filters for tactical airborne laser communication.

Description:

General - Tactical airborne laser communications (TALC) involves t .o-way communications between an autonomous high altitude, long endurance (HALE) aircraft and a submerged submarine. To perform robust downlink

communications, the HALE aircraft must utilize a small, lightweight, prime-power efficient transmitting laser matched in peak wavelength to a wide field-of-view, highly transmissive, narrow optical-bandwidth receiving filter carried onboard the submarine. Similar technology need hold for the submarine-to-aircraft uplink path. Conventional approaches to TALC either meet the required laser or filter characteristics, but have not been optimized for both ends of the link. This effort will define and develop candidate B/G transmitting lasers and receiving filters for TALC.

Phase I - Novel B/G laser and matching filter technologies for TALC will be investigated and assessed. Conventional Submarine Laser Communications technologies such as XeCl/Pb and 2xNd:YAG transmitting lasers, and Cesium atomic line receiving filters will be excluded from consideration. However, innovative lasers matching either the 455 or 459 nm lines of the Cesium atomic line filter, or novel green atomic line filters for 2xNd:YAG will be considered under this announcement. In addition, new frequency conversion techniques employing conventional laser concepts will also be considered. All laser proposals must show supporting material or provide convincing arguments that the candidate B/G transmitter has a high-performance matching optical receiving filter and can eventually meet the following minimum performance requirements:

Wavelength of operation: within the B/G window (450-540 nm)

Energy per pulse: 1-2 joules per pulse

Pulse repetition frequency: 40-100 Hz

Wallplug Efficiency: > 3%

Laser Lifetime: 10 to the eighth power Shots

All receiving filter proposals must show supporting material or provide convincing arguments that the candidate filter has a matching high-performance B/G transmitter and can eventually meet the following minimum performance requirements:

Optical bandwidth: < 0.1 nm

Field-of-view: > 30 deg

High transmission: > 30%

Phase II - Laboratory investigation of candidate technology. Phase II laboratory work should validate claims of selected technology eventually meeting Phase I minimum performance characteristics.

DARPA 90-009 Title: Interferometic Fiber Optic Gyro Manufacturability.

Category: Engineering Development

Objective: To develop innovative interferometic fiber optic gyro (IFOG) component manufacturing equipment and techniques.

Description:

General - Solid-state inertial navigation systems offer the potential of superior guidance capabilities at extremely low cost. Such navigation systems are needed in advanced tactical weapon concepts such as standoff missile defense, as well as in tactical and strategic surveillance applications. Among all the leading candidate technologies for expendable guidance units, IFOGs appear to have the greatest potential for reducing unit procurement costs to less than $1000 per axis. (The ultimate goal is to reduce IFOG unit fabrication costs to significantly less than $1000 per axis.)

This effort addresses the development of innovative manufacturing techniques and equipment for producing IFOG components at extremely low cost.

Phase I - Various manufacturing techniques and equipment improvements will be identified and assessed in terms of their ability to reduce IFOG unit production costs to less than $1000 per axis. Example areas of interest are:

(a) Rapid, gradient-free, optical fiber coil winding machinery. Technical emphasis should be for large production throughput of rotation sensing, polarization-maintaining, fiber coils.

(b) Robotic optical fiber/integrated optical circuit attachment machines. These machines should create device connections or splices possessing low-loss backscatter and precise polarization alignment.

(c) Robotic assembly machinery to fabricate g- and thermal-load resistant packaging of IFOG inertial measurement units.

(d) High-throughput production of wide-band 1.3-1.55 um optical sources, and

(e) High-throughput production of IFOG integrated optical circuitry.

Phase II - Demonstrate feasibility of the proposed IFOG manufacturability improvement concept.

DARPA 90-010 Title: Low Observable Technology for Infrared, Acoustic, and Visible Signature Suppression on Aircraft.

Category: Exploratory Development

Objective: To explore techniques, materials, and concepts to reduce the observability of airborne vehicles to surveillance and target acquisition sensors.

Description:

General - Modern sensor technology reduces the survivability of aircraft through enhanced target acquisition. New techniques that can reduce the acoustic, visible, radar, and infrared signatures of air vehicles are needed to maintain the battlefield effectiveness of air vehicles (which include manned aircraft, unmanned air vehicles, cruise missiles, and air launched weapons). Promising efforts will be

carried to the demonstration phase if the potential of the effort represents a significant advancement.

Phase I - Explore conceptually promising techniques, materials, and concepts that reduce air vehicle signatures in the different sensor spectrums. Analytical reports will be generated.

Phase II - A limited number of Phase I efforts showing extremely high potential will progress to Phase II. Depending on the work involved, this Phase II effort will continue the conceptual analysis to establish confidence in the initiative, or in some cases, will progress to a laboratory demonstration or measurements program.

DARPA 90-011 Title: Passive (Non-Radio Frequency/Non-Electro Optic) Sensors for Application to Low Observable Aircraft.

Category: Exploratory Development/Advanced Development

Objective: To develop brassboard sensors systems for proof-of-concept and demonstration of concept performance and effectiveness.

Description:

General - Current sensor systems on conventional and low observable aircraft exploit infrared and/or radiometirc information to provide passive detection of targets of interest. Technologies exist to defeat these sensors. Other types of passive systems (e. g. gravity gradiometers, electro-static detectors, magnetic sensors, etc.) need to be explored/developed as alternatives.

Phase I - Development of system concepts, analysis of performance and effectiveness, estimates of developmental costs/schedule, possible limited sub-component test.

Phase II - Design, lab and test of system or a representative critical sub-component of the system as a proof of concept demonstration.

DARPA 90-012 Title: Relocateable Target Sensor Technology.

Category: Exploratory Development

Objective: DARPA is investigating the technology for detecting and targeting strategic targets which are capable of relocating on a frequent basis. Examples of this category of target are rail-mobile and road-mobile intercontinental ballistic missiles. Because of the location uncertainty, targeting acquisition systems are required which are often based on imaging sensors that rely on distinguishing the target from the background using visible, infrared or radar portions of the spectrum. However, detection capability is degraded if the target is located in a heavily cluttered environment and employs active deception and denial techniques (e. g. camouflage). If the target location is uncertain or has changed before commit of a weapon, automatic target cueing/recognition techniques may

be required to handle the large number of images generated during the search to reacquire the target.

General - DARPA is interested in innovative sensor technology to detect these relocatable targets. Possible approaches may take advantage of other regions of the electromagnetic spectrum, of unique signature phenomenology of manmade versus natural objects, of innovative sensor combinations, or of innovative sensor processing technology. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally useful. It is anticipated that the investigation of these technologies would be divided into two phases:

Phase I - Concept definition and analysis. The concept definition will include the operational architecture and emphasize how the innovative approach will contribute to improved effectiveness. The analysis will include theoretical development based on physical principals as well as an analytical assessment of available experimental data.

Phase II - Based upon successful conceptual analysis, a laboratory demonstration will be developed to verify the technical approach.

DARPA 90-013 Title: Innovative Sensors for Target Acquisition and Tracking, for *Use on Hypersonic Weapons.*

Category: Exploratory Development

Objective: To develop and demonstrate innovative sensor concepts for use in acquiring and tracking airborne targets. These sensor concepts should be compatible with autonomous hypersonic vehicles and the necessary guidance requirements.

Description:

General - DARPA is currently embarking on a program to develop and demonstrate key technologies required for the introduction of an operational hypersonic weapon system concept. One of the key requirements of the hypersonic interceptor is the ability to autonomously acquire and track targets with a minimum of targeting and guidance updates from external sensors. As target signatures become smaller, through the introduction of advanced technologies, it becomes more difficult for the acquisition and tracking sensors onboard the hypersonic vehicle. The purpose of this effort is to investigate new and innovative technologies that can help to improve the capabilities of the onboard sensors for an autonomous hypersonic interceptor.

Phase I - Conceptually develop new sensors or sensor technology with analysis indicating the projected levels of performance. Provide a development and demonstration plan for the proposed sensor or sensor technology.

Phase II - Demonstration and validation of key technological issues upon which the innovative sensor(s) or sensor technology is based. Base this demonstration on the plan prepared in Phase I.

DARPA 90-014 Title: Remotely Piloted Vehicle Technology.

Category: Basic Research

Objective: To identify and exploit high pay off advanced technology that enhances the capability and cost effectiveness of unmanned aerial vehicle (UAV) systems.

Description:

General - Future UAV systems will need enhanced vehicle endurance, speed and payload capability. These systems will need to be more survivable, and associated sensors, data links, and control stations must provide much greater flexibility for the user.

Phase I - The development and demonstration of UAV subsystems and components that include air vehicle, avionics, sensors, data link, mission planning and control stations, launch and recovery concepts.

Phase II - Alternative launch and recovery techniques must be developed to reduce overall support requirements.

DARPA 90-015 Title: New Optical Materials on Which to Base Development of Solid State Lasers in the Mid - Infrared.

Category: Basic Research

Objective: New approaches to develop efficient solid state laser materials in the 2 to 5 micron spectral region. This program shall emphasize the feasibility of efficient laser operation, laser material growth and characterization techniques.

Description:

General - There is a strong requirement for efficient solid state laser materials in the 2 to 5 micron spectral region for both DoD and non-DoD applications. The data base on these materials is very limited. New approaches are required to develop crystal classes which show promise of yielding new laser materials. Demonstration of laser operation with tunability in the mid infrared, innovative material growth, evaluation, and characterization techniques will be emphasized in this program.

Phase I - Exhaustive search of crystal classes that show promise of yielding new laser materials in the mid infrared, and demonstration of laser operation.

Phase II - Optimization of laser design, demonstration of tunability, and evaluation of laser material growth techniques.

DARPA 90-016 Title: Innovative Methods for Protecting Mid-Infrared Sensors from Attack by Lasers.

Category: Exploratory Development

Objective: To develop innovative concepts and techniques for protection of mid-infrared sensors against in-band cw and pulsed lasers without degrading the performance of the sensor.

Description:

General - Mid-infrared (MIR) sensors are used in missile seekers and thermal imagers. These sensors must be protected against in band laser attack. Innovative concepts and techniques are needed to protect the sensor without degrading the performance characteristics (e. g., the development of survivable high performance sensors (SHPS). Protection techniques must be effective simultaneously against both cw and pulsed lasers in the MIR spectral region.

Phase I - A conceptual design, laboratory demonstration of MIR sensor protection concept against in-band cw and pulsed lasers.

Phase II - A proof of principle demonstration of protection concept without degrading the performance characteristics of sensors against in band laser cw and pulsed lasers.

DARPA 90-017 Title: Innovative Methods for Protecting Electro-Optic and Infrared Sensors from Attack by High Power Microwave Energy.

Category: Exploratory Development

Objective: To investigate, develop, demonstrate, and test innovative protection techniques to attenuate the effects of high power microwave (HPM) energy on electro-optic (EO) and infrared (IR) sensors and related signal processing electronics.

Description:

General - HPM energy can damage EO and IR sensors and related signal processing electronics of smart weapons, precision guided munitions/missiles and communications. The damage mechanism can be burn out of components or latch up/upset of electronics. Innovative techniques are needed for protection of sensor systems against HPM attack without affecting the performance. This program emphasizes the development and demonstration of concepts for protection against "front door" HPM attack which do not affect the performance of EO and IR sensors and related signal processing electronics.

Phase I - Identify and demonstrate innovative approaches for protection without affecting the performance of EO and IR sensors and related electronics against HPM attack. Determine the design and performance requirements for use of this technology in current and future EO and IR sensor systems and related electronics.

Phase II - Design, develop, demonstrate and test the technology concepts identified in Phase I.

DARPA 90-018 Title: Simple and Inexpensive Means of Detecting Laser Illumination of Tactical Platforms.

Category: Exploratory Development

Objective: Develop simple, compact, light weight, laser warning/sensing devices to detect unambiguous verification of laser illumination of tactical platforms.

Description:

General - Simple, compact, and light weight laser warning/sensing devices are needed for unambiguous detection of laser illumination of tactical platforms such as ground vehicles, low altitude fixed wing/rotary wing aircraft and submarines. These devices shall have a high sensitivity and shall be immune to false alarms due to fast risetime pulsed nonlaser radiation, sunglints, and radio frequency electromagnetic interference (RF/EMI). Measurement of laser characteristics and direction of arrival of laser radiation are also desired. These devices must be of low cost so that they can be proliferated on numerous tactical platforms.

Phase I - Develop a conceptual design of a high sensitivity, compact, light weight, low cost continuous wave and pulsed laser warning devices. Designs must adapt to numerous tactical platforms and be immune to false alarms due to fast risetime nonlaser radiation, sunglints, and RF/EMI.

Phase II - A proof of principle demonstration of the laser warning device against continuous wave and pulsed lasers in the visible and near infrared in the laboratory and field conditions.

DARPA 90-019 Title: Innovative Concepts to Test the Efficacy of Directed Energy Weapons (Lasers, Microwaves, Particle Beams) by Simulation/Wargaming.

Category: Exploratory Development

Objective: To develop concepts, algorithms, and software for computer simulation/wargaming to test the utility, and effectiveness of directed energy weapons (e. g. lasers, microwaves, and particle beams) in combined arms setting in the modern tactical battle field.

Description:

General - Unlike conventional weapons systems, directed energy weapons (DEW) system have line of sight, speed of light engagement and both soft and hard kill mechanisms for smart weapons sensors and guidance/control electronics and communications systems. To realize the full potential and understand the limitations and develop tactics, doctrine and training for the emerging DEW technology, utility and effectiveness must be established for combined arms

setting in simulation/wargaming in a distributed simulation network such as SIMNET-D developed by DARPA.

Phase I - Examine the data base for susceptibility and vulnerability of targets against DEW, define and formulate modelling requirements for the utility and effectiveness concepts for DEW technology in combined arms setting simulation/warfighting networks such as SIMNET-D.

Phase II - Develop computer simulation and modelling based on findings of Phase I for DEW beam propagation through atmosphere, accessibility and target interaction, and kill mechanism of selected targets to assess the utility and effectiveness in simulation/warfighting networks such as SIMNET-D.

DARPA 90-020 Title: Novel Ways to Monitor/Verify Use of Directed Energy Weapons Which May Be Restricted by Future Treaties.

Category: Exploratory Development

Objective: To develop novel concepts to unambiguously monitor/verify use of directed energy weapons (DEW) such as lasers for strategic applications, which may be restricted by future treaties. Remote/emplaced sensors will be developed to monitor/verify testing these weapons systems.

Description:

General - Directed energy weapons such as ground based lasers with sufficient brightness/energy can be used for strategic applications-ballistic missile defense (BMD) and anti-satellite (ASAT) uses. Treaties might be negotiated to restrict development of such weapons. However tests conducted at low brightness with cooperative targets might be concealed. Novel concepts are needed for remote/emplaced sensors and associated data processing requirements.

Phase I - Examine the data base on primary and secondary observables of DEW such as ground based lasers for strategic applications. Define design concepts for remote/emplaced sensors for unambiguous monitoring/verification of DEW use for strategic applications.

Phase II - Demonstrate proof of principle experiments at domestic facilities based on findings of Phase I.

DARPA 90-021 Title: New Approaches in the Design of Very Compact, Wideband, High Power, Microwave Antennas.

Category: Exploratory Development

Objective: The development of a portable, wideband, collapsible antenna which when deployed, will irradiate roughly ten square meters from a height of about twenty meters.

Description:

General - A super compact high power microwave device is currently being developed to fit inside a capsule of the size of a cannon shell. An antenna is also required to fit inside this capsule such that when deployed, will radiate an area roughly ten square meters from a height of about twenty meters. The frequency of the radiation centers around a few GHz with a power level of hundreds of MW.

Phase I - The conceptual design of this antenna showing the shape, the size, and its parametric dependence on the power, the height, and the area of coverage. A scheme must be identified that shows how this antenna is to be packaged and deployed.

Phase II - A proof-of-principle experiment is to be performed which can demonstrate the features of Phase I.

DARPA 90-022 Title: Innovative Technologies for the Production of High Current (10 kA), High Repetition Rate (10 kHz) Cathodes.

Category: Exploratory Development

Objective: To construct a lightweight, compact cathode that can generate at least 10 kA with a repetition rate of 10 kHz.

Description:

General - High current electron beam propagation study requires a cathode which can generate tens of kA at an energy of a few MeV, a pulse length about tens of ns., and a repetition rate of at least 10 kHz. This cathode will be used as the injector to a compact accelerator currently being developed. This injector must be compact, rugged, lightweight and able to operate over long intervals without interruptions.

Phase I - A conceptual design of this cathode showing the operating principle, the estimated size and weight.

Phase II - A proof-of-principle experiment showing the current scaling and the repetition rate capability.

DARPA 90-023 Title: New Ideas for High Power (10-100MW), High Repetition Rate (10 MHz) Switches.

Category: Exploratory Development

Objective: New concepts for relatively lightweight, inexpensive, and compact power conditioning systems to drive ferromagnetic induction cells for compact recirculating induction accelerators.

Description:

General - The power supply must provide an accelerating voltage of 250 - 300 kV to a group of induction cells with total load currents in the 10 KA range over a duration of 30 ns. A voltage risetime of a few nanoseconds is desired with a maximum of about 2% variation in voltage during the flattop. A reversed voltage must then be applied to the cells to reset the ferromagnetic cores with a reset pulse shape such that the volt-second product of reset is equal to that during the accelerating pulse. Approximately 10 - 20 pulses are required at a frequency of 10 - 15 MHz from the power system.

Phase I - A conceptual design of this pulsed power switching system showing the estimated size and weight.

Phase II - A proof-of-principle experiment will be performed that will demonstrate the operating principle, the power scaling and switching capability of the pulsed power system.

DARPA 90-024 Title: Diamond Films for Wear/Erosion Resistance

Category: Exploratory Development

Objective: The objective of this project is to completely characterize the deposition of polycrystalline diamond on infrared (IR) transmitting substrates, such that wear resistance, transmission and thermal conductivity are optimized.

Description:

General - Polycrystalline diamond films are being considered for a number of DoD applications requiring resistance to wear, as well as high transmissivity within the near infrared spectral region and high thermal conductivity. Generally, these films would be deposited onto IR dome materials, to provide enhanced dome properties for high speed missiles.

Phase I - The desired result of this effort is to demonstrate deposition of polycrystalline diamond films on generic IR dome materials, typically ZnS and ZnSe. Adhesion and wear resistance are to be evaluated, and optimized as a function of the deposition parameters.

Phase II - The result of this effort will be to extend the Phase I effort to include the evaluation of spectral transmissivity and thermal conductivity on deposited diamond films. A complete characterization of the deposition process with respect to adhesion, wear, transmission and thermal conductivity will be required.

DARPA 90-025 Title: Supercritical Fluid Processing Technology.

Category: Basic Research

Objective: To investigate and demonstrate the utilization of supercritical fluid technology as a novel processing capability for defense related systems that will lead to a

prototype demonstration that has viability for scale-up for practical application during Phase III. Possible areas for application of supercritical fluid processing technology include demilitarization of chemical and explosive munitions, the processing of high performance polymer systems, and the processing of energetic materials.

Description:

General - Supercritical fluid technology (SCF) through the use of the extraordinary solvating character of fluids at supercritical conditions offers unique opportunities for the development of novel processing techniques for material systems both generated and required by the Department of Defense. SCF offers the opportunity for demilitarization of chemical and explosive munitions including rockets under highly controlled conditions. Investigation of chemical reactions and solubilities of the various components of interest in SCF will be required to determine their dependence upon temperature, pressure and upon the supercritical fluid itself or perhaps a mixture of supercritical fluids. It also offers the opportunity to process high performance polymers and energetic materials as well as offering the possibility for extraction of desirable components from a complex mixture.

Phase I - Investigation of the reactions of organo-heteroatomic compounds such as chlorinated organics, pesticides and herbicides in supercritical fluid media. Identify reactions occurring and their dependence on temperature and pressure. Study the reactions of propellant and explosive compounds in supercritical fluid media. Investigate the extraction of nitramines from energetic binders without decomposition of individual components to permit recovery for subsequent use. Gain a greater understanding of supercritical fluid properties, development of experimental measurement techniques and better methods to predict a fluids solvating capabilities. Establish the efficacy of the SCF processing technology under investigation.

Phase II - Having established the efficacy of the SCF processing technology under investigation, Phase II will emphasize the optimization of the processing technology and the development of a prototype demonstration to verify the validity of the technique. The demonstration must also show the viability for scale-up for practical application should the project transition to Phase III.

DARPA 90-026 Title: Mathematical Modeling of Fluid Flow in Chemical Vapor Deposition and Plasma Reactors.

Category: Basic Research

Objective: Development and experimental verification of a computational description of the fluid dynamics, homogeneous/heterogeneous reactions and heat transfer phenomena in a plasma enhanced chemical vapor deposition (CVD) reactor.

Description:

General - Plasma enhanced CVD processes are an approach to densification of composites and deposition of protective coatings with considerable potential for expanded application in the future. However, process development is currently hindered by

a lack of understanding and mathematical models of the interactions between the plasma enhanced chemical reactions, fluid flow dynamics and heat transfer within the reactor. Recent progress has been achieved in the computational description of CVD silicon in a rotating plate reactor. Additional efforts to incorporate plasma enhancements and alternate reactor geometry are required.

Phase I - Develop reaction models and computational algorithms to incorporate plasma enhanced reaction chemistry into a mathematical description of CVD processing.

Phase II - Experimental testing and verification of the computational algorithms developed in Phase I.

DARPA 90-027 Title: Applications of Wavelet Theory in Modeling Functions of Defense Systems.

Category: Basic Research

Objective: To demonstrate properties of a signal that are best studied by affine wavelet or Weyl-Heisenberg wavelets, or Gabor bases.

Description:

General - In recent years the field of wavelet analysis has become recognized as an important signal processing tool. The object is to characterize the properties of a signal that are best distinguished by affine wavelet, Weyl-Heisenberg wavelets, or Gabor bases.

Phase I - The task will be to characterize both by theory and detailed numerical simulation, several properties that wavelets distinguish better than a Fourier transform sliding window.

Phase II - The task will be to extend this analysis to the Weyl-Heisenberg wavelets and the Gabor bases.

DARPA 90-028 Title: In-Situ Process Sensors for Real-Time Microcircuit Manufacturing Control.

Category: Basic Research

Objective: To develop sensors for real-time process control during wafer-at-a-time semiconductor device processing.

Description:

General - Sensors are required for real-time process control during wafer-at-a-time semiconductor device processing. They should be nonintrusive, monitor what is occurring at the wafer surface, and probe the processing environment. Examples include measurement of metal, polysilicon, and dielectric film thickness, refractive index, resistivity, and other properties at a number of locations on a 150- to 200-mm silicon wafer during film growth or deposition. Sensors for

monitoring the plasma environment during reactive ion etching and remote microwave etching of dielectric, polysilicon, metal, and silicide films are also sought. Dynamic and steady-state wafer temperature measurements are critical. Sensors for in-situ particle detection in pumping lines, load locks, and process chambers are required. Sensors are also sought to do real-time sensing of process equipment to ensure equipment reliability and enhance mean time between failure. These could include voltages, pressures, etc., for radio frequency plasma, microwave plasma, lamp heaters, gas flow controllers, pumps, power supplies, and other components. All sensors must be compact, robust, and highly cost effective.

Phase I - Initiate effort as described above by beginning exploration of advanced sensors. By the completion of Phase I, potential viability of the selected approach(es) should be clearly demonstrated.

Phase II - Take the initial concept to concrete demonstration of applicability. This should include cooperative evaluation with a semiconductor manufacturing activity.

DARPA 90-029 Title: Traveling Heater Method Growth of Bulk Compound Semiconductor Alloy Crystals.

Category: Basic Research/Exploratory Development

Objective: Explore the Growth of Bulk Compound Semiconductor Crystals, especially II-VI, using the Traveling Heater Method.

Description:

General - A method of bulk compound semiconductor crystal growth is needed which will yield material suitable for high performance electronic and optoelectronic devices. The traveling heater method (THM) has been successfully applied to the growth of a number of compound semiconductors, including mercury cadmium telluride. This announcement solicits proposals to apply THM to the growth of materials such as zinc telluride which are important for devices. In addition, further development of this technique is required in order to make it more suitable for use in a production facility.

Phase I - Apply THM to the growth of compound semiconductor material. Perform electrical, optical, and structural characterization of the grown material. Deliver several samples of material for independent characterization.

Phase II - Optimize THM. Develop a large data base of material samples upon which refinements of the growth process can be based. Explore variations in growth parameters such as spatial and temporal temperature profiles. Extend the technique to larger diameter crystal boules. Develop and/or exercize computer models of the growth process. Develop concepts for real time monitoring and controlling of the growth process. Perform characterization of material samples. Deliver samples for independent characterization.

DARPA 90-030 Title: Self-Assembling Microstructures.

Category: Basic Research

Objective: To explore the use of polymerizable self-assembling materials (SAM's) either directly -- because of their intrinsic physical or chemical properties -- or indirectly -- as templates of unique size and morphology -- for the "bottoms-up" fabrication of advanced optical and electronic materials/components leading to prototype device demonstrations which form the basis for Phase III.

Description:

General - Recent work has demonstrated the ability to form hollow, polymerizable soda-straw like structures whose nominal diameter is 0.5 microns and whose length can be made to vary from 10 microns to greater than 2 mm. Intrinsic particle properties include: (1) anisotropy, helicity and chirality on the micron scale -- which provide a basis for control of particle orientation and optical/electronic interactions; (2) quasicylindrical symmetry with a hollow core - which offers rigidity, porosity, low mass and non-linear optical interactions; (3) controlled aspect ratio -- which provides for tailored, broadband electromagnetic interactions/resonances, diffusion-limited separations, flow modification and fiber-like behavior; (4) internal/external surfaces and chemistry; (5) microvial capability -- for encapsulation and ceramic microengineering; (6) microhoneycomb structure -- for the fabrication of high strength to mass materials; (7) confined axial growth -- which might be exploited in the formation of controlled asymmetric interconnects and (8) "bottoms-up" fabrication -- which allows rational control of bulk, film and surface material properties. The particles may be exploited either directly, because of their intrinsic properties, or as substrates or templates of unique size and morphology for subsequent fabrication/processing steps (e.g. the formation of particle-based whisker reinforced composites). The particles have been successfully coated with thin metallic films of copper, nickel and permalloy to a length of 100 microns, aligned in both aqueous and non-aqueous media by flow, electric and magnetic fields, and embedded with controlled alignment in both epoxies and optical cements.

Current work explores their use in the fabrication of advanced electron source components, as optical limiters for laser eye protection, as birefringeant suspensions for advanced optical devices, and as low loss, high dielectric composites for electronic warfare use. Proposals seeking to investigate the use of SAM's in device design and fabrication are welcome.

Areas of interest include, but are not limited to, the use of SAM's in high dielectric composites for energy storage, conducting composites for radio frequency shielding, non-linear thin film optical devices, advanced acoustic sensors and field-emitter arrays.

Phase I - Material characterization and component/device design.

Phase II - Device proof of concept demonstration.

DARPA 90-031 Title: Artificial Neural Network Technology.

Category: Basic Research

Objective: To advance the state of the art in artificial neural network (ANN) theory and model development, develop and demonstrate hardware implementation technologies for future construction of full-scale ANN computers, and identify and investigate promising applications for ANNs.

Description:

General - Proposals must clearly describe the novel features proposed, their motivation, and their expected computational advantages.

In the theory and modeling category, DARPA is interested in new artificial neural network architectures that will provide enhanced information processing capabilities; faster, more efficient training procedures; requirements for scale-up to large-sized networks; characterization of properties, limitations, and data requirements of ANNs; and relationships between ANNs and conventional information processing approaches.

Special applications proposals must describe the motivation for choosing the specific application and the expected advantages of the proposed ANN system over competing approaches.

Hardware base development implementation technologies proposed may be specific for a particular ANN model architecture or general to accommodate a variety of different ANN model architectures. If the proposal addresses hardware specific for a particular ANN model architecture, the technology proposed must allow near-term implementation that will demonstrate the expected power of ANNs.

Phase I - Address the following tasks: theory and model development--develop and implement new conceptual systems; hardware--design and fabricate prototype hardware implementations; and applications--develop and implement tailored ANN systems.

Phase II - Focus on testing the newly developed ANN systems on specific applications and measuring their performance relative to competing technologies.

DARPA 90-032 Title: Electronic Ceramics for Novel Devices and High-Speed Packages.

Category: Basic Research

Objective: To develop and exploit ceramics for novel electronic devices and high-speed packages.

Description:

General - Innovative ideas in the utilization of familiar ceramics for military electronic applications or the development of new ceramics for such application are

solicited. Recent utilization of ceramics for nonvolatile memories, room-temperature thermal imagers, and high-speed packaging are examples of the type of applications that are of interest. These ceramics may result in either active or passive devices, or they may improve the signal transmission properties of packages. Work on ceramic single-crystal thin films or multi-grained thin films should result in films that are compatible with either silicon or gallium arsenide integrated circuit technologies.

Phase I - Initiate effort as described above by beginning exploration of novel materials, devices, or packaging structures. By the completion of Phase I, clearly demonstrate potential viability of the selected approach(es).

Phase II - Take the initial concept to concrete demonstration of applicability. For example, this could include demonstration of advanced electronic devices or packages.

DARPA 90-033 Title: Large-Diameter III-V Crystal Growth.

Category: Basic Research

Objective: To develop technology for large-diameter III-V crystal growth for optoelectronics applications.

Description:

General - DARPA is seeking the development of single-crystal growth methods that will result in at least three-inch diameter boules of either gallium arsenide or indium phosphide with improved reproducibility, uniformity, and crystalline perfection for optoelectronics and integrated optoelectronics applications. The method proposed should be capable of growing semi-insulating and low resistivity crystals. Target material parameters should be selected on the basis of optoelectronic device requirements.

Phase I - Answer key questions regarding crystal quality and potential for scale-up. While initial experiments may be conducted with small melt volumes, fundamental factors should not limit the crystal diameter to three inches or the boule to an insufficient length.

Phase II - Expand upon the initial results by scaling up to larger diameter and longer boule length and by beginning a correlation between materials, parameters and device performance.

DARPA 90-034 Title: Lightweight Payloads for High-Altitude Balloons.

Category: Exploratory Development

Objective: To provide demonstrated alternatives for payloads that have commercial and military applications.

Description:

General - DARPA is interested in exploring possible options for balloon borne payloads within the field of communications and surveillance. Balloon technology provides a unique platform for positioning small payloads at high altitude for significant periods of time. New technologies in packaging, electronics, spectral analysis, and power generation should make a wide array of payload options available. Two basic kinds of balloons are being considered as lifting candidates. One is a 24 hour life, zero pressure balloon intended for 70,000 feet and a nominal 5 pound payload. The other is a super pressure balloon intended for one year endurance at 120,000 feet with a 50 pound payload. Any novel payload concept for military application will be considered but some techniques are considered critical:

(1) A launch of the smaller balloon will be made by a ship at sea with minimum shipboard equipment and personnel. A separate ground launch version will be considered.

(2) The payload must be expendable.

Phase I - Provide analysis and/or experimental data on a proposed design to show technical feasibility of the payload and potential applications of the concept.

Phase II - Complete a working model of the proposed payload and conduct sufficient flight tests to demonstrate the concept.

DARPA 90-035 Title: Integration of Low-Cost Sensors with Fiber-Optic Links.

Category: Exploratory Development

Objective: To provide the basis for significantly lower cost and more efficient sensor arrays for military and commercial applications.

Description:

General - Innovative ideas are needed for new methods to reduce construction, installation, and maintenance costs, while increasing the efficiency of low-cost sensor arrays through the use of fiber-optic links. Large arrays of low-cost sensors are a critical component of numerous surveillance and data gathering techniques. Currently the number of sensors associated with any portion of an array is limited by the signal loss of the network between sensors. In addition, the existing methods of integrating those sensors is costly. New approaches and technologies utilizing fiber-optics have potential to solve these problems. Any novel technique will be considered; however, capability in the following areas is of high interest in this program

(1) Efficient construction and implementation techniques to reduce costs and achieve high performance.

(2) The capability to function in one or all of the following extreme environments: submergence in saltwater to several thousand fathoms; buried in

the ground to a depth of more than a mile; and maintenance of flexibility in temperatures near zero degrees Fahrenheit.

Phase I - Provide analysis on the feasibility of applying fiber-optic technology to sensor systems and integration, and identify the most promising path for development.

Phase II - Verify the feasibility of the technique through experimentation as identified in Phase I.

DARPA 90-036 Title: Development of Computer Aided Design Models for Microwave and Millimeter Wave Devices and Circuits.

Category: Exploratory Development

Objective: To provide models for microwave and millimeter wave frequency solid-state devices and monolithic format circuits that accurately predict actual device and circuit performance over the widest possible frequency range; and to interface these models with commercially available computer aided design software packages and workstations.

Description:

General - At the present time, reasonably accurate models are available for microwave solid-state devices and circuits that operate in a linear mode within the frequency range from 1 to 20 GHz. Additional work is needed to improve the accuracy of models for operation of devices and circuits in the 20 to 100 GHz range and for operation of active devices in a non-linear (high power) mode. Devices of particular interest are metal-semiconductor field effect transistors (MESFETs), high electron mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs) fabricated from III-V compound semiconductor materials. Circuits of particular interest are in a monolithic format fabricated from gallium arsenide. The most desirable models are those which can be used to tie processing parameters to circuit design parameters.

Phase I - Select one or more devices and/or circuit configurations and develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements. Consideration should be given to how models proposed will extend computer aided design capabilities beyond those afforded by use of currently existing models and to compatibility of models with existing commercially supported software packages and workstations.

Phase II - Complete model development and write an appropriate software description that can be used in conjunction with commercially supported software and workstations.

DARPA 90-037 Title: Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques.

Category: Exploratory Development

Objective: To provide computer aided design methods to accurately analyze the predicted performance of new analog device and/or circuit structures intended for operation in the 1 to 100 GHz frequency range.

Description:

General - A number of recent device structures have been proposed which may result in a superior transmitter and/or receiver performance at microwave and millimeter wave frequencies. In some cases, the basic device structure is not new but the material structure proposed for device fabrication is. In other cases, completely new device structures are under consideration. Similarly, new circuit designs are under consideration that result in performance advantages such as broader-band operation, higher efficiency operation or higher power outputs. This project will result in the development of computer aided design techniques and models that can be used to analyze the performance and advantages to be gained from incorporation of new devices and circuits in microwave and millimeter wave systems.

Phase I - Select one or more promising microwave and/or millimeter wave device and/or circuit structures for model development from technical discussions and literature searches. Provide a proposed model with a clear indication of accuracy and needed improvements.

Phase II - Complete modeling and computer aided design software. Emphasize accuracy and compatibility with existing commercially available computer aided design software and workstations.

DARPA 90-038 Title: Implementation of New Gallium Arsenide Growth Technique (Vertical Float Zone) Developed at Naval Research Laboratory.

Category: Exploratory Development

Objective: To develop a prototype vertical float zone gallium arsenide growth system suitable for producing substrates with characteristics desirable for fabrication of microwave and millimeter wave solid state devices and circuits.

Description:

General - The Electronics Technology Division of the Naval Research Laboratory (NRL) has produced high purity gallium arsenide crystals using the liquid encapsulated vertical zone melting technique. This growth method offers promise as a means of producing superior material because of low thermal stress. The samples produced at NRL exhibited lower etch pit densities and less crystalline defects than those produced by other means (e.g. liquid encapsulated Czochralski growth). Unfortunately, NRL only has the capability to produce crystals that are one inch in diameter. This project will result in the ability to fabricate gallium

arsenide crystals by the liquid encapsulated vertical zone melting technique that are at least three inches in diameter and single crystalline in structure. Material parameters that affect semiconductor device performance will be measured (e. g. mobility, dislocation densities, etch pit densities, etc.) and material will be supplied for fabrication of microwave and millimeter wave devices.

Phase I - Provide a design and plan for constructing the necessary fabrication system and fabricating the desired material.

Phase II - Construct the crystal puller designed in Phase I and grow at least three boules of three inch diameter gallium arsenide. Provide material parameter data on representative slices of gallium arsenide from the seed, middle and tail end of each boule. Deliver boules for use in device fabrication and further evaluation.

DARPA 90-039 Title: Developing Mach Operating System Family Modules.

Category: Exploratory Development

Objective: To develop a number of innovative servers, device drivers, and or user interface modules for Mach. Specific areas include (but are not limited to) device drivers, user interface tools, servers to provide special functionality to the Mach operating system for particular applications.

Description:

General - Mach, the Carnegie-Mellon University developed operating system supporting Unix compatibility, multiprocessors and extensable environments is becoming the base for a large number of systems. Acceptance of this operating system will be further enhanced by the availability of "public domain" implementations of device drivers and servers.

Individual proposals should describe specific modules that will be produced. Modules shall be developed in such a way as to make them free of subsidiary licenses and available, royalty free, to the entire Mach community. Potential bidders need to establish their technical credibility in the Mach operating system as well as the specific technical area in which their module covers. Selection will be based on the need for the proposed module, cost, and proposers' technical competence.

Phase I - Develop the specification of the module or modules proposed. In addition, a prototype implementation of the module will be completed.

Phase II - Complete implementation of the module with full functionality will be developed and full user documentation as well as design documentation will be produced.

DARPA 90-040 Title: Advanced Manufacturing Techniques for Flat Panel Displays.

Category: Exploratory Development

Objective: To identify and develop manufacturing techniques that can be applied to the low-cost, high-volume manufacture of direct-view, flat-panel displays.

Description:

General - Flat panel displays have many applications in military systems and potentially have significant applications in consumer and industrial products. Presently available flat panel displays are limited in size, resolution, ability to present color, grey scale and motion. They are expensive due to low manufacturing yields and complex processes.

Phase I - Select one or more direct view flat panel technologies (e.g. active matirx liquid crystal display or electroluminescent). Analyze the manufacturing process to identify opportunities for cost reduction through process simplification, yield enhancement, throughput improvement, replacement of specialized high cost manufacturing equipment with low cost equipment, materials substitution, changes in panel design (e. g. reduction in interconnects or driver requirements), etc. Provide a clear indication of how such changes would affect panel cost and manufacturability. Most desirable are approaches that combine the realities of the manufacturing environment with innovative technical solutions.

Phase II - Implement/demonstrate proposed changes on a production line. For this phase the production line can be the contractor's own, a team proposed by the contractor, or a contractor performing under another DARPA or U.S. Government contract.

DARPA 90-041 Title: Advanced Optical Techniques Extending Use of Optical Tools Below 0.5 Micrometer Geometry Constraints.

Category: Exploratory Development

Objective: To develop techniques for optical lithography used in the fabrication of integrated circuits with lateral feature sizes below 0.5 micrometers.

Description:

General - The ever evolving trend toward smaller features in integrated circuit technology continues to demand smaller tolerances in processing. Unless alternative approaches are developed, the resulting decrease in yield and reliability is catastrophic. Similarly, the trend toward larger chips requires improved uniformities in the optics over larger lens diameters. The lithography system is a complex combination of interactions among materials, processing, optics, and mechanical manipulations. Potential improvements may include work in such areas as: light sources of wavelength < 3000 angstroms, improved control for focal depth, larger lens diameters and higher numerical apertures, optical materials for appropriate wavelengths, better mechanical controls for mask-wafer alignment, improved resists, additives to resists, new combinations of multilayer

films, in situ diagnostics, test and evaluation approaches, and process parameter control.

Phase I - Select one or more approaches and demonstrate at the simplest level which will prove feasibility. Characterize and evaluate parameters against requirements projected for the final system configuration.

Phase II - Demonstrate the complete photolithography cycle of wafer exposure and pattern definition. Characterize and evaluate a complete set of pertinent parameters, including resolution, dimension control, and processing latitude.

DARPA 90-042 Title: Low Cost, High Throughput Test Methods for Analog Semiconductors.

Category: Exploratory Development

Objective: To develop the test equipment and methodology to non-destructively evaluate the electronic and optical (as applicable) performance of specialized analog circuits for full frame memory, infrared focal plane arrays and charge coupled device signal processing applications.

Description:

General - Analog processing electronics are essential in applications where digital conversion electronics are either impractical or the a-d converters with the necessary speed and accuracy are not available. Processing electro-optical sensor applications in the analog domain affords the potential of signal processing at the sensor. This provides an opportunity for smart sensor modules for autonomous submunitions. However, while technology for evaluation of digital electronics is commercially available, equipment for evaluation of analog processing electronics for DoD applications, does not benefit from this commercial leverage. As a result, the evaluation of analog circuits, especially circuits for specialized applications, is costly and the throughput is limited. Innovative test methods are required to completely evaluate analog circuit performance, including noise measurements, prior to integration of the circuit into the processing module. This is especially important for circuits with specialized operating conditions such as, cryogenic temperature requirements, stability for precision guidance and operation in a countermeasure environment. A test methodology and the equipment to reduce test time and qualify the part for system integration will reduce the cost of specialized analog circuits to DoD systems. This, in turn, will broaden the application base of analog processing electronics.

Phase I - Develop the concept for a test methodology to evaluate analog circuits. Circuits with broad DoD application will be selected and techniques for measurement of essential circuit parameters; signal-to-noise ratio, noise spectrum (if applicable), and frequency response will be determined. Establish a preliminary design for test equipment that will demonstrate a dramatic reduction in testing cost.

Phase II - Develop equipment to evaluate circuit performance under realistic system operating conditions and demonstrate the cost savings over previous test methods.

DARPA 90-043 Title: Dry Etching for III-V and II-VI Semiconductors.

Category: Exploratory Development

Objective: To demonstrate dry etching techniques with the potential for revolutionizing the manufacturing process for mercury cadmium telluride (MCT) infrared focal plane arrays (IRFPA).

Description:

General - MCT IRFPAs are produced with a wet chemical process for delineation of junctions, for definition of diffusion barriers between active regions and for cleaning surface areas prior to thin film deposition. The wet chemical process is difficult to control and is not amenable to the automation necessary for high throughput, high yield semiconductor manufacturing. Dry etching of compound semiconductors, either by laser ablation or in a plasma reactor, is feasible, but has not been demonstrated as a production technique for MCT detectors. Diode performance has been shown with the dry etching process, but the characteristics are not equivalent to state of the art diodes produced with the wet chemical process. Development of a production compatible dry etch process for MCT photodetectors requires design and demonstration of a reactor with geometry suitable for uniform, high throughput etching, optimization of the etch parameters (e.g. temperature, gas flow rates or laser power density), development of photomasking approaches and automation technology. Realization of this technique will substantially increase the control essential for process repeatability, and demonstrate a crucial submodule for a mercury cadmium telluride detector microfactory, where processing is accomplished in a completely controlled environment. In addition, the dry etching technique is potentially applicable to gallium arsenide, which has application as an IRFPA signal processing circuit.

Phase I - Establish the concept for dry etching MCT will by producing individual photodiodes with various geometries using wet processing and dry etching. Diode characteristics will be evaluated and the dry etching process parameters optimized to achieve performance equivalent to the best diodes produced with the wet chemical process.

Phase II - Produce IRFPAs with the dry chemical process and evaluate in a laboratory test bed. Establish a data base with a limited production run of IRFPAs designed to assess the dry etching performance.

DARPA 90-044 Title: Non-Invasive Characteristics Techniques for In-Process Control of II-VI Compound Material Growth Systems.

Category: Exploratory Development

Objective: To develop and demonstrate in-process sensors for production control of mercury cadmium telluride material growth for infrared focal plane arrays.

Description:

General - Mercury cadmium telluride growth by either bulk techniques, liquid phase epitaxy or vapor phase epitaxy is accomplished by control of the growth system parameters: temperature, pressure and reactor geometry. The characteristics of the material as it is grown are not monitored, and the material characterization is usually accomplished subsequent to growth by a series of evaluations which sample small sections of the wafer. Since several growth runs are completed before a thorough characterization is available, growth parameters can not be adjusted in real time to optimize the growth. An in-situ sensor to control material properties is needed to optimize the growth process for a production environment. This is also necessary to eliminate the successive growth of low quality material before a complete evaluation is obtained. This control philosophy not only achieves real time adjustment of growth parameters, but also eliminates the need for costly post-growth material evaluations. Several optical techniques are available to nondestructively map wafer properties, but these have not been integrated into the growth apparatus and investigated as growth control mechanisms. Significant cost reduction benefits can be realized from a reproducible, high quality material input to the infrared focal plane array manufacturing line before substantial value is added to the product.

Phase I - Investigate potential non-invasive sensors for in-situ monitoring of material parameters, and perform the material characterizations necessary to verify the feasibility of the selected approach. Complete the design of a production growth system with integral in-situ sensors for monitoring material characteristics.

Phase II - Build a prototype reactor with in-situ sensors and perform a series of controlled growth runs, validating material quality with optical and electrical measurements, and with diode array test structures. Provide improved material for fabrication of infrared focal plane arrays.

DARPA 90-045 Title: Anti-Reproduction Document Coating.

Category: Basic Research

Objective: To develop a coating or film that when applied to a document would prevent its reproduction.

Description:

General - Development of an "easy to apply" coating or film that when adhered to a document would prevent its reproduction by conventional xerographic techniques. Application of the coating or film must not impede the legibility of the document and must not be removable to allow reproduction.

Phase I - Initiate effort as described above by identifying candidate films and/or coatings and begin exploration of same.

Phase II - Take the initial concept to concrete demonstration of applicability.

DARPA 90-046 Title: Experimental Determination of Differences in Seismic Coupling of Explosions Detonated in Different, Hard, Brittle Rocks.

Category: Basic Research

Objective: To predict the yields of Soviet underground nuclear tests detonated in different, hard, brittle rocks.

Description:

General - Seismologists have generally assumed that explosions detonated in different, hard, brittle rocks such as granite or slate or sandstone will couple equally. However, this assumption is critical in view of recent possibilities to obtain information on the detailed geology of the emplacement sites of Soviet nuclear explosions which often are detonated in such rocks.

The theoretical analysis of coupling in these rocks is difficult and there is a substantial lack of experimental data. It is thought that laboratory and field experiments with conventional explosives can provide a great deal of insight into this problem.

Problems of importance to consider in experimental design include the roles of saturation, hydrostatic pressure, distance to the free surface, scaling of cracks with respect to explosion yield, yield scaling in general, and the effect of gravity on the development of spall.

An important objective is that a body of reliable, reproducible data be developed which can be used by future workers in the field.

Phase I - Outline the experimental plan for Phase II and illustrate the experimental techniques by the acquisition of good data for a few samples.

Phase II - Obtain results for several types of rocks with different degrees of saturation and hydrostatic pressure. Form a discussion of the applicability of these results to full scale underground nuclear testing, design a test and predict a result.

DARPA 90-047 Title: Experimental Determination of the Excitation of Seismic Regional Phases as a Function of Explosion Source Depth.

Category: Basic Research

Objective: To predict the relative and absolute excitation of regional phases of Soviet underground nuclear tests as a function of depth.

Description:

General - Several studies have recently shown that the Lg phase from explosions is of lower frequency than the Lg phase from nearby earthquakes. One explanation for this phenomenon is that the explosions, being near-surface, are detonated in a medium with a lower Q. A second explanation is that the Lg phase from explosions is generated from P to S conversions at the free surface. Theory

suggests that this conversion is more efficient the shorter the distance in terms of wavelengths from the source to the surface.

However, some theoretical analyses do not confirm the effect, and some theoreticians believe that the effect of spall is much larger than that of linear conversion at the free surface. Experimental laboratory and field data would help to resolve the problem.

In particular a complete accounting of the energy from the source is needed. For example,if in the linear case there is a reduction in amplitude of the fundamental and higher mode surface waves as the shot increases in depth, where does the energy go?

Experimental results are desired for both the linear and non-linear case. However, it is clear that the linear problem must be experimentally solved first, and that the non-linear problem may involve experimentally difficult problems related to medium destruction, yield scaling, and effects of gravity.

Phase I - Outline the experimental plan for Phase II and the experimental techniques illustrated by the acquisition of good data for a few depths. Compare the data with theoretical linear predictions.

Phase II - Obtain results for different depths, horizontally layered structures, and recording distances. Illustrate the effects of non-linearity for a few cases. Outline a series of large scale conventional or nuclear tests to conclusively illustrate the differential effects of different source depths on the relative amplitudes of regional phases.

DARPA 90-048 Title: Applications of Acoustic Charge Transport Technology.

Category: Exploratory Development

Objective: To obtain applications of acoustic charge transport devices.

Description:

General - Acoustic charge transport (ACT) technology has evolved in recent years from a basic research activity to the demonstration of ACT devices which are suitable for application in 6.2 and 6.3 developmental systems. ACT devices are sampled-analog signal processing elements similar in some respects to both charge-coupled devices and surface acoustic wave devices, but without the more serious limitations of either of those older technologies. The devices demonstrated to date or under development include digitally programmable transversal filters, fixed and programmable vector processors, correlators, analog memories, convolvers, and various hybrid structures. These devices all offer extremely wide bandwidths and dynamic range, low noise operation, and the advantages of implementation as monolithic gallium arsenide integrated circuits. Ultimately, the integration of ACT devices with digital processing elements on the same chip will provide extremely powerful and compact processor structures. The application areas for ACT devices include radar and radar electronic countermeasures, electronic support measures, and communications systems. The devices allow for enhanced performance of conventional concepts as well as

making possible new, innovative approaches. Proposals which address the exploitation of ACT technology and devices for military systems are of current interest to DARPA. Any novel application concept will be considered, ranging from insertion into existing systems to entirely new system or sub-system concepts made potentially feasible because of ACT. Novel ACT device/processor architectures and their applications are also of interest, including research in fabrication, production and testing of such devices.

Phase I - A complete description of the proposed application, including identification and justification of required performance characteristics; a complete description of the proposed ACT-based system, including detailed system design and description of operation, predicted performance, including experimental data or analysis as appropriate estimated size and cost, identification of risk areas, specifications for the ACT device, and the underlying tradeoffs, analysis, and options in the design. Results will be documented in a Phase I final report.

Phase II - Demonstrate the proposed system in hardware. Level of demonstration (e. g. laboratory quality, field hardened, fully integrated, etc.) will depend upon the specific program as described in the Phase II proposal.

DARPA 90-049 Title: New Ideas for Unconventional Sensors for Ground Targets and Helicopters.

Category: Exploratory Development

Objective: To obtain new ideas for unconventional sensors for ground targets and helicopters.

Description:

General - Modern military craft generally emphasize a reduction of observable signature (e.g. radar, infrared, visible, etc.) to enhance their battlefield survivability. In addition, modern forces can be expected to take full advantage of cover, concealment, and deception techniques. These factors will combine to reduce the effectiveness of conventional military sensors systems in the detection and classification of targets. In light of such efforts to reduce the effectiveness of conventional systems, DARPA is interested in examining unconventional sensing concepts which, though perhaps less capable in a general sense, possess special characteristics which make them desirable or even required for target detection, tracking, or classification/identification. Such sensors may seek to exploit unusual target signatures which are perhaps unsuppressed, or use a form of energy which is less affected by current conventional techniques. The interest includes specialized sensor concepts that may have been previously discarded but merit reexamination in light of technological advances in signal processing, components, or other underlying technologies. All military target classes are of interest, but with special emphasis on ground based moving and stationary and airborne rotary. Similarly, a wide variety of sensor platforms/configuration are of interest, including ground based, airborne manned and unmanned, unattended, and active or passive, distributed, netted, or point.

Phase I - Complete description of the sensing technology, including underlying theory and experimental data as appropriate; complete discussion of the application of this

technology to the detection, tracking, or classification of targets, including system concepts, hardware configurations, predicted performance, critical supporting technologies, sample designs, estimated sizes and costs, and in particular a detailed description of the various signal processing.

Phase II - Demonstrate a system concept in hardware or the execution of some critical feasibility experiments. Level of demonstration or experiment (e.g. field, laboratory, simulation, etc.) and status of hardware (e.g. laboratory quality, field hardened, etc.) will depend upon the specific program as described in the Phase II proposal.

DARPA 90-050 Title: Thin Films with Electrically Controllable Reflectivity/Transmissivity to Visual or Infrared.

Category: Exploratory Development

Objective: To demonstrate cost effective, low current, durable panels of one square foot or larger with variabilities of at least 0.2, for example, $0.1 < R < 0.3$.

Description:

General - Electrical control of the visual and infrared signatures of aircraft, ships, land vehicles and other systems is sought through the application of lightweight surface modification technologies.

Phase I - Define quantification of physical parameters, producibility/cost analysis, potential applications and fabrication techniques. Small scale experimental results are desired.

Phase II - Fabricate and thoroughly test panels for technical performance and for robustness/potential degradations. Further producibility work is desired.

DARPA 90-051 Title: New Wide-Area Mine Concepts/Munitions.

Category: Exploratory Development

Objective: To demonstrate key components or technologies and the system cost effectiveness quantified for new wide-area mine concepts or munitions.

Description:

General - Anti-armor and anti-helicopter wide-area mines are currently under development. New concepts capable of attacking aircraft, railroads, missiles, or other targets are sought. This includes improved munitions (e.g. warheads) for any of the above applications.

Phase I - Define concept technical parameters and operational concept. Assess the required key technology developments and quantify the cost effectiveness.

Phase II - Fabricate and test the system or key components. Deliver a producibility analysis and fabrication plan.

DARPA 90-052 Title: The Use of Active Materials to Enhance Fragment-Impact Initiation of Explosives.

Category: Exploratory Development

Objective: To demonstrate greatly improved energy efficiencies for the initiation of explosives by fragment-impact relative to those required for shock initiation.

Description:

General - A fragment of a given size can initiate an explosion if it impacts at a high enough speed. Reductions in both the mass and speed required are desired for fragments between 1 and 20 grams through the use of detonation boosting materials or techniques.

Phase I - Perform parameter analysis and verification of the technique , preferably through experiment. Provide warhead concepts and cost estimates and identify potential applications .

Phase II - Perform rigorous testing and quantification of the concept.Producibility planning and cost reduction analysis is desired.

DARPA 90-053 Title: Innovative Application of Binary Phasegrating Optics.

Category: Advanced Development

Objective: To test binary optic elements with appropriate hardware to demonstrate innovative military or space applications. Applications should demonstrate an optics cost or weight savings, a simpler system design (optics, housing, processing, etc.), or an application that could not otherwise be addressed with reasonable (cost, weight, size, etc.) conventional optics.

Description:

General - Binary optics technology has the potential to be used in unique applications that could not otherwise be provided with conventional (grind and polish) optics. This effort should concentrate on demonstrating a unique applications(s) that uses binary optics.

Phase I - Develop a military or space application that would uniquely benefit from binary optic elements and complete the optical design.

Phase II - Fabricate the binary optical element(s) and measure the capability of the elements separately, and with the application hardware.

DARPA 90-054 Title: Innovative Uncooled, Infrared Imaging Techniques That Minimize the Thermal Isolation Effect of the Focal Plane Array.

Category: Exploratory Research

Objective: To develop and demonstrate in the laboratory an innovative technique to thermally isolate an uncooled focal plane array from its surrounding environment. Techniques should use a non-contact read-out of the array, with detectors less than three mils on a side.

Description:

General - The present uncooled, infrared imaging arrays are read-out through interconnects that thermally connect the array to its surrounding environment. This limits the ultimate sensitivity of the array. Ultimately, the limit can be improved by eliminating all thermal contact with its surroundings with innovative read-out techniques, such as optical, magnetic, or electro-magnetic.

Phase I - Perform experiments to demonstrate the thermal isolation capability and technique for a non-contact read-out. Demonstration can be on large area detectors (less than 25 mils per side).

Phase II - Demonstrate the concept using detectors less than 5 mils per side.

DARPA 90-055 Title: Integrated Earphone, Night Vision Goggles and Burst Communications in Helmet for Low Probability of Detection and Intercept for Small Units.

Category: Exploratory Development

Objective: To reach Phase III several copies of a demonstration system must be evaluated by operational users under simulated field conditions and system components (e.g. earphone, night vision goggles and burst communications) must be integrated in a helmet in the demonstration.

Description:

General - Small units (5-15) people may require a system that allows local communications with low probability of interception, enhanced vision in low or night light and long range low probability of intercept communications. To allow hands free operation, the system must be integrated in a helmet. It must also be low cost and easy to maintain and use.

Phase I - Design a detailed system, demonstrate components and provide a helmet mockup.

Phase II - Conduct test in laboratory and field, by potential operational users, of general junctional, integrated units under various conditions of weather, terrain, distance and numbers.

DARPA 90-056 Title: Novel Configurations of Electromagnetic Launchers and Their Associated Power Supplies.

Category: Exploratory Development

Objective: To explore alternative approaches and configurations for electromagnetic launcher and power supply components.

Description:

General - Concepts are sought for novel configurations of electromagnetic launchers and their associated power supplies. The emphasis should be on high electrical efficiency and the absence of high current arcs, current collection brushes and mechanical commutation.

DARPA and the services have been engaged in programs to develop electromagnetic guns and launcher. The SBIR solicitations are regarded as a source of new ideas for future component alternatives.

Phase I - In detail, refine the proposed concepts, execute an optimized design and conduct a performance analysis of proof-of principle hardware. Subcomponent development may be appropriate.

Phase II - Construct and test demonstration hardware.

DARPA 90-057 Title: Innovative and Novel Means of Attacking Tactical Armored Vehicles by Reducing Their Firepower, Mobility, Armor, Crew Capability, etc.

Category: Exploratory Development

Objective: To explore new and innovative means of defeating armored vehicles other than massive disruption of armor.

Description:

General - Concepts are sought for innovative and novel means of attacking tactical armored vehicles by reducing or eliminating effectiveness of firepower, mobility, armor, crew capability and/or rendering them vulnerable to further attack. Concepts for penetration of heavy armor are not of interest in this solicitation. This work will be part of a more general Mission Kill program.

Phase I - Provide a detailed refinement of the proposed concepts and execute an optimized design and perform an analysis of proof-of principle hardware. Subcomponent development may be appropriate.

Phase II - Construct and test demonstration hardware.

DARPA 90-058 Title: Speech Recognition Modules.

Category: Exploratory Development

Objective: To establish a library of reusable modules written in a standard, portable language (preferably Common Lisp or Ada) and embodying state-of-the-art techniques for speech recognition.

Description:

General - This library will serve as a base for composing future applications requiring these components. Individual modules would use standard interfaces, structures, and descriptions. Complicated functions would be composed from other less complex modules.

Considerable progress has been made in the development of speech recognition techniques, but each research group typically writes its own, machine- and site-dependent software. This has the unintended effect of inhibiting technology transfer. A tool kit of component modules with well specified interfaces and structures written in a standard language will significantly alleviate this problem.

Phase I - Develop the framework for constructing a library of speech recognition modules. Carry this framework through the coding and documentation of a few modules.

Phase II - Significantly expand the initial library. Use it to construct a real application. Successfully export the library to at least one other site.

DARPA 90-059 Title: Generic Reasoning Modules.

Category: Exploratory Development

Objective: To establish a prototype library of reusable, generic reasoning modules bases on well researched cognitive (information processing) models written in standard languages (Common lisp or Ada).

Description:

General - This library will serve as a base for rapid prototyping future applications requiring advanced reasoning components. Individual modules should use standard interfaces, structure and descriptions. Complicated functionality would be composed from primitive library modules.

Use of artificial intelligence (AI) techniques within the broader strategic computing community has been spotty because the majority of AI tools and components are vertically integrated (only operate within the framework for which they were designed). A tool kit of AI components with well specified interfaces and module structures written in standard languages will significantly alleviate this problem.

Phase I - Develop the framework for construction of a library of AI modules and components. Carry this framework through the documentation of one or two simple AI modules (such as an inference engine, or unification modules).

Phase II - Extend the initial concept of the AI component library and add several more modules to the library. Exercise the library in the construction of a simple test "application" development.

DARPA 90-060 Title: Knowledge-Based Replanning in Resource Constrained Domains.

Category: Exploratory Development

Objective: To investigate and develop new or extended knowledge-based techniques to facilitate replanning in application domains subject to resource scarcity and uncertainty.

Description:

General - Traditional artificial intelligence planners develop plans assuming complete world knowledge and unlimited resources. Plan generation is distinct from plan execution and replanning implies the generation of a new plan. This effort addresses the development of new techniques that enable a planner to modify its plan during execution due to changing environmental conditions, resource constraints, or uncertainty about the effect of plan actions.

Phase I - Characterize and assess state-of-the-art knowledge-based approaches to replanning. Describe an approach that exploits the strengths of these approaches or incorporates a new approach. Illustrate the technique on a simplified, but scalable problem agreeable to both DARPA and the contractor.

Phase II - Extend the approach in a more complex problem that exhibits characteristics of resource scarcity, uncertainty, and changing environmental conditions. Perform an evaluation that illustrates the value added of the new approach over those assessed in Phase I.

DARPA 90-061 Title: Distributed Artificial Intelligence/Database for Command and Control.

Category: Basic Research

Objective: To explore a layered approach to intelligent command and control system implementation.

Description:

General - Significant advances have been made in the past several years in the area of distributed systems design. However, most work has assumed the availability of communication services on demand. Command and control systems that must operate in areas with limited and unreliable communication may be faced with decision making in absence of adequate communications. In such a system, it will be impossible to maintain database consistency. In addition, very limited communications will make state update and database reconciliation difficult or impossible.

By partitioning the problem into three layers: decision making, distributed state, and communication infrastructure, each layer may be implemented and evaluated in isolation and then merged to provide a distributed robust system.

This SBIR requests development of layer interface specification between the upper two layers of this system. It specifically will include services provided and characteristics of those interfaces in periods of stress such as network partition. (Note: modal implementation is specifically not desirable. Rather, a continual degradation from high communication availability to partition is desired.)

Phase I - Develop the specification of inter-layer interfaces. Some exploratory implementation of components within the two layers in question is desirable.

Phase II - Prototype implementation of layers for a trial system, with analysis of performance under a variety of traffic and partition scenarios.

SUBMITTING PROPOSALS ON DEFENSE NUCLEAR AGENCY TOPICS

The Defense Nuclear Agency is seeking Small Business firms with a strong research and development capability and experience in nuclear weapons effects and nuclear weapons phenomenology areas. Proposals should be submitted to:

Headquarters
Defense Nuclear Agency
Attn: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

Questions concerning the research topics should be submitted to:

James Gerding
(202) 325-1217

The research categories proposed for study under this program are:

DNA90-001 TITLE: Nuclear Weapon Effects Calculation
DNA90-002 TITLE: Response of Materials to Nuclear Weapon Effects
DNA90-003 TITLE: Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications
DNA90-004 TITLE: Nuclear Weapon Effects Simulation
DNA90-005 TITLE: Instrumentation
DNA90-006 TITLE: Directed Energy Effects
DNA90-007 TITLE: Nuclear Hardening and Survivability
DNA90-008 TITLE: Security of Nuclear Weapons
DNA90-009 TITLE: Theater Nuclear Forces (TNF) Survivability
DNA90-010 TITLE: Operational Planning and Targeting
DNA90-011 TITLE: Underground Nuclear Testing
DNA90-012 TITLE: Verification Technology Development
DNA90-013 TITLE: Nuclear Weapon Effects on Propagation
DNA90-014 TITLE: Tactical Application of Pulsed Power Technology
DNA90-015 TITLE: Advances in Pulsed Power Technology
DNA90-016 TITLE: X-Ray Nuclear Weapons Effects Source Development
DNA90-017 TITLE: Response of In-situ Rocks to Nuclear Weapons Effects

Defense Nuclear Agency

FY 1990 Topic Descriptions

DNA 90-001 TITLE: Nuclear Weapon Effects Calculation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the accuracy and/or runtime of nuclear weapon effects calculations.

DESCRIPTION:

General - The accurate calculation of nuclear weapon effects is a major concern of DNA. Areas of interest include more accurate calculations, faster running calculations, microcomputer versions to enable use by a wide audience, and new and improved ways to enable users to calculate, estimate, and appreciate nuclear weapon effects. Nuclear weapon effects include air blast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and X-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; dust cloud formation; and the effects of these on personnel. Also of interest is calculating the response of materials and structures to these effects.

Phase I - Demonstrate the feasibility of the proposed methodology to calculate nuclear weapon effects.

Phase II - Fully develop the proposed methodology and, if appropriate, incorporate into appropriate codes.

DNA 90-002 TITLE: Response of Materials to Nuclear Weapon Effects

CATEGORY: Exploratory Development

OBJECTIVE: Measure the response of new and existing materials to nuclear weapon effects and develop methods to improve the survivability of these materials.

DESCRIPTION:

General - Of interest to DNA is the response of materials, structures, and systems to nuclear weapons effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as a structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. The response of underground structures such as missile silos, command and control facilities and communications facilities are especially important. Concepts and techniques which will improve the survivability (decrease the response) of these types of systems to nuclear weapons effects are required.

Phase I - Develop the testing plan and conduct feasibility studies on the material.

Phase II - Test the material and develop any conclusions from the test results.

DNA 90-003 TITLE: Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications

CATEGORY: Exploratory Development

OBJECTIVE: Explore the effects of nuclear weapons and neutral particle beams on electronics and communications.

DESCRIPTION:

General - The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation and neutral particle beams on electronics, electronic systems, opto-electrical devices and sensors in the phenomenology areas of a) Transient Radiation Effects on Electronics (TREE); b) Electromagnetic Pulse (EMP); and c) System Generated EMP (SGEMP) are of interest to DNA. Particular areas of concern include; methods by which designers of space, strategic and tactical systems can assess their susceptibility to TREE, EMP, and SGEMP; hardening technology to reduce the susceptibilities of electronic systems and devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects and neutral particle beam are required.

Phase I - Conduct initial feasibility studies to demonstrate the viability of the proposed approach.

Phase II - Continue the investigate began in Phase I to fully develop the proposed approach.

DNA 90-004 TITLE: Nuclear Weapon Effects Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation.

DESCRIPTION:

General - International treaties preclude the testing of nuclear weapons in the atmosphere and hence it is not possible to test military systems in an actual nuclear environment. To compensate for this, other testing

methods are used to simulate the effects of the nuclear detonation. Nuclear weapons effects simulation includes: high explosive testing to simulate the mechanical effects, EMP simulation, thermal radiation simulation, and nuclear radiation simulation. Simulation techniques should be as realistic as possible, relatively inexpensive to perform and comparable to the threat environment. One should become familiar with existing programs to see how they can be improved and/or combined in order to make the total process more realistic and more representative of the actual nuclear weapons effect being studied. Both destructive and non-destructive test methods are desired.

Phase I - Demonstrate the feasibility of the proposed simulation technique.

Phase II - Develop the simulation technique to include technical and cost comparisons with existing techniques.

DNA 90-005 TITLE: Instrumentation

CATEGORY: Exploratory Development

OBJECTIVE: Develop new instrumentation or make improvements to existing instrument used in nuclear weapon effect simulators and in underground nuclear testing.

DESCRIPTION:

General - Instrumentation is used for measuring nuclear weapons effects, phenomenology parameters and the response of test items exposed to real or simulated nuclear weapon effects produced by underground testing or in an above ground simulator or in a water shock test. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in underground nuclear tests, high explosive tests, or tests involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should survive long enough to record the needed data and include recording, data transmission and data analysis capabilities. Innovative concepts are required for new instrumentation such as gauges that will survive in environments so severe that existing gauges fail or perform inadequately. Calibration facilities are needed to calibrate existing gauges in every environment where the gauge could likely be used.

Phase I - Demonstrate the feasibility of the proposed instrumentation.

Phase II - Demonstrate the instrumentation in its working environment. This will involve coordination with DNA to schedule testing in a simulator or underground nuclear test.

DNA 90-006 TITLE: Directed Energy Effects

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the effects of directed energy and identify materials which may survive effects of directed energy weapons.

DESCRIPTION:

General - The effects of directed energy sources on materials, structures and systems are of interest to DNA. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and mechanisms by which the directed energy sources actually interact with target materials/structures.

Phase I - Demonstrate the feasibility of the proposed investigation.

Phase II - Characterize the effects of directed energy on materials, structures, etc.

DNA 90-007 TITLE: Nuclear Hardening and Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques to improve the nuclear hardening and survivability of defense systems.

DESCRIPTION:

General - Techniques for nuclear hardening and survivability of systems/structures against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal and nuclear radiation in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required. Systems include planned and operational strategic and tactical ground mobile systems, missiles, aircraft, spacecraft and their subsystems and components.

Phase I - Demonstrate the feasibility and usefulness of the proposed technique.

Phase II - Fully develop the proposed technique and characterize it usefulness in both technical and cost terms.

DNA 90-008 TITLE: Security of Nuclear Weapons

CATEGORY: Exploratory Development

OBJECTIVE: Improve the security of US nuclear weapons against all types of threats.

DESCRIPTION:

General - Measures to improve the security of nuclear weapons against all possible threats are required. These methods are expected to include weapon storage facility designs, transportation facility designs, new security senor and sensor system development, methods to improve the secure handling of nuclear weapons, and methods to improve the effectiveness and efficiency of nuclear weapon security operations. Proposals should describe how they will improve protection against known and predicted threats and should emphasize weapon concealment where appropriate.

Phase I - Demonstrate the feasibility and potential usefulness of the proposed security measures.

Phase II - Fully develop the proposed security measures so they can be compared to existing techniques.

DNA 90-009 TITLE: Theater Nuclear Forces (TNF) Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Improve the survivability of US nuclear weapons.

DESCRIPTION:

General - The prelaunch survivability (PLS) of the TNF is of vital concern. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats to the TNF include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, theater nuclear force movements, and operational survivability of theater nuclear systems (aircraft, missiles, and cannon systems). Survivability concepts are warranted for the period of the 1990's and beyond. Concepts should employ innovative ideas and make use of new and emerging technologies.

Phase I - Demonstrate the feasibility and potential usefulness of the proposed survivability measures.

Phase II - Fully develop the proposed survivability measures so they can be compared to existing techniques.

DNA 90-010 TITLE: Operational Planning and Targeting

CATEGORY: Exploratory Development

OBJECTIVE: Improve the ability of US nuclear commanders to plan for nuclear engagements and target their nuclear weapons.

DESCRIPTION:

General - The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes.

Phase I - Develop the proposed technique in sufficient detail to demonstrate its feasibility.

Phase II - Continue the development of the proposed technique to the point it can be incorporated into existing planning/targeting methodologies.

DNA 90-011 TITLE: Underground Nuclear Testing

CATEGORY: Exploratory Development

OBJECTIVE: Improve the design, execution, and evaluation of underground nuclear tests.

DESCRIPTION:

General - Underground nuclear effects tests are used in situations for which no suitable above ground simulator exists. Areas of interest include improvements in the design and execution of tests (horizontal/vertical line of sight and cavity), the design of new experiments which extend the capability of current test beds, and innovative test concepts to meet future needs. To improve our understanding of the results improvements to the mathematical methods used to perform various calculations within the test design and analysis program are needed. New methods of characterizing existing materials which are used in critical portions of the test bed (such as the A box) and new materials for such applications, new approaches to the geological problems encountered in the construction of the test beds, and new methods for all test activities (excavation, fabrication, assembly in the tunnel complex, recording data, transmission of data) are also of interest to DNA.

Phase I - Demonstrate the feasibility of the proposed test/experiment improvement. This will be done using laboratory and/or above ground testing.

Phase II - Demonstrate the proposed techniques with underground nuclear testing and/or above ground testing.

DNA 90-012 TITLE: Verification Technology Development

CATEGORY: Advanced Development

OBJECTIVE: Improve the US and Soviet capabilities to verify existing and proposed nuclear treaties.

DESCRIPTION:

General - New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations. The problem will basically involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor.

Phase I - Demonstrate the feasibility of the proposed technology.

Phase II - Develop a proof of design to demonstrate the proposed technology.

DNA 90-013 TITLE: Nuclear Weapon Effects on Propagation

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the effects of nuclear weapon explosions on electromagnetic propagation with specific interest in communications, radar, and sensors.

DESCRIPTION:

General - The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of electromagnetic radiation with a nuclear perturbed atmosphere. Part of DNA's mission is to predict effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF communications, HF/VHF communications, radar systems and sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapon energy to the atmosphere; physical and chemical phenomena arising from nuclear detonations; natural analogs of nuclear environments and processes; predictions of the performance of communications, optical, infrared, ultraviolet, radar and directed energy systems in the nuclear environment; techniques to mitigate nuclear effects on DoD systems mentioned above; unique instrumentation to measure or simulate nuclear

effects; and experiments to study naturally disturbed atmosphere as it would relate to nuclear environments.

Pnase I - Demonstrate the feasibility of the proposed investigation to better the understanding, mitigating, measuring, or simulation of the effects.

Phase II - Continue the investigation to the development of a product that can be incorporated into the existing technology base.

DNA 90-014 TITLE: Tactical Application of Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Development of new applications of existing pulse power technology.

DESCRIPTION:

General - Recent advances in energy storage and switching now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Concepts proposed should be highly innovative and make full use of the emerging pulse power technology.

Phase I - Demonstrate the feasibility of the proposed pulsed power application.

Phase II - Continue the development of the concept to an engineering model and conduct tests of the effectiveness of the idea.

DNA 90-015 TITLE: Advances in Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Dramatic Improvements in energy storage, switching, and power conditioning state of technology

DESCRIPTION:

General - Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliaoility, and performance. Innovative approaches for component or subsystem development are sought to meet the needs of radiation simulators and tactical applications requiring operation at kilovolts to megavolts, kiloamperes to mega amperes, and repetition rates from single pulse to 10 kilohertz.

Phase I - Demonstrate the feasibility of the proposed concept.

Phase II - Develop, test, and evaluate proof-of-principle hardware.

DNA 90-016 TITLE: X-Ray Nuclear Weapons Effects Source Development

CATEGORY: Exploratory Development

OBJECTIVE: Innovative concepts for the production of x-ray radiation used in nuclear weapon effects testing.

DESCRIPTION:

General - Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts fro producing soft x-rays (1-5 kev), warm x-rays (5-15 kev), and hot x-rays (>15kev). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

Phase I - Demonstrate the feasibility of the proposed concept.

Phase II - Develop, test, and evaluate proof-of-principle x-ray source capability.

DNA 90-017 TITLE: Response of Insitu Rocks to Nuclear Weapons Effects

CATEGORY: Exploratory Development

OBJECTIVE: Development of methods to measure material properties of insitu rock and the incorporation of this data in ground shock/ground motion models.

DESCRIPTION:

General - Present techniques used to define material properties of insitu rocks generally consist of testing high quality, intact core samples in a laboratory and then degrading those laboratory derived properties by a measure of rock quality (i.e. RQD) to better represent the insitu material. Techniques are needed that more directly assess or replicate the response of insitu rocks to ground shock; including field observations and measurements, laboratory testing, and material modeling of insitu quality rocks.

Phase I - Conduct feasibility studies to demonstrate the viability of the proposed research.

Phase II - Implement the proposed technique(s) in the field, laboratory, explosive tests, and/or in first principle code calculations.

INDEX
STRATEGIC DEFENSE INITIATIVE ORGANIZATION
FY 1990 Small Business Innovation Research Topics

SDIO 90-001 Directed Energy Concepts
SDIO 90-002 Kinetic Energy Weapons
SDIO 90-003 Sensors
SDIO 90-004 Nuclear Space Power
SDIO 90-005 Non-nuclear Space Power and Power Conditioning
SDIO 90-006 Propulsion and Logistics
SDIO 90-007 Thermal Management
SDIO 90-008 Survivability
SDIO 90-009 Lethality
SDIO 90-010 Computer Architecture, Algorithms, and Language
SDIO 90-011 Optical Computing and Optical Signal Processing
SDIO 90-012 Space Structures
SDIO 90-013 Structural Materials
SDIO 90-014 Electronic Materials
SDIO 90-015 Superconductivity

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Phase I proposals (five copies of the full proposal, PLUS three copies of Appendices A and B only) should be sent by US mail addressed to :

Strategic Defense Initiative Organization
ATTN: T/IS/SBIR
The Pentagon
Room 1E118
Washington, D.C. 20301-7100

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient. US Postal Service Express Mail is the only express service with unconditional access.

Receipt of proposals will be acknowledged only if the proposal includes a self addressed stamped envelope and a form (like Reference B) that needs only a signature by SDIO.

SDI is a DoD project to explore the feasibility of finding and disabling a ballistic missile in flight. Its SBIR seeks projects that fit in the category of exploratory developments.

Topics on the following pages are broad statements of SDI interests. SDI seeks innovative concepts on the cutting edge of technology that might enable a defense against a missile in flight. SDI seeks concepts for its general technological need of lighter, faster, smarter, more reliable components. The proposer need not know details of possible SDI systems.

SDI SBIR seeks a demonstrable product that makes a leap in capability-components that might fit into a larger design. SDI seeks to invest seed-capital, to supplement private capital, in a product with a future market potential and a measurable SDI benefit. New algorithms and computer codes qualify if the Phase 2 product would be used extensively outside the firm. SDI SBIR will not fund ordinary research or studies (including technical assistance, surveys and assessments, data collection, or systems studies). Nor will it further develop already mature concepts.

Phase I will show the concept feasibility and the merit of a further investment in a Phase II that will demonstrate a prototype or at least show proof-of-principle. The concept development must be within the scale appropriate for a small firm.

SDI will invest in small firms where the Principal Investigator is primarily employed. Tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any request for waiver must be stated explicitly with a justification showing a compelling national need. SDI expects to grant no waivers.

SDIO 90-001. Title: Directed Energy Concepts

DESCRIPTION: Innovative research in the generation and propagation of directed energy plays an important role in the determination of effective ballistic missile defense systems. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, and free electron lasers. Hybrid approaches are also of interest. Interests in the concepts include the full range of embodiments, i.e., low mass spaced-based, ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, optics, and countermeasures. Approaches are needed that either extend or improve the present concepts.

SDIO 90-002. Title: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons systems are an integral part of candidate strategic defense systems. System candidates presently include ground-based exoatmospheric re-entry vehicle interceptors (ERIS) and space-based interceptors (SBI), high endoatmospheric defense interceptors (HEDI) and hypervelocity guns (HVG) [electromagnetic (EM), electrothermal (ET), and hybrid systems].

Approaches are sought which extend, facilitate, or reduce the cost of the concepts. Elements of the systems include the space-based carrier vehicles (CV) or ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: SBI acquisition of booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C. G. Control algorithms, fast frame and U.V. seekers, acquisition and track; ERIS target discrimination, seeker operational environments, lethality/miss distance; HEDI aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermo-structural integrity, non nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control, and projectile launch survivability; and, common among all systems, reliability, producibility, maintainability, and low cost/low mass.

SDIO 90-003. Title: Sensors

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), superconducting focal plane detector arrays (for both the IR and sub-mm spectral

regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based SDI application (uv-sub-mm wave), new optics and optical mateials. Entirely new approaches as well as approaches that expand and improve present concepts are sought.

SDIO 90-004. Title: Nuclear Space Power

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include: thermionic, and Rankine cycle. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 89-007, innovative thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO 90-005. Title: Non-nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO 89-004, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO 90-006. Title: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operations of the spacecraft have been major factors in determining the life cycle costs of space-based assets. This burden on the deployment of strategic defense systems has been identified a major cost driver. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluents, and sensors and controls for autonomous operation.

Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of the SP-100 reference mission and solar power demonstration missions incorporating arcjet thrusters, attention is being directed at 30 kw arcjet thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid) in 30-1000 g range.

SDIO 90-007. Title: Thermal Management

DESCRIPTION: The high power levels for space stations will need effective heat dissipation. Expected power levels required for SDI space platforms will stress state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems and space platform payloads.

Some space platforms will require long term (years) storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under conditions of zero -g, microgravity and maneuvering loads. Innovations are sought for concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

SDIO 90-008. Title: Survivability

DESCRIPTION: The various components of a space-based missile defense system must survive both attack and the environment in space. Products, processes, and techniques for active and passive hardening against directed and kinetic energy devices, and natural threats such as UV/radiation damage, thermal cycling, and atomic oxygen degradation are sought. Components to be made survivable include sensors, battle management systems, power systems, and directed/kinetic energy weapon configurations. Survivable sub-components include large and small optics, electronics, structures for support and fuel containment, and specific materials critical for shielding, maneuvering, propulsion, and targeting. In addition to shielding, other well designed and innovative countermeasures are encouraged. Specific examples of areas to be addressed include thermo-mechanical shock hardening, heat dissipation techniques, protective coatings, baffling techniques, materials conditioning, orientation or deployment strategies, insulation methods, threat radiation activated optical limiters and switches, and the non-linear optical materials/techniques involved in their fabrication. Of particular interest is hardening and survivability against x-ray lasers and bright short wavelength ground-based lasers.

SDIO 90-009. Title: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. Innovative ideas or concepts for measurement of radiation or particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off. New concepts to produce higher probability of kill-given-a-hit.

SDIO 90-010. Title: Computer Architecture, Algorithms, and Language

DESCRIPTION: Strategic defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.

- Language design to develop code optimized for highly parallel processed architectures.

- Testing techniques that will provide a high level of confidence in the successful operation of extremely large software systems.

- Computer network and communications security. R&D for trusted computer systems in accordance with DOD 5200.28.STD; integration of COMPUSEC with COMSEC (DOD 5200.5).

- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.

- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for desision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

SDIO 90-011. Title: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

SDIO 90-012. Title: Space Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vessels. All of these present individual

challenges in terms of stiffness, impact resistance, high temperature capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Techniques for both passive and active control of the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression. There is also a need for novel, lightweight large optical structures that are compatible with the space environment, and for innovative optics/information processing techniques which maximize the imaging performance that can be achieved with imperfect, temporarily unstable structures.

SDIO 90-013. Title: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 89-012 will depend on major improvements in material properties and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Specific goals requiring advanced techniques and processes include imparting oxidation resistance and damage tolerance to composites, enhancing the static and dynamic toughness of ceramic composites, and creating fatigue-resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to minimize fiber-matrix reactions in composites exposed to high operating temperatures. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, low density alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. Proposals involving these as well as other space structure and material-related research and innovative technology topics are sought. Techniques are needed to monitor structures and materials in space.

SDIO 90-014. Title: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/super lattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many SDI electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

SDIO 90-015. Title: Superconductive Materials

DESCRIPTION: Interest in these high temperature superconducting materials includes material characterization, stabilization of new high-Tc phases, and development of novel fabrication techniques for both the thin-film and bulk materials. Areas of application are also being stressed and include: novel, low-power infrared (IR) staring-array sensors, particularly those with monolithic focal plane pixel arrays and read-out electronics; high-Tc superconductive materials for various electronic applications, e.g., Josephson junctions and SIS mixers; bulk materials for power transmission, conditioning, and storage; compact, high-gradient accelerator cavities for novel particle beam and free-electron laser design concepts; magnetic shielding of critical components from EMP effects. Note that in the applications area interest is not limited to only this new class of high-Tc superconductors but attention is also given to the more mature low-Tc materials as well, e.g., Niobium and Niobium Nitride. Of particular interest this year is low-temperature superconductive electronics for high-speed processing and logic circuitry.

Reference A

PRIOR YEARS RESULTS OF DOD SBIR PROGRAM

FY 83 - FY 88	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	1193	9157	1092	356
Navy	1119	7902	1035	324
Air Force	1283	9408	1543	451
DARPA	135	1492	202	42
DNA	48	821	128	22
* SDIO	59	2369	540	108
	3,837	31,149	4,540	1,303**

FY 89	Number of Topics	Proposals Received	Number Selected For Phase I Negotiations
Army	86	998	100
Navy	213	2232	281
Air Force	257	3392	300
DARPA	47	599	100
DNA	14	213	19
SDIO	15	857	158
	632	8,291	958***

* SDIO began participation in FY 1985.
** Awards made as of July 1989.
*** Selections as of July 1989.

Reference B

TO: _____
(Fill in firm's name and mailing address)

SUBJECT: SBIR Solicitation No. 90.1
Topic No._____
(Fill in topic no.)

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

_____
(Fill in name of organization to which you will send your proposal.)

_____ _____
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Reference C

TO: SBIR Participants

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For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur in December.

DTIC authorization to provide this service expires January 5, 1990, the DoD SBIR Program Solicitation closing date.

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1_____	6_____	**PLEASE TYPE OR PRINT IN THE ORDER TOPICS APPEAR IN THE SOLICITATION**	11_____	16_____
2_____	7_____		12_____	17_____
3_____	8_____		13_____	18_____
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5_____	10_____		15_____	20_____

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in section 2.2 of the DoD Program Solicitation No. 90.1

This is our first request during the current solicitation: yes__no__.

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Signature of Requester

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