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The Department of Defense

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Advanced Research
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Strategic Defense
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PROGRAM SOLICITATION 92.1
CLOSING DATE: 10 JANUARY 1992

91-15776



**FY 1992
SMALL BUSINESS
INNOVATION
RESEARCH (SBIR)
PROGRAM**

PROGRAM SOLICITATION

Number 92.1

Small Business
Innovation
Research Program

U.S. Department of Defense

SBIR Program Office

Washington, DC 20301

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The 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.

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 measure of Phase

I success includes evaluations of the extent to 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 the 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 of 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
(703) 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 solicitation.

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, Alexandria, Virginia 22304-6415; telephone toll free (800) 368-5211 commercial for Virginia, Alaska and Hawaii (703) 274-6902.

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% owned, or in the case of a publicly owned business, at least 51% 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 (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual 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 Minority 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 subcontinent-Asian Americans.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% 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 PROPOSAL 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 an innovative 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 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 7.1) and also the free assistance available at the DCAS near you (Section 7.3) and your State organization listed in Reference D.
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.

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 or 12 pitch 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 and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. **Cover Sheet.** Complete RED COPY of Appendix A, photocopy the completed form and use a copy as Page 1 of each additional copy of your proposal.

b. **Project Summary.** Complete RED COPY of Appendix B, photocopy the completed form and use a copy as Page 2 of each additional copy 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 description 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 instrumentation 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. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

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 Phase I 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 received.
- (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 SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current or pending support for proposed work."

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 Red Cover Sheet (Appendix A) and a Red Project Summary Sheet (Appendix B) of this solicitation. Copies of Appendixes along with 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 successful 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 will 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 receive 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 10, 1992. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 1200 Phase I awards during Fiscal Year 1991.*

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 on 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 400 Phase II awards during Fiscal Year 1992.*

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.

c. **Project Continuity.** 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 effort 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.

d. **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 completion of negotiations between the DoD and the successful Phase I offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 85% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or 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 except for Appendixes A and B. 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 or 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 which appears on the title page (Appendix A) of the proposal is completed:

"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 information 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 Information 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. **Examination 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 Convenience.** 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

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Appendix D.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY).

6.1 Address

Each proposal or modification package 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.

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 of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 10, 1992. Any proposal received at the office designated in the solicitation 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 26, 1991 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 stamped envelope and a copy of the notification form (Reference A) 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 will 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 requesters 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)
(703) 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 B at the back of this solicitation or telephone DTIC 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. *To assure the fastest possible mail service, give DTIC your Federal Express Account Number to which mailing charges will be made for overnight delivery.*

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
P.O. 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 DOD 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 Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements 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 C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance
- Matching funds to SBIR recipients
- Assistance in obtaining Phase III funding

Reference D contains a listing of States with established SBIR organizations known to the DOD SBIR Coordinator.

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 special instructions for contacting and submitting proposals to each DoD Component.

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

APPENDIX A

PROPOSAL COVER SHEET

Submit a hard copy of this original form with proposal to the
in all appropriate spaces may contain your proposal to the agency.

PROPOSAL NUMBER:

PROPOSAL TITLE:

COMPANY:

MAIL ADDRESS:

CITY:

STATE:

ZIP:

PROPOSED COST:

PHASE I OR II
PROPOSAL

PROPOSED DURATION:
IN MONTHS

PROPOSER'S CERTIFICATION

YES

NO

Are you a small business as described in paragraph 2.2.7?

☐☐

Are you a minority or small disadvantaged business as defined in paragraph 2.2.7?
(Collected for statistical purposes only)

☐☐

Are you a woman owned small business as described in paragraph 2.2.7?
(Collected for statistical purposes only)

☐☐

Has this proposal been submitted to another DoD government agency/office or DoD component or other
DoD activity? If yes, list the name(s) of the agency, DoD component or other DoD office in the spaces on
the left below. If it has been submitted to another DoD activity list the topic numbers in the spaces to the
right below.

☐☐

Number of employees including all affiliates (average for preceding 12 months)

PROJECT MANAGER/PRINCIPAL INVESTIGATOR

CORPORATE OFFICIAL (BUSINESS)

NAME

NAME

TITLE

TITLE

TELEPHONE:

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 on the
line below.

PROPRIETARY INFORMATION:

DISCLOSURE PERMISSION STATEMENTS. All data on Appendix A are releasable. All data on Appendix B, of an awarded contract, are
also releasable.

Best Available Copy

SIGNATURE OF PRINCIPAL INVESTIGATOR

DATE

SIGNATURE OF CORPORATE BUSINESS OFFICIAL

DATE

INSTRUCTIONS FOR COMPLETING ~~APPENDIX A~~ AND APPENDIX B

General

DOD Agencies employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typstyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT SIX).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-0902 (Commercial)

Best Available Copy

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

APPENDIX B

This summary is to be used by the Small Business Administration (SBA) to determine if your project is eligible for funding under the SBIR program. It is not to be used for other purposes.

1. Project Title

2. Project Description

3. Project Objectives

4. Project Results

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

6. Anticipated Benefits/Potential Commercial Applications of the Research or Development

Best Available Copy

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

8. Key Words

9. Key Words

10. Key Words

11. Key Words

12. Key Words

13. Key Words

14. Key Words

INSTRUCTIONS FOR COMPLETING APPENDIX A AND APPENDIX B

General:

FBI Agencies employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typewriters:

- IBM Selectric 10 or 12 pitch
- IBM Selectric 14 10 pitch
- IBM 71
- Other Selectric 10 or 12 pitch
- IBM 14 10 or 12 pitch
- IBM 14 10 pitch
- Other Type Plate 10 or 12 pitch
- Other Type Plate 14 10 pitch

When entering numerical values, do not type the numerical character (i.e. in "Proposed Duration" type 6 NOT SIX).

When typing address information use the two alpha characters used by the Post Office for the state, DO NOT type THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and **SUBMIT THE ORIGINAL RED FORMS** found in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (3) complete copies must be submitted (see Submission).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be obtained from your State SBIR Organization (Reference D) or:

Science Technical Information Center
ACRIS: DTIC/NSBP
Building 5, Cannon Station
Arlington, VA 22204-6145
Phone: 848-5211 (Toll Free)
Or: 703-274-6902 (Commercial)

Best Available Copy

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
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
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 transfers (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.

TECHNICAL TOPICS

Each DOD component topic section contains special instructions for preparing and submitting proposals to organizations within that component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

<u>COMPONENT</u>	<u>PAGES</u>
NAVY	NAVY 1-51
AIR FORCE	AF 1-91
DEFENSE ADVANCE RESEARCH PROJECTS AGENCY	DARPA 1-58
DEFENSE NUCLEAR AGENCY	DNA 1-12
STRATEGIC DEFENSE INITIATIVE ORGANIZATION	SDIO 1-9

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
800 North Quincy Street, BCT #1, Room 922
Arlington, VA 22217-5000
(703) 696-4286

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 represent a portion of the problems encountered by the Navy in order to fulfill its mission.

The Navy has identified 106 technical topics in this DOD Solicitation to which small R&D businesses may respond. This is a reduction in the amount of topics normally identified by the Navy in the typical October DOD SBIR solicitation. The reduction of the amount of topics is a reflection of the funding reduction the Navy has incurred in FY 1991 and expects similar funding constraints in FY 1992 and beyond. While the reduction in funds will not impact the Phase I awards that result from the topics listed in this solicitation, it makes it extremely important that Phase I award recipients influence the end uses of the technology since Phase II SBIR funds will be limited and thus highly competitive.

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 awards funded under any topic and only those proposals 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. N92-001 through N92-011

Administrative
SBIR Contact

Mail/Handcarry Address:

Office of Naval Technology
Attn: ONT Code 20T1, Room 502
SBIR Program, Topic No. N91-_____
800 N. Quincy Street, BCT #1
Arlington, VA 22217-5000

Mr. Doug Harry
(703) 696-4453

Topic Nos. N92-012 through N92-017

Mail Address:

Commanding Officer
MCRDAC, SBIR Program, Topic No. N91-_____
Amphibious Warfare Technology Directorate
Quantico, VA 22134-5080

Mr. Robert Stith
(703) 640-2761

Handcarry Address:

MCRDAC, SBIR Program, Topic No. N91-_____
Amphibious Warfare Technology Directorate
Lucas Hall, Room 9
Marine Corps Base
Quantico, VA 22134-5080

Topic Nos. N92-018 through N92-037

Mail Address:

Commander
Space and Naval Warfare Systems Command
Attn: SPAWAR OOK, SBIR Program, Topic No. N91-_____
Washington, DC 20363-5100

Ms. Betty Geesey
(703) 602-6092

Handcarry Address:

Space and Naval Warfare Systems Command
National Center #1, Room 1E58
2511 Jefferson Davis Highway
Attn: SPAWAR OOK, SBIR Program, Topic No. N91-_____
Arlington, VA 22202

Topic Nos. N92-038 through N92-068

Administrative
SBIR Contact

Mail Address:

Commander
Naval Sea Systems Command
Attn: Code 06HE, SBIR Program, Topic No. N91 ____
Washington, DC 20362-5101

Mr. William Degentesh
(703) 602-3005

Handcarry Address:

Commander
Naval Sea Systems Command
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Attn: Code 06HE, SBIR Program, Topic No. N91- ____
Arlington, VA 22202

Topic Nos. N92-069 through N92-085

Mail Address:

Commander
Naval Surface Warfare Center
White Oak Laboratory
Attn: Code R-05, SBIR Program, Topic No. N91- ____
Silver Spring, MD 20903-5000

Mr. Donald Wilson
(301) 394-1279

Handcarry Address:

Commander
Naval Surface Warfare Center
White Oak Laboratory
Bldg. #1, Reception Room
Attn: Code R-05, SBIR Program, Topic No. N91- ____
Silver Spring, MD 20910

Topic Nos. N92-086 through N92-089

Mail/Handcarry Address:

Commercial Acquisition Department
Naval Underwater Systems Center
Attn: Code 0911, SBIR Program, Topic No. N91- ____
Shaws Cove Office Park, Bldg. #4
Howard Street
New London, CT 06320-5594

Mr. Jack Griffin
(203) 440-4116

Topic No. N92-090 through N92-094

Administrative
SBIR Contact

Mail/Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Bldg. 560
Attn: Code L03B, SBIR Program, Topic No. N91-____
Port Hueneme, CA 93043-5003

Ms. Mary Lingua
(805) 982-1082

Topic Nos. N92-095 and N92-096

Mail Address:

Commanding Officer
Naval Weapons Support Center
Attn: Code 052G, SBIR Program, Topic No. N91-____
Crane, IN 47522-5060

Mr. James Linn
(812) 854-1352

Handcarry Address:

Commanding Officer
Naval Weapons Support Center
Bldg. 1
Attn: Code 052G, SBIR Program, Topic No. N91-____
Crane, IN 47522-5060

Topic No. N92-097

Mail Address:

Commander
Naval Ocean Systems Center
Attn: Code 0144, SBIR Program, Topic No. N91-____
San Diego, CA 92152-5000

Dr. Richard November
(619) 553-2103

Handcarry Address:

Commander
Naval Ocean Systems Center
Attn: Code 232B, Bldg. 88, SBIR Program, No. N91-____
San Diego, CA 92152-5000

Topic Nos. N92-098 through N92-100

Administrative
SBIR Contact

Mail Address:

Commander
David Taylor Research Center
Attn: Code 0112, SBIR Program, Topic No.91-____
Bethesda, MD 20084-5000

Mr. Frank Halsall
(301) 227-1094

Handcarry Address:

Commander
David Taylor Research Center
Attn: Code 0112, SBIR Program, Topic No. N91-____
Bldg. #1, Room 211
Bethesda, MD 20084-5000

Topic Nos. N92-101 through N92-106

Mail Address:

Commander
Naval Sea Systems Command
Attn: Code 06HE, SBIR Program, Topic No. N91_____
Washington, DC 20362-5101

Mr. William Degentesh
(703) 602-3005

Handcarry Address:

Commander
Naval Sea Systems Command
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Attn: Code 06HE, SBIR Program, Topic No. N91-____
Arlington, VA 22202

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N92-106 Modeling Naval Ship Construction Delays

DEPARTMENT OF THE NAVY

FY 1992 TOPIC DESCRIPTIONS

OFFICE OF NAVAL TECHNOLOGY

N92-001 TITLE: Multi-Spectral Sensor Fusion System for Identification of Relocatable Targets

CATEGORY: Exploratory Development

OBJECTIVE: To devise a method for fusing multi-spectral/multi-sensor data to obtain identification and localization information on relocatable targets.

DESCRIPTION: A proof of concept is sought that demonstrates new methodology for intelligent integration of information from various sensors for cruise missile missions. A hierarchical and adaptive control scheme of multisensor integration systems is desired for improvement of image understanding, correspondence problem, and sensory data fusion. The potential advantages in integrating and/or fusing information from multiple sensors are that the information concerning features that are impossible to perceive with individual sensors can be obtained more accurately, in less time, and at a lesser cost. Data fusion using object-oriented data structure may be achieved by considering simultaneous multiple images of the same scene as well as other intelligent information. Also data on the road nets and local terrain can be stored by giving to limit search area possible off-road locations for relocatable targets. A knowledge-based system can be constructed which would consider the particular description of each primal structure before deciding how to incorporate it into the final representation of the scene. Heuristics would be based on tentative classifications of structures or on domain-independent knowledge such as those used for single-band imagery.

Phase I: Determine the feasibility of a new methodology to integrate information obtained from various sensors.

Phase II: Based on results of Phase I study, develop proof of concept designs and experimental verification of the proposed methodology.

Phase III: Transition opportunities to the ONT precision strike initiative, and LRCSW exist.

N92-002 TITLE: Virtual Environment Control for Advanced Undersea Manipulators and Unmanned Underwater Vehicles.

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to provide a virtual environment to control underwater manipulators and unmanned underwater vehicles for performing of a large variety of tasks.

DESCRIPTION: Control of unmanned undersea manipulators and submersibles becomes increasingly critical as distances between the system and the human operator increases. In particular, the bandwidth of the control and data link for acoustically controlled systems quickly become limited to regions of hundreds of hertz or less. Maintaining visual and acoustic image data contact with the surrounding environment becomes, therefore, increasingly difficult, even if effective data compression techniques are employed. The purpose of this SBIR investigation is to provide a human operator with a feeling of telepresence with the environment even in conditions where the bandwidth or time delays in the communication link prevent real time television or sonar displays of the remote environment. A virtual world or virtual environment can produce the feeling of a real time presence using low bandwidth updates for positions of objects in the remote environment.

Phase I: Study and design of interaction of virtual environment and low bandwidth feedback signals.

Phase II: Provide full demonstration of virtual environment control concepts.

N92-003 TITLE: Bidirectional Modifiable Synaptic Element for Artificial Neural Networks (ANNs)

CATEGORY: Exploratory Development

OBJECTIVE: Investigation, design and demonstration of novel bidirectional modifiable synaptic functions for highly dense and efficient learning neural networks.

DESCRIPTION: In order to meet present and projected "Smart autonomous weapon/robot" signal handling requirements for surveillance, detection, tracking and delivery of munitions/submunitions, an "in-situ learning" VLSI chip that emulates both the propagation of patterns through (and modifications of weights in) a neural network (NN) is under development in various research

centers within the Department of Defense, industry and academia. To achieve a desired connectivity in density (10^{11} connections) and speed (10^{12} connections/sec) - similar to a bee's brain - with a few analog VLSICs of a neural "system", innovation in algorithms, architecture and design is a prerequisite to a useful, high density, efficient learning and low power NN. Bidirectional interconnection weights would facilitate efficient implementation of a number of NN paradigms. ANNs offer promise as highly efficient analog computers in a number of application areas of interest to the Navy/DoD; e.g., sensor interpretation for pattern recognition; image (target) recognition; associative computer memory and control; and radar and sonar signal processing and preprocessing. Although ANNs are presently in a phase of hardware implementation, the result falls extremely short from the potential of compactness, speed and truly parallelism for real time application; e.g., the Intel ETANN has the capability of 10^4 interconnects (storage) and 10^{10} interconnects/sec while the human brain, where a significant minority of the interconnections between neurons are electrotonic (resistive and bidirectional in nature), is estimated at 10^{14} - 10^{16} interconnects/sec. Where a significant minority of the interconnecting between neurons are electronic (resistive and bidirectional in nature), bidirectional weights could allow simplified hardware implementation of such a network again by duplexing feedforward and feedback signals through the same weight matrix.

Phase I: Address (a) theory and concept of a bidirectional modifiable synaptic function for compact implementation with sufficient parallelism to still allow for real time applications, and (b) implementation and demonstration (in analog silicon VLSI) of the optimum synaptic function: the design should be scalable to achieve 10^{11} interconnects and 10^{12} interconnects/sec for target recognition using multidimensional inputs.

Phase II: The effort will explore the practical implementation into a large multiarray comprising at least 10^6 synapses per array, followed by a feasibility demonstration illustrating the approach to achieve I(b), above.

N92-004 TITLE: Superconductor Transformer and Inductor Lead Interface Connection Technology

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to make maximum effective use of superconduction devices and to find a practical way to utilize their highly attractive characteristics with minimum complexity.

DESCRIPTION: High temperature superconductor materials are metallic oxides in the form of solid matrix similar to ceramics. Silver has been used extensively as the interconnecting material, however, silver does not bond well to the superconductor material and may well conduct too much heat into the superconductor and thereby cause it to transition into the normal state, rather than remaining in the superconducting state. The result could destroy the superconducting device. A better interface connection material is urgently needed.

Phase I: Search for best possible electrical, mechanical, thermal, and chemically stable connection material to provide circuit connection between superconductors and normal room temperature circuits.

Phase II: Demonstrate feasibility of method.

N92-005 TITLE: Organic and Organic-Ceramic Composite Materials for Optical Memory, Switching and Light Modulation

CATEGORY: Exploratory Development

OBJECTIVE: Develop organic materials or composites of organic materials including ceramics for optical memory, switching and modulation.

DESCRIPTION: There is a need to develop organic, ceramic or composite materials capable of optical memory, modulation and switching. The material should be responsive in the wavelength region between 850nm to 1.5 micrometers. The switching time should be optimized with a goal of submicroseconds. Choice of materials should be optimized to operate in severe military environments. Potential applications may include replacement for rotating switch, crossbar switch, waveguide switching and optical neurons and optical computing. The Naval Surface Warfare Center, has in-house capability to test these materials and encourages small businesses that are not equipped with optical diagnostics.

Phase I: A study showing the material is a stable memory or switch and has possibility to survive in a military environment.

Phase II: A prototype device meeting military specifications will be produced.

N92-006 TITLE: Dynamic Holographic Nonlinear Optical Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop new materials which are capable of sustaining dynamic (real-time) holographic phase gratings.

DESCRIPTION: There is a need to develop fast, sensitive and efficient dynamic holographic nonlinear optical materials for applications such as all-optical beam steering, beam deflection, phase image storage, optical implementation of parallel processing, all-optical associative type memory, reconfigurable optical interconnections, non-reciprocal energy transfer and beam amplification, and phase conjugation. The materials for these applications shall be capable of containing phase holograms (phase gratings) which are induced (written) by incident optical interference patterns (spatially varying incident light) and are required to be erasable, for example, by flooding the medium with uniform light. These materials may be organic, inorganic or a hybrid configuration, and are required to have a wavelength response in the visible and near-infrared spectral region, compatible with existing low power laser beams. Response times to optical excitation are required to be milliseconds or less. The Naval Surface Warfare Center has an optical diagnostic facility capable of observing and evaluating important material parameters required for photonics and opto-electronics research, and will assist contract awardee in determining relevant parameters for the materials produced during this effort.

Phase I: Deliver a prototype material meeting the above requirements.

Phase II: Optimization of both the growth and synthesis techniques and relevant material characteristics of optical materials meeting the above requirements.

N92-007 **TITLE:** Growth of Large Beta Silicon Carbide (SiC) Single Crystals

CATEGORY: Exploratory Development

OBJECTIVE: Growth of large Beta SiC single crystals for high-power and high-frequency devices.

DESCRIPTION: Beta silicon carbide (β -SiC) possesses a unique combination of properties important for high power device applications, especially for high frequency devices. The combination of its wide bandgap, high saturated electron drift velocity, high breakdown electric field, low dielectric constant and high thermal conductivity give it a figure of merit for high power microwave applications that is 1100 times better than that of Silicon (Si) and 183 times better than that of GaAs. The most common polytype of SiC, designated 6H-SiC, has similar properties but, because of its lower electron mobility, has a figure of merit which is 700 times greater than Si for high power microwave devices. Modeling of 6H-SiC MESFETs using empirical values show that these devices will output 75 W at 10 GHz (0.5 μ m gate length) and, based on its higher mobility value, β -SiC should give significantly higher power output. The power density value for 6H-SiC is about 5 times higher power output. The power density value for 6H-SiC is about 5 times higher than that obtained for state of the art Si or GaAs devices of similar dimensions. Currently, there is no source of large single crystals (boules) of β -SiC from which to make wafers. It is herein proposed to grow boules of β -SiC, suitable for use as substrates for epitaxial growth of β -Si thin films.

Phase I: Identify growth concept and estimate characteristics.

Phase II: Optimize and demonstrate feasibility of method.

N92-008 **TITLE:** Improved Electrochemical Test System for Evaluating Disbondment of Organic Coatings.

CATEGORY: Exploratory Development

OBJECTIVE: To fabricate and demonstrate an improved portable, non-destructive instrument based on Electrochemical Impedance Spectroscopy (EIS) for use in objectively evaluating subfilm coating disbondment on coated metal surfaces, such as ship hulls and tanks, long before surface evidence of coating deterioration is apparent.

DESCRIPTION: The vendor/manufacturer will demonstrate an improved EIS system with a design centered around lap-top sized personal computer technology.

Phase I: An EIS system will be designed specifically at evaluating organic coatings on metal surfaces in field environments. An in-house demonstration of the breadboarded system measurement capabilities to 10^{12} ohms at 10^3 Hz with an input signal of ≤ 10 mv a-c will be conducted.

Phase II: The second phase will be focus on the delivery of two prototype units to the David Taylor Research Center (DTRC), including documentation for field usage.

N92-009 **TITLE:** Signal Representation for System Identification

CATEGORY: Exploratory Development

OBJECTIVE: Design, develop, and evaluate innovative algorithms which operate on signals to reveal features which parameterize nonstationarity, nonlinearity, and statistical properties of the systems radiating those signals.

DESCRIPTION: New technologies such as large scale integration electronic chips and neural nets have gained some success in application to automatic recognition of undersea acoustic, electromagnetic, and communication signals represented by standard spectrograms. However, large false alarm rates, coupled with the need for automatic alertment in multichannel systems, requires new signal spaces which go beyond the usual linear models of time/frequency distributions and wavelets. This SBIR task seeks innovative approaches which yield multidimensional measurements related to system linearity and stationarity as well as statistical properties.

Phase I: Develop the algorithms.

Phase II: Evaluate applications of these algorithms using real data from operational systems.

N92-010 **TITLE:** Shallow Water Mine Countermeasures.

CATEGORY: Exploratory Development

OBJECTIVE: Identify innovative techniques and technologies required in the detection, classification, identification, neutralization and clearance of mines and minefields in water depths from 80 feet to the high water mark.

DESCRIPTION: Technologies may include any innovative mix of acoustic, electromagnetic, electro-optic, explosive and non-explosive techniques. Concepts should emphasize high payoff for rapid reconnaissance and wide-area clearance, as well as near-term (1995-2000) and far-term (2000-2010) applications.

Phase I: Identify potential concept, means of deployment and cost per system for countermeasure missions. Quantify capabilities of each concept.

Phase II: Demonstrate optimum concept(s) from Phase I study, showing performance objective is achievable and capable of being deployed from existing Fleet assets.

N92-011 **TITLE:** Noncontact Measurement Techniques for Surface Stress Distribution

CATEGORY: Exploratory Development

OBJECTIVE: To develop a measurement technique, associated equipment and procedures which can be used to map out the surface stress distribution on complex naval structures using noncontact techniques.

DESCRIPTION: In the structural design, evaluation, and monitoring of naval ship structures improved methods to measure surface stresses are required. Contact methods of measuring surface strains often require surface preparation of the structure that may not be desirable in the case of organic composites or access to the location may be difficult. Comparison of analytically predicted strains with contact measurements frequently allows only point by point comparisons. Capabilities required for the new method are: (1) noncontact measurement of surface stresses; (2) scan and record stress field due to static and dynamic loads; and (3) produce color stress contour plots, which can be compared to finite element analyses.

Phase I will evaluate candidate technologies which have the potential of meeting the objective and are suitable for testing naval structures.

Phase II should develop the selected technology and prototype equipment and should demonstrate the applicability of the technique on representative naval structures in shipyard, shipboard and laboratory environments.

U.S. MARINE CORPS

N92-012 **TITLE:** Standardized Teleremote Kit for Marine Corps Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a standardized remote control (Line Of Sight/ Fiber Optic) system which uses off-the- shelf components and can be easily programmed/ adapted to all Marine Corps vehicles.

DESCRIPTION: This solicitation attempts to take advantage of Robotics technology related to robotics control architectures, actuators, autonomous vehicles, data compression, flexible linkages and automation for remote control operations of Marine Corp vehicles.

The envisioned concepts may replace classical "man-in-the-loop" operations and concurrently provide a system that is easily attached to all Marine Corps vehicles and can significantly reduce the exposure of Marine Corps personnel during hazardous operations. Devices used to remotely control various Marine Corps vehicles are extremely limited and lack any degree of standardization. The advantages of a standardized remote control unit/ system are: an increased ability to utilize any remote control system on any Marine

Corps Vehicle, flexibility in providing necessary remote control operation to the Fleet Marine Force (FMF), and ease of adaptation/installation of the remote control systems.

The primary mission of the Remote Control System is Remote Control (LOS/ NON LOS) operation of all Marine Corps vehicles. Its secondary capability would be the standardization of remote control architectures and components to reduce duplicity.

Phase I would consist of concept exploration resulting in a feasibility study, review of current documentation, and a preliminary design study which produces a System Concept Document (SCD), or equivalent. The SCD or equivalent must describe the proposed hardware design to include materials, proposed remote control architecture, actuators, data compression, frequencies, flexible linkages, tactical employment, storage and use, flexibility, size and weight estimates.

Phase II would consist of preparation of detailed design drawings and assembly of the prototype devices. Prototype design will be verified by remote operational testing for effectiveness using Marine Corps vehicles.

N92-013 TITLE: Rechargeable Batteries

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a "family" of rechargeable batteries to power military vehicles, radios, computers, and other military/commercial electrical devices.

DESCRIPTION: This solicitation attempts to take advantage of new materials technology related to rechargeable batteries for military applications. By having a rechargeable battery that can be molded/cut into the various shapes, the unused space found in vehicles, computers, radios, and other battery-powered devices could be utilized to pack more electrical energy on board that equipment than is currently possible. With improved battery performance, field units can sustain their electrical devices over a greater period of time with less logistical support. Research is not limited to polymer technology.

Desired characteristics are as follows:

Rechargeable life of at least 1500 cycles.

Reduced weight by 80% of current battery

Charge retention of 300% of current battery

Shaped, cut, molded into conventional and nonconventional shapes

Operating temperature range of 30 to 140 degrees F.

Ruggedized to minimize power loss from punctures, such as bullet holes.

Phase I should include, as a minimum, two prototype batteries of different size, but do not have to be to exact form/ fit of the battery being replaced. Contractor should demonstrate by analysis that all of the above characteristics can be achieved by the selected technology for a wide range of batteries for military applications. Limited testing should be performed and documented to verify the design of the two prototype batteries.

Phase II would be the design and development of a designated group of batteries in exact form/fit for test and evaluation.

N92-014 TITLE: Retractable Mechanical Suspension for Tracked Vehicle

CATEGORY: Exploratory Development

OBJECTIVE: This effort will be directed at the development of feasibility designs to show packaging, layout, system requirement, weight, and volume requirements for the given system.

DESCRIPTION: Future amphibious and non-amphibious track laying combat vehicles can benefit from a suspension system that retracts the roadwheels/track. This will allow the vehicle to reduce its silhouette while on land. While in water, this will allow the track and roadwheels to be brought up flush with the underside of the vehicle to reduce hydrodynamic drag.

Development efforts in the past have centered on complex hydropneumatic and fluidic suspension systems that require transference of fluid to effect retraction. A simple mechanical system that can be operated reliably is desired. It is also highly desired to reduce the length of protrusion into the vehicle hull by the suspension system. Enlarging the mounting face is acceptable (within limits).

Technical requirements are: static load of 5000-6000 pounds adjustable, 16 jounce travel, 5 inches rebound travel, damping of up to 6000 pounds, vehicle ground clearance of 16 inches, 3.5 to 4 g load at full jounce. An actuation mechanism is required to enable retraction and extension by driver control. Protrusion into the vehicle of 24 inches or less is desired, total diameter of mounting provision should be 24 inches or less. A nominal roadwheel diameter of 24 inches, roadwheel spacing of 30 inches, and a 3 inch thick, 21 inch wide track should be assumed.

During this effort, it is expected that layout drawings and engineering calculations will be generated of the hardware system to demonstrate feasibility and show packaging, layout, system requirement, weight, and volume requirements for the given system.

N92-015

TITLE: Electrical Rotary Motion Actuator

CATEGORY: Exploratory Development

OBJECTIVE: This effort will be directed at the development of feasibility designs to show packaging, layout, system requirement, weight, and volume requirements for the given system.

DESCRIPTION: Future combat vehicles will incorporate appendages that need to be operated and stowed or extended based on vehicle mode of operation (land or water). Current components to actuate these systems are hydraulic rotary actuators that operate at medium to high pressure, but minimal flow. Incorporation of electronic power busses and survivability concerns encourage replacement of hydraulic components with electric components where applicable. This effort is to develop a rotary electric actuator with lockout capability to power and move combat vehicle components.

Technical Requirements are: rotational torque level of 12,000 inch-pounds, 180 degrees of rotation, weight of 50 pounds or less, body diameter (less flanges) of 8 inches or less. Input voltage of 270 VDC is required, and control electronics may be located separately from the actuator, but need to be minimized in size. The actuator shall be capable of positively locking and holding full load at either position with less than 5 degrees slippage. Operation while submerged in saltwater is a requirement. Rotation of the 180 degrees while under full load should be accomplished in less than 10 seconds.

During this effort, it is expected that layout drawings and engineering calculations will be generated of the hardware system concepts to demonstrate feasibility and show packaging, layout, system requirement, weight, efficiency, and volume requirements for the given system. A non-functioning mock-up that accurately represents all necessary components shall be delivered at completion of the effort.

N92-016

TITLE: In-Arm Drive System for Wheeled and Tracked Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: This effort will be directed at the development of feasibility designs to show packaging, layout, system requirement, efficiency, weight, and volume requirements for the given system.

DESCRIPTION: Future wheeled and tracked vehicles may encompass common components for mobility. A compatible in-arm drive system would allow utilization on either a track laying system where the roadwheel need not be powered, or a wheeled vehicle where power to the hub is selectable. Current tracked vehicles do not use powered wheel hubs, but instead rely on a sprocket to drive the track. Most wheeled vehicles utilize drive shafts and constant velocity joints to power the wheel through the hub. One drive system that incorporates a roadarm and wheel hub capable of driving a wheeled vehicle or supporting a roadwheel is envisioned. Suspension support is also required in this system.

Technical requirements are: static load of 5000-6000 pounds adjustable, 16 jounce travel, 5 inches rebound travel, damping of up to 6000 pounds, vehicle ground clearance of 16 inches, 3.5 to 4 g load at full jounce. A nominal roadwheel diameter of 24 inches for a tracked vehicle or a pneumatic tire of 36 to 42 inches is envisioned. Drive power in the wheel mode of operation is anticipated at 25 - 50 HP per wheel. Free-wheeling as a roadwheel hub is necessary.

During this effort, it is expected that layout drawings and engineering calculations will be generated of the hardware system concepts to demonstrate feasibility and show packaging, layout, system requirement, weight, efficiency, and volume requirements for the given system.

N92-017

TITLE: Combined Antenna System for Assault Amphibian Use

CATEGORY: Advanced Development

OBJECTIVE: Produce a high performance, multi-band vertical antenna for simultaneous use of multiple spread spectrum transceivers.

DESCRIPTION: Future improvements of Amphibious Assault Vehicles (AAV) call for the use of at least two radio transceivers operating simultaneously in the 30-90 Mhz spectrum. Because of limited space on the AAV and the desire to maintain low profile, it is desirable to use a single wide band vertical antenna. The antenna may be a stack of a number of elements in the vertical direction but overall length is limited to twenty (20) feet. The antenna system must provide sufficiently high intra-antenna isolation to allow operation of all transceivers without degradation of receive or transmit capabilities. SWR presented to either transceiver shall be no greater than 3:1 across the specified spectrum.

Each phase will require:

- a) an initial brief including a program objective, actions and milestone review,
- b) a final review and
- c) a brief and final report to the USMC project manager.

Phase I: Investigation and assessment of various options. Selection of appropriate concept. Analysis of selected concept.

Phase II: Detailed design of selected concept will be completed and several prototype systems will be constructed. Testing will be conducted in factory by contractor and by Marine Corps at various Government facilities after installation in AAVs.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N92-018

TITLE: Automatic Detection of Acoustic Signals on Lofargrams Using Image Processing Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop, demonstrate, test, and evaluate multiple dimensional filters for detection and feature extraction algorithms as automatic signal detectors and determine the Receiver Operating Characteristics (ROC) curve of each algorithm.

DESCRIPTION: The task is to develop, demonstrate, and measure the applicability of various multiple dimensional filtering algorithms/techniques to the problem of extracting the maximum amount of information from the Full Spectrum of acoustic radiation, and presenting that information to an acoustic operator in a form which maximizes the operator's performance in a highly cluttered environment. It is also required that these algorithms reject biologic activity and profiler activity from the acoustic spectral regions in which they occur while preserving the signals of interest in that spectral region. The measures of algorithmic performance include probability of detection, probability of false alarm, and recognition differential over a fix observation period. Proper spectral preparation of the time series data in frequency time format to the algorithms is required with attention paid to both frequency and time redundancy of the presented data. Real (from the Full Spectrum Database) and simulated data will be supplied by the Navy for demonstrations and testing. Candidate algorithms/techniques are to include: Two dimensional Fourier Transforms, Radon/Hough Transforms, Gabor/Wavelet Transforms, Wigner-Ville, etc.. The use of public domain applications (e.g., NIH's Image with Fourier Transforms) and commercially available applications for signal and image processing is encouraged.

Phase I: Develop as required and implement on a computer critical applications (at least the two dimensional Fourier Transform) for testing with real (provided by the Navy) and simulated time series data. Determine and present the ROC curves for three signal types of interest to the Navy.

Phase II: Perform as directed by the Navy, ROC curve analysis for other signal types and for the other transforms. For Navy selected algorithms/techniques, develop and specify acoustic processing chains and processing functions for implementation on a Navy workstation.

Phase III: Implement the multiple dimensional filtering applications as a complete operable computer program in a high level language (C, FORTRAN, Pascal, Ada, etc.) on a Navy workstation (DTC III processor and display) for sea test at an IUSS site during an exercise.

N92-019

TITLE: Global Positioning System (GPS) Top Sounder

CATEGORY: Exploratory Development

OBJECTIVE: Exploit GPS error signals to characterize and gauge the ionosphere for cross-section analysis of HF radar and communication paths.

DESCRIPTION: GPS uses two frequencies to ascertain signal delays passing through the ionosphere. These are measured as errors and used to correct position solutions. Since this process is a means of measuring columns of Total Electronic Content (TEC), multiple top-soundings from the GPS constellation could provide significant detail of the ionospheric pattern and possibly lead to enhancement of predictions for selectable areas and sites.

Phase I: Develop and demonstrate the feasibility of techniques and algorithms to transform propagation delays (errors) into TEC presentation and evaluation.

Phase II: Demonstrate TEC contours on a PC style workstation in real and integrated time, providing high confidence in predicting hour to hour trends.

N92-020 TITLE: Mobile Surveillance System (MSS) Performance; Analytical Capability

CATEGORY: Exploratory Development

OBJECTIVE: Develop the capability to comprehensively analyze the performance of Mobile Surveillance Systems (MSS).

DESCRIPTION: This topic is to determine the feasibility of exploiting Petri Net technology to analyze the performance of large scale sensor and/or C3 systems. A Prototype will be produced that demonstrates the full capability of the target system using advanced Petri Net methodology. The prototype will have a complete, if not fully detailed, model of a representative MSS, Combat DF. The prototype will be capable of being exercised and producing output that is representative of the performance of the MSS, but not necessarily to the level of detail required for full-scale system analysis.

Phase I: Develop prototype.

Phase II: A robust system capability will be produced, including a full working model of the MSS. In addition, complete design and implementation plans for Phase III will be supplied.

Phase III: The complete capability will be installed at a suitable site.

N92-021 TITLE: Protocols for DATA/Voice Networking

CATEGORY: Exploratory Development

OBJECTIVE: Develop network protocols which support the exchange of voice and data transmission over a given RF link such that a voice and a data link user can time share the same RF circuit.

DESCRIPTION: Network protocols are sought that permit the efficient exchange of voice and data over low data rate Navy RF links. The concept is to implement one (or a family of) network protocol(s) which establish(es) the required connectivity and dynamically allocate(s) link capacity for the required voice or data exchange. Network management overhead and response time are to be minimized. This effort will include the development of software for test in the Naval Ocean Systems Center (NOSC San Diego, CA) Communication Support System (CSS) test facility.

Phase I: Demonstrate technical feasibility of network protocols.

N92-022 TITLE: SHF SATCOM Networking

CATEGORY: Exploratory Development

OBJECTIVE: Develop, define, and show feasibility of SHF SATCOM multi-access network protocols and control schemes.

DESCRIPTION: In the development of the Navy Copernicus and CSS information management and transfer architectures, SHF SATCOM has gained considerable importance because of the increased performance to be obtained for SHF over UHF. The lightweight SHF SATCOM terminals the Navy is seeking to develop will operate in the FDMA and CDMA modes of the DSCS satellite Channel 2. These terminals will provide ship to ship and ship to shore connectivity at data rates from 2.4 to 64 kbps. SHF compatible multi-access protocols and network control schemes are required to support exchange of voice, data and image information. Net management overhead and response time are to be minimized.

Phase I: Demonstrate feasibility of network protocols.

N92-023 TITLE: Anti-Surface Warfare Tactical Decision Aid

CATEGORY: Advanced Development

OBJECTIVE: Provide a comprehensive decision support system within the Navy Tactical Command System - Afloat (NTCS-A) to assist in planning and monitoring the ship or battle group Anti-Surface Warfare (ASUW) mission.

DESCRIPTION: The purpose of this development is to create a full scale Decision Support System (DSS) capable of providing a complete range of support functions for ASUW missions. The DSS should operate on all NTCS-A configurations, have the capability of taking automatic data inputs, and provide the user with a full range of mission related decision support. The system must be fully integrated with the NTCS-A system including man-machine interface, databases and communication functions. Mission support functions will include, but not be limited to, mission planning for surveillance using multiple sensors, mission planning for war at sea engagements, battle damage assessment, communication planning, underway replenishment planning, readiness assessment and casualty reconfiguration for minimum mission degradation. The system functions must be fully integrated.

Phase I: Produce a prototype on a Navy standard Desktop Computer - 2 that demonstrates the full functionality of the target system. The prototype will be capable of being exercised and producing output that is representative of the desired performance, but not necessarily to the level of detail required for the final full scale system.

Phase II: Produce a robust system capability that contains all of the functionality ready for at sea evaluations under realistic conditions complete design and implementation plans for Phase III will be supplied.

N92-024 TITLE: Acoustic Communication From Integrated Undersea Surveillance System (IUSS) to Naval Forces

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate the application of acoustic communications systems concepts to provide improved tactical connectivity for Anti-Submarine Warfare (ASW) forces.

DESCRIPTION: Improved acoustic communications techniques are required to provide survivable and enduring ASW communications. This project will examine the potential for application of acoustic communications to IUSS as an alternate path for ASW users. Each phase will require an initial brief including program objectives, actions and a milestone review; a final review and brief; and a final report.

Phase I: Analysis should include an operational concept and a system design for integration of acoustic communications to ASW platforms, systems and sensors. The plan will include a survey of existing and planned IUSS/Fleet resources. IUSS system/subsystem improvements, acoustic conditions and environmental parameters/issues will be addressed. The feasibility of the proposed system concept must be demonstrated.

Phase II: Encompass modeling, development, laboratory testing, validation and demonstration of the utility of the design concepts. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N92-025 TITLE: Optical Technology for Towed Acoustic Arrays

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate a feasible concept for a very long, low noise towed array which makes maximum use of low power optic technology.

DESCRIPTION: See Phases I and II below:

Phase I: A design concept description for an optic line array, including optic/acoustic sensors, telemetry, shape sensing and power scheme.

Phase II: A laboratory or lake test to demonstrate the feasibility of the key technology components. Successful Phase II design concept will be considered for implementation in an advanced development model for at sea testing.

N92-026 TITLE: Performance Modeling for Automatic DAMA Control

CATEGORY: Exploratory Development

OBJECTIVE: Develop Computer models to analyze the expected performance of the DAMA control channels to perform Automatic DAMA Slot Management.

DESCRIPTION: Since the DAMA slot process can be complex, it is important to understand the delays, set up times, queue management strategies, pending request management strategies, and channel overload strategies for a range of expected circumstances. The DAMA system is used to share access to shipboard UHF satellite communication resources. Users are allowed access to DAMA by written directive. Dynamic assignment abilities are being developed to better utilize the DAMA resources. The DAMA control channels (the CCOW and RCCOW channels) may have inadequate capacity to handle all cases of this dynamic management.

Phase I: Describe the exchange of DAMA messages for all types of transactions that the DAMA Automatic Controller supports. Describe the system modeling tools planned and describe the operational scenarios to model.

Phase II: Gather data on DAMA orderwire loading for the expected scenarios, and develop strategies for use of the orderwires to cope with the loading conditions expected.

N92-027

TITLE: Remote Sensing of Meteorological Parameters Using Light Detection and Ranging (LIDAR)

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to investigate new approaches for the measurement of in-situ meteorological parameters, specifically wind speed and direction, using LIDAR sounding techniques. Atmospheric winds affect a broad range of current and future weapons systems, including the TOMAHAWK and all ballistic missiles. Such measurements are vital in describing and predicting chemical and biological weapon dispersion within a tactical operational area.

DESCRIPTION: New approaches and innovative ideas are sought for instruments to measure wind speed and direction utilizing advanced LIDAR techniques for remote sensing. The local area measurements of the wind speed and direction are required for the region between the surface and 3 km altitude. The vertical resolution of the measurements should be 100 meters or better. The local wind and wind shear measurements obtained and displayed in real time can significantly improve the data available for planning and carrying out Naval operations, and would be especially valuable for safety of flight. The effort seeks new capabilities for making remote measurements using techniques such as coherent and direction detection Doppler LIDAR, or other new developing approaches. Proposed instruments should be operable in congested areas, with both civilian and military air traffic, and issues such as eye safety, operating lifetime, technician level operation and servicing should be considered. The techniques will be evaluated based upon their potential utility for advanced atmospheric and meteorological sounder instruments.

Phase I: The Phase I effort should provide a design approach for the concept proposed, and definition of the instrument capability based upon calculations of performance. The concept development should include a plan of action which will result in transition of the basic technology into fielded instruments.

Phase II: The Phase II effort would include a performance demonstration which will confirm the accuracy and capability expected from the fielded system.

N92-028

TITLE: Automatic Classification/Sanitization Using an Expert Systems Approach

CATEGORY: Research

OBJECTIVE: Research the use of Expert Systems to automatically classify and sanitize sensitive compartmented data to allow the transfer of information to a system or sub-system operating at a lower classification level.

DESCRIPTION: This topic centers on providing an expert system approach to assigning classification to cryptologic raw information, managing the classification of the information while in the host system, and providing for automatic sanitization when demanded by the system operator. The classification process will be implemented like a spell check feature.

Phase I: Research the nature of the material being processed; the availability of rules for classification and sanitization; the availability, reliability, affordability of Expert Systems and supporting Software to deal with classification and sanitization rules; an investigation of the schema for the Expert System in which the sanitization rules could be trusted to operate; and a description of at least one alternative for implementing the capability.

Phase II: Prototype development and test in a controlled environment. Phase II will provide for the development of production quality modules to insert in existing/planned tactical Cryptologic systems (OUTBOARD, Combat DF, CCSC, CCSS, BGPHEs, etc.).

N92-029

TITLE: Data Base Compression/Decompression

CATEGORY: Advanced Development

OBJECTIVE: Develop a minimum data base compression ratio of 12:1 for unique ASCII data elements contained in selected intelligence data bases.

DESCRIPTION: There is a critical need to replicate selected data base files aboard designated afloat systems from a shore-based data based data base system. Deployed cryptologic units initially load a subset of the shore-based data base system based on expected operating area. If/when the operating area changes, e.g., in response to a particular third world scenario, replication of new data base files may be constrained by existing communications pipe-line/throughput. The objective is to incorporate or adapt ongoing research of data compression techniques into data base compression. Compression of intelligence data files is distinct and unique with specialized application. When combined with a data compression front end, the effective compression ratio is essentially multiplied by the data compression ratio. The need for this compression capability carries special importance in the intelligence community; however, it has wider applications.

Phase I: Identify and survey existing and ongoing data compression techniques. Perform an analysis of representative intelligence data files to be sent from shore-to-ship. Analyze and synthesize potential data base compression algorithms, transformations, and techniques.

Phase II: Adapt/develop and test data base compression software/system that will satisfy the minimum 12:1 compression ratio. Combine with readily available data communications compression software/systems to determine effective compression ratio.

N92-030 TITLE: Video Environmental Product Compression

CATEGORY: Engineering Development

OBJECTIVE: The objective is to test and develop video compression technology which will be suitable for Fleet use with newly developed environmental computer equipment and systems.

DESCRIPTION: Test and evaluation should be expected during all phases in execution of this proposal. Video compression technology suitable for distribution of video and animated environmental products, including but not limited to, imagery and graphic products is urgently needed to support new, higher technology, sensors and weapon systems.

Phase I: Trade-off analysis of existing or modified compression technology.

Phase II: Complete development.

N92-031 TITLE: Synthetic Aperture for Surveillance Applications Using a Towed Array

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the benefits of synthetic aperture processing in ocean acoustics. Application of this signal processing technique in ASW would provide the opportunity to perform high resolution sonar processing using existing low resolution systems. Development of this technology would demonstrate increased capability in signal to noise enhancement and bearing resolution.

DESCRIPTION: Existing implementation of synthetic aperture processing has been in radar application. Implementation has been primarily to enhance radar resolution of stationary targets. The difficulty of applying this technology to ocean acoustics is that the target is not stationary in space or time. As a result of these constraints the synthetic aperture application in ocean acoustics will require a space time transform.

Phase I: Develop the mathematical implementation to perform synthetic aperture processing for both moving source and target geometries.

Phase II: Implement Phase I with data obtained during the 3X experiment. The 3X data provides a unique truth basis in that a IX configuration can be tested and results validated against the measured high resolution performance of the 3X system.

N92-032 TITLE: Voice/Data Integration

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques which permit baseband integration of voice and data to support transmission over a common RF network.

DESCRIPTION: Integration of voice and data is one way to achieve a higher efficiency of RF link utilization especially if voice communication is related to a particular data network. The concept is to minimize the required voice bandwidth and to add a control and packet structure to the voice/data flow to permit exchange over existing and new low data rate Navy RF links. This effort will include the development of software for use in the Naval Ocean Systems Center (NOSC San Diego, CA) Communication Support System (CSS) test facility.

Phase I: Demonstrate feasibility of the proposed technique.

N92-033 TITLE: Surveillance System Planning and Resource Allocation

CATEGORY: Advanced Development

OBJECTIVE: Many operating modes are provided in modern long range sonar systems. The objective is to assist supervisors in selecting system modes and parameters which best allocate system resources. The development is needed to support currently planned fixed and mobile surveillance systems.

DESCRIPTION: Modern surveillance systems are capable of application to many different environments, target types, and missions. This flexibility of operation in selecting transmit and receive directionality, frequency bands, processing approaches (coherent vs non-coherent), waveforms, and other parameters confronts a system operator with a bewildering variety of alternative configurations. This task is to develop the concept and implementation plan for an automated sonar system planner to assist operators in selecting surveillance system parameters best suited to the acoustic environment, the mission, a priority target information, and system capability. It is expected that a variety of disciplines including decision theory, numerical analysis, and expert systems may need to be applied to effectively solve this problem. The offeror shall explain how this approach can be applied to specific existing and developing surveillance systems and how existing tools for surveillance planning can be profitably integrated into a final system design.

Phase I: Define the required input data and outline an overall allocation procedure.

Phase II: Procedure will be further developed and included as an integral part of ongoing developmental trials, and will include automation of the operator assistance procedures.

N92-034 **TITLE:** Low Cost HEMP Hardening Approach for Navy Sites/Stations

CATEGORY: Advanced Engineering

OBJECTIVE: Develop a low cost HEMP hardening approach for Navy sites/stations.

DESCRIPTION: HEMP hardening of existing Navy sites is necessary to protect mission critical C³I operations capability. For maintenance and personnel training purposes, the approach should be one of creating standardized/modular hardware for new and existing facilities.

Phase I: Shall consist of the HEMP event (i.e., frequency spectrum, power level, time duration) and required safety margin. A standardized listing for C³I systems requiring HEMP protection shall be compiled. Also consist of developing and demonstrating through empirical analysis, a standardized ECP (incorporating terminal protection devices, MOVs, RF filters and gaskets, conductive coatings) which would provide the desired level of HEMP hardened protection for the identified site/station common C³I systems.

Phase II: Provide a detail design for Navy facility using techniques proposed in Phase I. The preliminary design will incorporate current DOD guidance on HEMP requirements.

N92-035 **TITLE:** Modulated Pulse Laser Radar Systems

CATEGORY: Research

OBJECTIVE: By modulating the optical pulse of laser radar at microwave frequencies, many of the techniques used to improve the performance of microwave radars can be applied to optical systems. This is particularly useful for underwater applications, where the optical carrier will propagate but the microwave will not. These techniques include, but are not limited to, F-M detection, chirping, mono-pulse compression, and Doppler.

DESCRIPTION: The use of modulated pulses would increase the effective duty cycle of the laser. This has several direct systems benefits. The peak power required (which defines the damage thresholds for short pulse systems) would be reduced, and the average power (which defines the system performance) could be increased commensurately. For systems that have limited power available, a longer pulse would permit the use of doubled solid state laser diodes (which have efficiencies 10 times better than laser presently in use).

Other possible advantages include motion detection (via Doppler) which is not possible in water using coherent optical techniques. Pulse compression techniques could result in systems with higher spatial resolution than with direct short pulse detection.

The use of existing models would allow a concise and definitive comparison of various modulation techniques within the limits of an SBIR budget. To date no one has applied microwave techniques to non-coherent optical radars. The possible high payoff of such an approach warrants investment by the Navy to document expected performance.

Phase I: Propagating various pulse shapes through a water model that includes spatial and temporal pulse stretching effects. The resulting performance of such approaches can be compared to the modeling results using un-modulated short pulses.

Phase II: Laboratory measurements of promising modeling predications. This would occur only if the results of Phase I indicated sufficient possible Navy utility. Phase III would follow successful laboratory demonstrations, if results indicated utility for a Navy applications.

N92-036 TITLE: Real Time, CRT Computer Based Training Package Creation

CATEGORY: Exploratory Development

OBJECTIVE: To develop new concepts for embedded training aids for the IUSS which will allow creation of on the job training using real data as those data are processed.

DESCRIPTION: The Integrated Undersea Surveillance System (IUSS) consists of hardware and software for the purpose of detecting, locating, classifying and reporting on surface and sub-surface targets. This process is labor intensive in all its phases. The operators on which it depends are currently trained in a classroom by watch personnel who would otherwise be operating the system. The Space and Naval Warfare Systems Command requests proposals to develop and imbed real time, computer based training package creations in the IUSS. This will allow on the job training using real data as those data are processed. The real time, computer based training package creation should substantially reduce over-sight by previously trained operators in creating, administering and documenting on the job training.

Phase I: A concept review and cost benefits study.

Phase II: Automation concepts will be implemented, installed and tested as a Naval Facility.

N92-037 TITLE: Display Devices and Techniques to Minimize Fatigue

CATEGORY: Engineering Development

OBJECTIVE: Develop techniques and electronic devices which minimize fatigue in IUSS operators. Develop a figure of merit which allows quantitative measurement of fatigue levels for these operators.

DESCRIPTION: Ocean Technologists currently examine paper copies of Lofargrams to identify and classify lines from threat and non-threat targets. These displays are more difficult to interpret than text. It is expected that future workstations will use an electronic rather than paper display for analysis of these Lofargrams. However, current electronic displays such as cathode ray tubes lead to excessive operator fatigue after several hours.

Phase I: The Space and Naval Warfare Systems Command requests proposals to determine the best from of electronic display for Ocean Technologists. The display must have adequate resolution in time, frequency and amplitude, display and adequate amount of data and be economically feasible.

Phase II: Involve construction of a prototype workstation and demonstration with real data at a Naval Facility. These techniques and technology will have applications in other warfare areas.

NAVAL SEA SYSTEMS COMMAND

N92-038 TITLE: Integrated Logistic Support Life Cycle Cost Model

CATEGORY: Exploratory Development

OBJECTIVE: To develop a model that can both estimate system/equipment logistics life cycle costs and perform trade-offs between alternative designs to determine the lowest logistics life cycle cost design alternative.

DESCRIPTION: The actual cost of logistics support (including all costs associated with each of the ten Integrated Logistics Support (ILS) elements for both system/equipment acquisition and operational phases) is difficult to determine. Considerable attempts have been made to capture this data but they have primarily focused on supply support costs associated with operation and maintaining a system/equipment. The remaining nine ILS elements have received less attention as has the resources required during the acquisition process to design, plan, and implement a system/equipment logistics program. The Navy Program Manager must be able to more accurately define total system/equipment life cycle costs associated with logistics. This is essential for effective planning and budgeting. Additionally, a method to evaluate differing system/equipment designs based on logistics life cycle costs must be developed. The Navy promotes the use of innovative designs that will lessen the logistics burden. One example would be embedded training that will save money in instructional material, student training, instructor time, and training facilities. Often however, these innovative designs are initially more costly. A method to evaluate both the acquisition and operational costs must be developed so that the lowest life cycle cost design is selected versus the lowest acquisition cost design.

Phase I: Develop an innovative method to estimate total logistics life cycle costs for Navy systems/ equipment that also allows for trade-offs to be performed between competing designs that will select the design that has the lowest life cycle logistics costs.

Phase II: Develop a paper model of the concept resulting from Phase I. Demonstrate the model on a Navy test case.

N92-039

TITLE: Next Generation Low Cost Self Indicating Casualty Dosimeter

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate alternative approaches to an inexpensive dosimetry system for use in radiation casualty situations as a replacement for the existing DT-60/PD system. A new system could save the Navy over \$130,000 a year in calibration costs.

DESCRIPTION: The need exists for a casualty dosimeter which can be used to determine personnel dose exposure during potential nuclear conflicts. The dosimeters must be capable of being read without extra equipment such as a mechanical reader or charger. For example a change in color such as in Litmus paper or a change in liquid level in a tube is acceptable. Use of a table to translate the change in the dosimeter to a dose is also acceptable. These types of dosimeters are stored for more than 20 years and must remain stable over a broad range of storage conditions. The price should be less than \$2 per dosimeter.

Phase I: Explore and evaluate available technologies based on cost/unit, method of indication, sensitivity (min range 50-1000R), long shelf life stability, and accuracy ($\pm 20\%$).

Phase II: Build and test prototype models. Establish product specification.

Phase III: Develop production model for fleet use.

N92-040

TITLE: Advanced Gun Barrel Design

CATEGORY: Exploratory Development

OBJECTIVE: Develop an improved gun barrel which dissipates heat rapidly and is wear resistant

DESCRIPTION: A need exists for improved gun barrels capable of performing in any high rate-of-fire gun which require firing sustained bursts with very high projectile velocities. These barrels must be configured to allow quick heat dispersion and withstand high frictional wear.

Phase I: Identify current state of the art Powder Metallurgy, composite materials, super alloys, and manufacturing technology areas such as CVD, HIP, etc., which could increase the longevity of high rate-of-fire gun barrels. Design and analysis will be performed to determine feasibility of selected concepts.

Phase II: Design, fabricate and test prototype barrels, jackets and liners based on Phase I concepts which demonstrate quick heat dissipation, excellent erosion resistance, relatively light weight, and significantly increased barrel life. Analytical tools and diagnostic test fixtures will be utilized to maximize fundamental understanding of advanced gun barrel technology.

N92-041

TITLE: PC Based Computer Model and Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To develop software to compare effectiveness of different Anti-Air Warfare scenarios

DESCRIPTION: The Navy is interested in developing a PC based computer model and simulation that is capable of evaluating and comparing the mission effectiveness of alternative Anti-Air Warfare (AAW) combat system suites versus various threats to new classes of ships. The current methodology to support suite selection decisions for new and existing ships is based on large-scale Monte Carlo simulations that are costly to set-up and run, and do not produce timely results. What is needed is a modeling methodology that can be easily run on desktop personal computers, and that will produce numerical and graphical results to support suite selection decisions. The model should be capable of accepting inputs including, but not limited to, ship mission requirements, system effectiveness of various hard-kill and soft-kill AAW systems, and threat effectiveness and characteristics for various known or technologically projected threats. The model should produce an output that can be used by decision makers to evaluate development options related to combat system equipments to be installed on future ship classes or for modernization of existing ship classes.

Phase I: Develop PC-based prototype software and demonstrate the feasibility using the software to evaluate the effectiveness of alternative combat system suites to meet ship mission requirements against various threats. Phase I will include the implementation of the software on personal computers, and proof of concept for the simulation using hypothetical but realistic inputs for ship mission requirements, systems effectiveness and threat systems.

Phase II: Complete the development of the simulation software. Perform detailed analyses, test and validation of the software by comparing the results to actual applications of other more costly and time consuming simulations

N92-042 TITLE: Combat System Distributed Operating System

CATEGORY: Exploratory Development

OBJECTIVE: Establish requirements and performance of a distributed operating system to support new ship designs in the year 2000 and beyond.

DESCRIPTION: See Phases I and II below:

Phase I: Provide an evaluation of available commercial distributed operating systems which would have potential application to combat systems citing characteristics and suitability advantages and disadvantages of the most likely candidates.

Phase II: Quantify recommended performance requirements of a combat system distributed operating system, and provide detailed specification guidelines and a model specification meeting Navy guidelines for a combat system distributed operating system.

N92-043 TITLE: Distributed Explosives for Use in Surf Zone Mine Clearance

CATEGORY: Advanced Development

OBJECTIVE: Develop an effective concept and prototype for rapidly clearing mines from the surf zone (0 to 10 feet water depth) using distributed explosives technology which will transition during Phase III to the Amphibious Mine Countermeasures Program.

DESCRIPTION: See Phases I and II below:

Phase I: Conduct analysis of existing documentation on using distributed explosives for clearing mines from the surf zone. Develop an effective concept which must include a full description of the explosives to be used and the means to deploy the explosives. In addition the concept must be responsive to the Navy's Incentive Munitions policy and minimize volume and weight of the explosives carried aboard ship. Determine testing necessary to quantify distributed explosive size (e.g. diameter of net or line charge) to be effective against threat mines. Deliverables will be: (1) a report on the analysis which clearly defines the concept (including the deployment method), projects total system as well as explosives volume and weight, and addresses Insensitive Munitions; and (2) a test plan for verification of deployment method and explosive size requirements during Phase II

Phase II: Phase IIA: Develop a scale model system prototype for rapid clearance of mines in the surf zone using distributed explosive technology. The deliverables will include a scale model prototype of both the deployment system and the explosive array suitable for in-field testing during Phase IIB.

Phase IIB: Conduct tests to determine distributed explosive size required to be effective against threat mines in the surf zone. Collect data on blast and pressure profiles to show that all mines covered by the distributed explosive would have been neutralized. Deliverables will be a technical report on the tests and a design disclosure for both the distributed explosive and the deployment system. The report will include: (1) blast and pressure profile data sufficient for the government to validate size and effectiveness; (2) recommendations for refinement of the concept which quantifies distributed explosive size, weight; and volume, (3) consideration of the Navy's Insensitive Munitions policy; and (4) recommendations for refinement of the deployment method.

N92-044 TITLE: Non-Acoustic Detection of Underwater Objects Near the Sea Surface

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative non-acoustic concepts to detect and, if successful, to classify and/or localize underwater objects near the sea surface. Objects of interest range in size from mines to underwater vehicles to submarines. Depth of the objects ranges from 150 feet to the sea surface. Speed of the objects is variable. Successful products from this SBIR program (phases I and II) will be considered for transition to advanced development programs for surface ships. Applications in ASW, mine warfare and self defense, particularly in shallow water and regional conflict scenarios, are envisioned.

DESCRIPTION: See Phases I and II below:

Phase I: Develop theoretical predictions and/or analyze experiments performed to date to assess feasibility of the non-acoustic concepts proposed. The following points should be included in the consideration:

-Consider both current and emerging technologies

-Ship board requirements: transmitter power (if active), receiver sensitivities and size of sensor/electronics. Assess maturity of current and future technologies to support developing the capabilities for ship board use.

-Extractable contact information: For current technologies, what can be achieved in detection/classification/localization of contacts? Performance parameters include detection probability, false alarm rate, classification clues, accuracies in contact bearing/range determination. Where possible, these parameters should be measured as a function of contact size, type, depth and critical environmental parameters. What can evolving technologies achieve?

-Environmental Constraints: address all factors such as sea state, biologic, surface wave scattering, absorption by propagation media, etc. which have impacts on the performance and operation of the conceptual system. outputs from phase I are expected to be study reports.

Phase II: If the conceptual studies conducted in Phase I proved promising, Phase II will demonstrate feasibility of the system concept. The details of the demonstration will depend largely on the particular non-acoustic technology proposed and its maturity as assessed in Phase I and on the cost required. The system demonstration may be as simple as that done in a laboratory, using models and "scaling laws" to show potential utility. Or it can be a full scale demonstration with sea going vessels and objects. If funding permits, additional efforts will be conducted to assess enhancements which will facilitate transition to advanced development systems for demonstration with tactical platforms.

Outputs from Phase II include test plans and reports, system descriptions and transition plans.

N92-045 TITLE: Training for Submarine Desktop Computer

CATEGORY: Engineering Development

OBJECTIVE: Develop software to train Naval personnel in the use of The Navy Standard Desktop Computer (NSTDTC) System.

DESCRIPTION: The Navy Desktop Computer (DTC) is installed on all fleet submarines. The DTC hosts the Submarine Fleet Mission Program Library (SF MPL) and serves as multi-purpose tactical decision aid. Due to the varied and numerous functions performed by the NSDTC system it is desirable to provide interactive training that will allow Naval personnel to learn and review the skills needed to operate the NSDTC system.

Phase I: The contractor will review the existing SF MPL for the current submarine DTC, and develop a plan for providing onboard interactive training, which will allow personnel to train themselves on the use of SF MPL software. To the maximum extent possible, the design must allow the user to train in the use of one program independently of his training on other programs. As a demonstration of the training approach, the contractor will develop training software for the use of the hardware and one SF MPL program.

Phase II: The contractor will implement the plan developed in Phase I, and test the training aid on submarine fleet personnel typical of those who would use it at sea

N92-046 TITLE: Radar Waveform Classification Using Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To develop an advanced, hybrid, signal processing system to perform high speed detection and classification of sensor emitters.

DESCRIPTION: A new and innovative approach to RF waveform detection and classification of Radar, IO/IR and ESM signals which integrates proven optical signal processing technology with advanced signal classification techniques, such as optically implementable artificial neural network.

Phase I: Develop the theory, concept and specifications for sensor classification systems based on optical processing techniques for spectral analysis and optically implementable artificial neural network or other parallel processing techniques for signal classification. Provide detailed technical report.

Phase II: Design, develop, demonstrate and deliver a working prototype optical signal processing system for sensor detection and classification. The system can be packaged as an transportable optical breadboard in rackmount size subunits, but must be capable of operating on actual radar inputs, not just simulated data.

N92-047

TITLE: Accurate Low Sample Rate Tracking of Highly Maneuvering Targets

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate alternative means for reducing track data rate requirements in multi-function phased array radars using advanced signal processing techniques.

DESCRIPTION: Recent advances in optimal control theory (e.g. μ -synthesis and H_∞ controllers) have proven to be effective in improving response characteristics of nonlinear feedback control systems under conditions of plant uncertainty and noise corrupted measurements. The dual problem of estimating the dynamic state vector of a target vehicle (i.e. spatial position, velocity and acceleration) which is to a large extent kinematically constrained by its innate aerodynamic properties and the manner in which it is employed, has not been adequately addressed within the context of these new theoretical developments.

Phase I: Perform a thorough re-examination of the problem of reducing the track data rate burden on a phased array radar implementation and select candidate implementations.

Phase II: Implement selected algorithms for evaluation. For purposes of comparison, this effort is to include an evaluation of data rate requirements for more conventional tracking algorithms such as those based upon Kalman filtering. It is expected that there are numerous military and commercial applications for these techniques.

N92-048

TITLE: General Purpose Hardware Test Set for Rapid Verification of Low Error (False Alarm) Rates in Digital Communications and Radar Systems

CATEGORY: Advanced Development

OBJECTIVE: Develop a hardware test set for rapidly verifying low error rate performance of digital communications or radar receivers via importance sampling techniques.

DESCRIPTION: Developing confidence in the ability of a communications or radar receivers to meet a critical error (or false alarm) rate requirement often requires testing which directly involves actual receiver hardware. When testing at low error rates this process is often impaired by the large number of trials required. The objective of this effort is to reduce the number of trials required by several orders of magnitude by appropriately altering the underlying noise distribution so the number of errors occurring in a given time interval is increased. Commonly referred to as "importance sampling," this technique has been limited in application to analytical studies employing mathematical models rather than actual receiver hardware.

Phase I: Develop methods and criteria for altering noise distributions applied to the error rate testing of modern digital communications or radar receivers as well as the development or specification of instrumentation needed to support testing.

Phase II: Construct and demonstrate an importance sampling test set with representative equipment. Numerous Phase III military and commercial applications are anticipated.

N92-049

TITLE: Radar High Angle Resolution Techniques

CATEGORY: Advanced Development

OBJECTIVE: Develop Radar High Angle Resolution Techniques.

DESCRIPTION: Existing radars have difficulty in resolving multiple targets which are within one beamwidth and within the same range cell with similar Dopplers. It is desired to improve the angular resolution of radars.

Phase I: Survey existing resolution techniques and develop baseline scenarios for proposed resolution technique evaluation. Additionally, innovative techniques should be proposed for Phase II development and evaluation.

Phase II: Additional high angle resolution techniques shall be developed and evaluated. Evaluations should be analytical and verified via computer program simulation. The best candidate techniques should be evaluated by equipment implementation. Numerous Phase III military and commercial applications are anticipated.

N92-050

TITLE: Development of Small, High Efficiency Thermoelectric Cooling Devices

CATEGORY: Exploratory Development

OBJECTIVE: The development of better cooling methods for high heat dissipation and temperature sensitive devices in high density packaging applications.

DESCRIPTION: See Phases I and II below:

Phase I: Analyze existing thermoelectric coolers and possible redesign for use in high density electronic packing such as surface mount devices. The design should be suitable for both simple cooling and maintaining device temperature within close tolerance.

Phase II: Fabricate miniature thermoelectric cooling devices and mount in high density circuit card application to demonstrate the efficacy of the temperature control. The demonstration should include electrical, mechanical, thermal, and any other relevant measurements.

N92-051 **TITLE:** RAM Plastic Periscope Outer Head

CATEGORY: Advanced Development

OBJECTIVE: Develop RAM plastic periscope outer head for improved RAM capability and combat survivability. Phase III not required.

DESCRIPTION: See Phases I and II below:

Phase I: Develop procedures and processes for incorporating current technology RAM with low cost plastic or elastomers to provide a material system compatible with operational RAM and survivability requirements. Progress and Final Report(s) are required.

Phase II: Provide four operationally configured outer heads for radar absorption and underwater explosion Test and Evaluation. Progress and Final Report(s) are required.

N92-052 **TITLE:** Low Profile Submarine Antenna Array

CATEGORY: Exploratory Development

OBJECTIVE: Develop a submarine antenna array for both communications and electronic warfare support measures (ESM) that is flush with the water's surface.

DESCRIPTION: See Phases I and II below:

Phase I: Investigate the feasibility of an antenna array for submarine communications and electronic warfare support measures (ESM) systems that is a horizontal disk-shaped array, concentric with the search periscope, that rides essentially flush with the water's surface, undetectable by hostile radars. The investigation should cover electrical, hydrodynamic, and mechanical aspects. Output of Phase I will be an engineering report.

Phase II: Construct a feasibility demonstration model (FDM) of the antenna. Test in both static and dynamic water environment to verify transmission, reception, and direction finding characteristics. Output of Phase II is the FDM and associated test report.

N92-053 **TITLE:** Universal Submarine Electronics Equipment Packaging

CATEGORY: Engineering Development

OBJECTIVE: To develop a low-cost universal packaging approach for the use of commercial electronics equipment onboard submarines.

DESCRIPTION: As a result of increasing construction costs, the need exists within the Navy for a low-cost alternative to the current installation approach for electronics equipment onboard submarines. Significant expense is normally incurred in efforts to repackage readily available commercial equipment on a case by case basis to ensure its survival in the submarine environment. The investigation should include the development of a low-cost packaging approach that provides for adequate protection, operation and maintainability of commercial electronics equipment with respect to the shipboard environment, while providing universal application to the wide range of commercial electronics equipment under consideration.

Phase I: Define the range of problems associated with candidate commercial electronics equipment and identify the necessary constraints and requirements for application of a low-cost packaging approach.

Phase II: Generate potential low-cost packaging approaches, conduct trade-off analyses, generate prototype design and evaluate the prototype design utilizing modeling techniques and prototype hardware as appropriate.

N92-054

TITLE: Light Weight Shipboard Electronic Equipment Enclosures

CATEGORY: Engineering Development

OBJECTIVE: To develop a light weight environmental electronic equipment enclosure design for general shipboard Combat Systems applicability.

DESCRIPTION: Significant shipboard weight decreases could be achieved by the development of light weight electronic equipment enclosures for submarine Combat Systems applications. There is a significant potential for the achievement of decreases in the structural weight of current environmental electronic equipment enclosures by application of new materials and construction techniques. Innovative application of materials and construction techniques to the design of shipboard electronic equipment enclosures should lead to the development of light weight Combat Systems environmental electronic equipment enclosures.

Phase I: Define specific areas for improvement, identify alternative design/construction techniques, and analyze/assess potential improvement and feasibility. Assess overall impact on performance, cost, size, health & safety factors and any other significant aspect effected by the postulated alternatives.

Phase II: Evaluate the alternative design/construction areas having high potential/feasibility, generate a prototype design, and evaluate the prototype design utilizing modeling techniques and prototype hardware as appropriate.

N92-055

TITLE: Tethered Airborne Imaging System

CATEGORY: Advanced Development

OBJECTIVE: Develop a tethered imaging device capable of extending the imaging capability of submarines and surface ships.

DESCRIPTION: See Phase I below:

Phase I: Investigate the feasibility of developing a stable inflatable device deployable from submarine and surface ships capable of carrying an imaging system payload of up to 20 lbs in winds of up to 70 mph without grounding.

N92-056

TITLE: Automated Software Regression Testing, Analysis, and Reporting

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate the application of PMO 411's Data Capture system to automated testing. Identify specific analysis tools and processes and develop supporting software.

DESCRIPTION: See Phases I and II below:

Phase I: Review existing capability of Data Capture System. Evaluate storage requirements, process scenarios, reporting requirements and other aspects of the Data Capture System to support automated regression testing. Address the configuration control of benchmarks. Investigate the effect of operator sequencing and timing on the comparability benchmarks with regression test results. Propose tool set to be developed in Phase II to assist in automated regression testing. Prepare a Software Development Plan and a tools philosophy. Evaluate the use of the ADA language for development. Prepare cost benefit analysis for the use of Data Capture System in regression testing situation.

Phase II: Develop tool set to support automated regression testing using PMO 411's Data Capture System. Use ADA as the development language unless otherwise authorized. Establish benchmarks for AN/SQQ-89(V)6. Validate benchmarks. Test the performance, correctness, completeness and compatibility of tools in the tool set. Prepare design, operation, and maintenance documentation. Establish the Configuration Control Plan and Procedures for tools and benchmark data.

N92-057

TITLE: Accelerated Life Test Development for Determining the Reliability of SSN-21 Hull Coatings

CATEGORY: Engineering Development

OBJECTIVE: Provide a means of quantifying the expected life of selected hull coating systems for the SSN-21.

DESCRIPTION: As the SSN-21 enters service the reliability of the hull coating system is unknown, and the repair frequency and need for replacement is a major price consideration. A test is needed to provide a means of ranking coating system candidates for life expectancy, providing data on repair frequency for final coating systems, and to provide a means of evaluating coating improvements in future builds and upgrades. The accelerated life test design must take into account all stresses which hull coatings aboard an SSN-21 would experience. The test must be standardized and repeatable over a time frame approaching 15 years, e.g. as

new coatings become available the test must be sufficiently robust that data collected in 1995 are comparable to data collected in 2010. In order to be useful the test design should be directed toward life evaluations out to 15 years, with a test length of less than 1.5 years.

Phase I: Develop an accelerated life test design which thoroughly emulates the Fleet stresses the SSN-21 hull coatings will undergo in 15 years of service. Test articles are expected to be approximately 0.5 meters square.

Phase II: Develop a prototype test facility for the life evaluation of hull coatings. Test three candidate coating articles in a six month verification effort. Based on these results provide a final accelerated life test design for SSN-21 hull coating evaluation.

N92-058 TITLE: Non-Destructive Bond Evaluation for Submarine Hull Coatings

CATEGORY: Engineering Development

OBJECTIVE: Develop a Prototype Device for Bond Inspection of submarine Hull Coatings Systems.

DESCRIPTION: The SSN-21 submarine uses hull coatings in variety of applications. These coatings are polymeric in nature, bonded to the external hull, and are expected to last through the life of the boat, or at a minimum through a full yard cycle. The life of these coatings is determined to a large extent by the quality of the rubber to metal bonds between the coating and hull. To insure the quality of these bonds an inspection technique is required which can scan large surfaces at high rates, identify the location of debonded sites in real time, and be sufficiently user friendly to be operated effectively by shipyard personnel. Inspection coverage should approach 100, but should be selectable to allow sampling to make the determination of the need for 100% coverage.

Phase I: Conduct a trade study to determine the best non-destructive inspection (NDI) technique(s) for conducting the inspection and provide a notional design of the system which is ruggedized to withstand the shipyard environment.

Phase II: Fabricate and test a prototype NDI system capable of inspecting a 3 square meter area in less than 3 minutes. After prototype fabrication and testing at the laboratory level provide a system design capable of inspecting all coated areas of the SSN-21.

N92-059 TITLE: Innovative Management Concepts for Modal Analysis and Testing

CATEGORY: Exploratory Development

OBJECTIVE: Develop improved procedures for instrumentation installation and data reduction to reduce costs of Navy ship underwater shock testing.

DESCRIPTION: Continuing advances in modal analysis capabilities and decreases in sensor costs has resulted in the desire for increased usage of gages during shock tests. As a result, NAVY shock tests contribute significant amounts of time and money to gage installation and data reduction. Cost and time saving measures, such as quicker and more efficient calibration and installation procedures as well as less expensive data recording methods, need to be implemented.

Phase I: Conduct concept, feasibility and cost reduction studies of instrumentation installation and data reduction procedures in support of planned full scale surface ship and submarine shock tests as well as underwater explosion vehicle tests. Provide a final report with a summary of findings.

Phase II: Conduct more detailed feasibility studies during actual pre-test preparations. Upon NAVY approval, pursue integrating the concepts into standard test operations procedures. Deliverables for this phase include, but are not limited to, providing all necessary hardware and support to integrate the approved concepts, such as manufacturing specialized equipment, developing computer software or providing training programs.

N92-060 TITLE: New Methods of Conducting Submarine Maintenance and Repairs While Waterborne

CATEGORY: Exploratory Development

OBJECTIVE: Develop new methods of maintaining, repairing, and inspecting submarine systems and components located in free-flood areas while the submarine remains waterborne.

DESCRIPTION: Due to increasing intervals between depot level availabilities, the Navy requires new ways of conducting submarine maintenance, repairs, and inspections which in the past have required the ship to be placed in drydock. New methods must meet Navy safety requirements and be within the capabilities of submarine Intermediate Maintenance Activities (IMAs).

Phase I: Phase I of the project should identify new concepts to be used, systems or components the concepts apply to, the relative pay-back to be expected over existing methods, technical development risks involved, risks to ship and personnel safety, and a description of the Phase II effort.

Phase II: Phase II would require full scale prototype development of the actual technology required and demonstration of it in a Navy IMA environment, as well as further development to a final configuration. The contractor will be expected to deliver the final procurement specifications and contract CDRL requirements for inclusion in a system procurement solicitation for Phase III.

N92-061

TITLE: New Applications of Underwater Ship Husbandry (USH) Technologies to Submarines

CATEGORY: Engineering Development

OBJECTIVE: Apply existing technologies of USH to maintaining, repairing, and inspecting submarine systems and components.

DESCRIPTION: Due to increasing intervals between depot level availabilities, the Navy requires new ways of conducting submarine maintenance, repairs, and inspections which in the past have required the ship to be placed in drydock. New methods must meet Navy safety requirements and be within the capabilities of submarine Intermediate Maintenance Activities (IMAs).

Phase I: Phase I of the project should identify existing USH technologies currently in use on Naval surface ships or commercial ships which can be applied to Naval Submarine systems and components, the submarine systems or components the technology can be applied to, the relative pay-back to be expected over existing methods, technical development risks involved, risks to ship and personnel safety, and a description of the Phase II effort.

Phase II: Phase II would require modification of existing technologies as necessary, and subsequent demonstration of it in a Navy IMA environment on submarine systems or components. After adequate demonstration, the contractor will be expected to develop and deliver final procurement specifications and contract CDRL requirements for inclusion in a system procurement solicitation for Phase III.

N92-062

TITLE: Information Resources Management (IRM) Project Manager Tools

CATEGORY: Exploratory Development

OBJECTIVE: Define management techniques and develop automated tools which help government program managers control ADP system design, development, implementation & change processes.

DESCRIPTION: Various unintegrated tools exist which perform separate tasks under the purview of the Project Manager of data systems. The ideal tools and methodology should integrate the ability to establish functional requirements, prioritize the requirements in phased development schedules, track development of the product baseline against the requirements, assess product quality and manage changes throughout the system life cycle.

Phase I: Includes analyzing candidate methodologies and tools formulating a strategy for management of ADP development projects, integrating off-the-shelf software tools to support the management strategy and establishing criteria for tailoring the methodology and tools to the unique requirements of individual ADP development projects. The products of Phase I will be documentation describing the management strategy and prototype tools.

Phase II: Includes refining concepts developed in Phase I for an ADP development project selected by the government, implementing the management strategy for the selected project and completing development and integration of the prototype automated tools.

N92-063

TITLE: Submarine System Value Engineering

CATEGORY: Exploratory Development

OBJECTIVE: To develop components, methods, or techniques that reduce the cost of acquiring and operating systems on submarines without compromising performance.

DESCRIPTION: The combat capability of submarines depends on silent operation, high-performance electronics, sensitive sensor arrays, and survivable support systems. These systems are inherently complex and expensive. Innovative concepts are sought to reduce the cost of these systems, to simplify their installation, to make them more reliable, or to reduce their crew requirements without significant sacrifices of performance.

Phase I: Determine the feasibility of the proposed savings approach through analysis and supportable cost-benefit comparisons.

Phase II: Construct and test a proof-of-principle demonstrator.

N92-064

TITLE: Towed Array Handling

CATEGORY: Exploratory Development

OBJECTIVE: To reduce the complexity, cost, and ship impact of towed sonar array handling systems. Submarines use towed sonar arrays to reduce the influence of noise generated by own ship.

DESCRIPTION: The arrays themselves are long to maintain directivity at very low frequencies. The long tow cables and arrays require complex and expensive reeling machines and stowage drums that consume valuable space aboard ship. Simpler, smaller, less expensive alternatives are required for handling towed arrays on submarines.

Phase I: Provide a detailed functional description of the proposed system and determine its feasibility through design analysis.

Phase II: Construct and test a proof-of-principle demonstrator at a scale suitable for testing with a small boat.

N92-065

TITLE: Composite Materials Applications for Cost Savings

CATEGORY: Exploratory Development

OBJECTIVE: To develop fabrication methods and installation techniques that use composite materials to reduce the cost of structures and components used in submarines.

DESCRIPTION: Composite materials offer potential savings in structural weight but the high-performance matrix polymers that meet submarine requirements for low flammability, longevity in sea water, minimal outgassing, and the like are typically quite expensive. Components made of composite materials are sought that reduce the cost of total acquisition, including fabrication, installation aboard ship, testing prior to ship delivery, and maintenance cost through the life cycle.

Phase I: Provide a detailed description of the component proposed, the material system proposed, the fabrication technique applicable to its manufacture and a supportable cost analysis.

Phase II: Construct and test a proof-of-principle demonstrator.

N92-066

TITLE: Submarine Electronic Power Service

CATEGORY: Exploratory Development

OBJECTIVE: To develop a reliable, sustainable power system to support the strict power continuity requirements of submarine combat systems.

DESCRIPTION: Combat systems on submarines need electrical power support systems that can carry them through supply outages caused by switching between unparalleled AC sources. The existing system that converts AC to DC for dual-source auctioneering through diodes is heavy, complex, and expensive. A simpler, lighter, more reliable means of power supply is required. The eventual system must have a capacity of 75 kilowatts and survive outages of 100 milliseconds.

Phase I: Determine the feasibility of the proposed power supply system through analysis and breadboard system design.

Phase II: Construct and test a proof-of-principle demonstrator with a capacity of 5 to 10 kilowatts.

N92-067

TITLE: Submarine Silencing Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop components, methods, or techniques that reduce the cost of limiting the noise emanated by submarines.

DESCRIPTION: Silent operation is a key factor in submarine performance. Resilient machinery mounts, close tolerance machine elements, noise damping, and active noise cancellation being used or studied are expensive in terms of weight, ship volume consumed, acquisition cost, installation effort, and maintenance requirements. Innovative concepts are sought to reduce the cost and ship impact of silencing submarine systems.

Phase I: Determine the feasibility of the proposed silencing technique by comparing its quieting performance with that of existing methods and by providing supportable cost-benefit comparisons.

Phase II: Construct and test a proof-of-principle demonstrator.

N92-068

TITLE: Classroom of the Future

CATEGORY: Exploratory Development

OBJECTIVE: To tailor methodologies and technology of modern personnel training techniques for integration into the aegis training center classroom of the future initiative.

DESCRIPTION: The AEGIS Training Center (ATC) conducts its technical training by conventional methods with limited use of interactive video trainers, video tapes and part task trainers. Training tasks are becoming more complex due to the increasing sophistication and capability of shipboard electronic systems while demographic data predicts that the number and skill level of Navy trainees will decline over the remainder of this decade. Furthermore, it is anticipated that the ATC operating budget and instructor staff will be decreased. The technical training mission is becoming more difficult while resources are being restricted hence there is a challenge on how to do more with less.

The technical work is to determine the effectiveness of current training methods and seek improvements in the following areas, 1) advances in technology of knowledge in training which are more effective than ones currently employed, 2) remediation for students when existing techniques are unsuccessful, 3) requirement that less skilled trainees do not require longer training courses, 4) ways to obtain more productivity from instructors, and 5) teaming of instructors to insure each course is taught by most highly skilled teacher.

Phase I: Produce a plan for improvement of ATC training.

Phase II: Implementation the plan for improvement of ATC training. Phase III transition to implementation of a fully integrated program is likely.

NAVAL SURFACE WARFARE CENTER

N92-069

TITLE: Advanced Computer Code Development for Underwater Explosion Analysis

CATEGORY: Research

OBJECTIVE: Computational Analysis of Underwater Explosion Fluid-Structure Interaction. The objective of this SBIR project will be to demonstrate the interaction of underwater explosions with naval structures: examples of "coupled" problems in the analysis of fluid-structure interaction.

DESCRIPTION: Current capabilities of Continuum Mechanics computer codes fall short of some requirements for practically modeling the interaction of underwater explosions with naval structures. Fundamentally, a code must be capable of analyzing both Fluid Dynamics and Solid/Structural Mechanics behavior in a coupled fashion, since this is a coupled problem. The Fluid Dynamics algorithms must include multiple material, compressible, reactive and multiphase flow capabilities. The Solid/Structural Dynamics algorithms must handle high strain rate, large strain and strain-rate dependant material behavior, in both a Solid Mechanics (continuum) sense and a Structural Dynamics (shell and beam) sense.

An available method for such analyses is the Coupled Eulerian-Lagrangian approach, in which the fluid (modeled within an Eulerian framework) is fully coupled to a structure (modeled within a Lagrangian framework). Under development are Arbitrary Lagrangian-Eulerian codes in which the discretization is confined to neither a Lagrangian or Eulerian framework, and Boundary Element codes in which material interfaces and other boundaries are discretized in a Lagrangian sense. It is anticipated that an SBIR topic will expand on these ideas or develop newer ones. An example of an undemonstrated technology is the Free-Lagrange or Particle Hydrodynamics method, in which Lagrangian elements or particles are free to move in the flowfield, overcoming the most limiting factor of Lagrangian analyses as applied to fluid motions.

The final produce must be available in a high-level standard language source code that is not machine-specific. It must be modular in the sense that changes and additions can easily be incorporated. The code must handle three-dimensional geometries, but must also be capable of analyzing simpler two-dimensional cases. The code must not be limited to fluid-structure interaction problems; it must be versatile enough to handle standard "hydrocode"-type analyses: penetrators, shaped charges, etc.

Phase I, as a feasibility study, should demonstrate the applicability of the chosen method to the underwater explosion fluid-structure interaction problem.

Phase II will be the development of the technique(s) into a viable and usable product; this includes the generation of full documentation, the integration of user-friendly pre-and post-processor, the validation of the code(s) with benchmark test cases for comparison with data provided by the Navy, and likely the porting of the code(s) to vectorized and/or parallelized machines.

Anticipated Phase II transitions include the adaption of the chose method to fields outside the underwater explosion arena, including other highly dynamic fluid-structure interaction problems: nuclear reactor design, airblast simulation, etc.

N92-070 TITLE: Optical Signal Enhancements for Optical Digital Computing

CATEGORY: Exploratory Development

OBJECTIVE: To develop and provide a passive optical generator for use in an optical digital computer which uses self electro-optic self.

DESCRIPTION: Self electro-optic effect devices (SEEDs) are currently available to control and enhance optical transmissions passing from one optical device to another in optical networks. SEEDs are useful in optical computing networks where they will be used to boost or refresh optical power or to act as efficient optical switching devices. A passive optical element which acts as a generator of a two dimensional light array from a laser diode is needed for use with SEED(s) in optical digital computing. The generator must work with an optical wavelength of 850 nanometers, be compact in size (less than 31 mm in diameter), and must generate equally spaced light spots of equal optical power.

Phase I - Construct a prototype passive optical generator capable of producing a 6 by 6 light matrix array.

Phase II - Build the compact passive optical generator which produces a 64 x 64 light array for use in a to-be-specified optical computing system.

N92-071 TITLE: Infra-Red Detector Array on a Silicon-Compatible Substrate

CATEGORY: Advanced Development

OBJECTIVE: Fabricate photovoltaic semiconductor infra-red detector array of magnesium silicide overlaying (100) silicon.

DESCRIPTION: The substrate at the focus of this project has the following attractive features: a) Good lattice-match with common narrow-gap semiconductors. b) Affinity to Si. Recent work reports the successful growth of Si/Mg₂Si. c) The Mg₂Si fluorite structure is known to promote growth of good epitaxial quality of some narrow-gap semiconductors. d) Mg₂Si is transparent in the IR. The present approach may provide an alternative to other approaches to bridge the lattice constant and thermal expansion gap between Si(100), the standard electronics material, and common narrow gap semiconductors.

Phase I is a feasibility study of fabricating di-magnesium silicon on top of a (100) silicon wafer. The study will be comprised of 1) exploring the formation of Mg₂Si by deposition of Mg on a clean (100) Si surface. The ensuing silicide layer will be characterized for its epitaxial quality and morphology. If necessary, further anneal treatment will be devised to improved epitaxial quality. 2) Establishing the mechanical endurance of the Mg₂Si layer under thermal recycling between room and liquid nitrogen temperatures.

Phase II of the project will be comprised of deposition of s semiconductor IR detector and a small array of detectors on the silicide and testing the performance and mechanical endurance of the structure under the thermal recycling described above.

N92-072 TITLE: Rapid Data Access Through Optical Processing

CATEGORY: Exploratory Development

OBJECTIVE: Development of a high density optical information storage material for parallel optical processing systems.

DESCRIPTION: Naval systems must store and access ever increasing amounts of data in target signature libraries which characterize the many targets or false targets encountered by sonar surveillance systems. These data banks must be rapidly accessed to allow the earliest identification of threats. Improved surveillance and signal processing systems of the future will use larger signature libraries and will require parallel optical processing systems to store, access and reference data. Parallel optical processing begins with a addressable memory unit with very high density storage and very fast access capability. Novel materials which exhibit resolution in microns, can be addressed in nanoseconds, and can be affordably produced are sought. Photochromic materials suitable for high density memory units should be tested in the laboratory to characterize their photochemical and photophysical properties for use in an optical processing system.

Phase I: Characterize a suitable photochromic materials for use in the memory unit of a high density, fast access, parallel addressable optical information system.

Show feasibility of material use based on its performance, its ease of device fabrication, and its suitability for use in optical processing.

Phase II: Conduct an engineering analysis of an addressable memory device built of the material shown to be feasible in Phase I. Fabricate and test a breadboard high density optical memory unit which could be part of a future phased array optical scanning system having nanosecond access time.

N92-073

TITLE: Cost-Effective Ingredients for High Performance Underwater Warheads

CATEGORY: Exploratory Development

OBJECTIVE: To develop low cost methods for making a new chemical intermediate called pentafluorosulfanyldichloroimine or $SF_5 = CCl_2$. This key intermediate can lead to underwater explosives with improved performance and reduced safety hazards.

DESCRIPTION: Pentafluorosulfanyl (SF_5) compounds are of interest as ingredients of explosives, especially high-yield underwater explosives, and pyrotechnic compositions. $SF_5N=CCl_2$ has recently been used to prepare a number of energetic SF_5 plasticizers/solids that exhibit improved physical and explosive properties (high density, low volatility, decreased sensitivity). Other uses for $SF_5 = CCl_2$ (preparation of energetic polymers, etc) can be anticipated, but the overall utility of $SF_5N=CCl_2$ is limited by its high cost.

The Phase I effort would identify and evaluate novel approaches to the economical synthesis of $SF_5N=CCl_2$. This effort would demonstrate feasibility and promising procedures would be scaled up to provide quantities of $SF_5N=CCl_2$ to NAVSWC for testing.

Phase II will optimize the scale-up and use of the SF_5 intermediate to produce energetic materials which will be supplied to NAVSWC for further testing.

In Phase III, sufficient quantities of new improved SF_5 energetic materials (made in Phase II) will be provided to formulators of underwater explosives for evaluation (performance, sensitivity, etc).

N92-074

TITLE: New, High-Pressure Underwater Gauge for Warhead Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: To develop a new underwater pressure gauge for measuring higher shock pressures than can now be measured with piezoelectric gauges.

DESCRIPTION: The piezoelectric gauges currently used for measuring the shock pressure generated by an underwater explosion fail at 10 kbar (100 GPa); the data based on these gauge measurements cannot be extrapolated to the region close to the target where the severe damage occurs. The use of the new, high pressure underwater gauge will permit the detailed investigation of phenomena affecting the lethality of underwater warheads, such as the measurement of the loads on a target from bow shocks of shaped-charge jets and the study of the reactions occurring in the products of an underwater explosion.

The new underwater pressure gauge shall operate in the pressure range of 3 to 250 kbar (30 to 2500 Gpa), with a response time of less than 0.1 microseconds, a recording time of at least 50 microseconds and a desired measurement accuracy of 5%. The sensing area of the gauge should be less than 2 mm in diameter to allow use with curved shock fronts and small explosive charges. The underwater shock shall be produced in accordance with reference (1).

Innovative ideas are sought, however, one possible approach is to mount a ruby crystal on the end of an optical fiber, excite the ruby with a laser, and measure the pressure-induced fluorescence shift of the ruby with a spectroscope. The optical fiber serves to conduct the laser beam to the ruby and to return the fluorescence data to the spectroscope. The line shift could be measured with a silicon diode array or a streak camera.

Phase I shall test the feasibility of the concept. A prototype system will be developed to the point where it can produce a pressure vs time measurement for a shock known to be above 50kb (500 MPa). This will test probe survival, response time, and recording time. Thermal effects at the probe need not be removed from the pressure vs time records during Phase I. Proposals for Phase I shall contain probe designs, expected required instrumentation, and a feasibility study on the expected results from a gauge when placed near an immersed 82 mm diameter pentolite sphere (see reference (1)). The gauge response is desired at distances of 5, 40, and 100 mm from the surface of the sphere. The corresponding peak pressures are 102, 19, and 6 kbar and the times for the pressure to fall to half of peak are 6, 11, and 19 microseconds.

Phase II shall produce a laboratory instrument. A prototype system built with improvements suggested by Phase I would be subjected to testing by NAVSWC. From these tests, NAVSWC would evaluate and/make suggestions or further improvements. Phase II would result in several pressure probes and instrumentation capable of making underwater pressure measurements for explosive experiments. In Phase II, direct comparisons will be made with standardized results with other gauges. Phase II will include processing of the raw measurements to remove thermal effects at the probe.

N92-075

TITLE: Methodology for Predicting Fragment Induced Damage to Operating Missile Batteries

CATEGORY: Exploratory Development

OBJECTIVE: Develop methodology to predict the change in output from operating missile batteries resulting from warhead fragment impacts.

DESCRIPTION: Methodology shall be developed to predict the failure of an operating missile battery attacked by warhead fragments. Little work has been conducted to determine and understand the damage modes and failure mechanisms on missile batteries due to high velocity fragment impact (up to 16000 ft/s). The batteries of interest are 27-30 volt dc, chemical action, single-usage, reserve-type. Voltage and current vs. time history of the batteries under load after fragment impact is of interest.

Phase I: The effort would involve postulation of the failure mechanisms, a predictive methodology and a general test plan.

Phase II: The effort would involve specific test planning, conduct of the tests and finalization of the model.

N92-076

TITLE: New Generation Vulnerability/Lethality Computational Process

CATEGORY: Exploratory Development

OBJECTIVE: Develop a new, highly integrated, modern vulnerability/lethality computational process

DESCRIPTION: The vulnerability, lethality (V/L) and survivability computational process for conventional weapons involves computerized geometric modeling, preparation of vulnerability-specific information such as component Pkh functions, the tracing of shotlines through the geometric models to produce intermediate vulnerability measures (vulnerable area tables), which are then handed over to an end-game code for the generation of kill probabilities. This process is embodied in a number of stand-alone computer programs (FASTGEN, COVART, JSEM, etc.), which was appropriate for the computer technology of the time. But newer computer technology may allow significant improvements by integrating the process into one seamless computing environment. It may even be possible to eliminate one or more of the intermediate steps in the current process by adopting a new approach to the V/L process itself.

Phase I: This task should explore the possibility of developing a new highly integrated V/L process that will greatly improve the accuracy, efficiency, and ultimately time and cost to evaluate the lethality of new and existing weapon systems.

Phase II: Collect and review current codes and assessment processes, and computer hardware and software options; develop an overall concept and preliminary system design.

N92-077

TITLE: Target Aim Point Selection Based on Optical Processing of Infrared Images

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an optical processing system capable of unambiguously recognizing target features of certain temperatures in an infra-red image, in real-time.

DESCRIPTION: Optical processing systems have been successfully developed for real-time correlation of two dimensional objects. However, all of these correlator systems still have limitations in terms of scale, rotation and distortion invariancy, which significantly reduces their potential application in autonomous smart weapon systems. Another formidable problem associated with the use of optical correlators for automatic target recognition is the inability to identify specific features on targets of interest for accurate terminal phase homing. What is needed is a new and innovative approach to the design of an optical correlator system capable of inputting an infrared generated scene and extracting and recognizing target features of selected temperature characteristics in the presence of clutter. Phase I should consist of the development of the theory and algorithms and an optical architecture concept. Some limited optical bench demonstration of some features of the design is desirable. Phase 2 should result in the detailed design, test, demonstration and delivery of a working prototype system, including all optics, lasers, input/output interfaces, post processors, and special devices, such as spatial light modulators, assembled on a compact, easily transportable base.

Phase I: Development of theory, algorithms, architecture and limited Demonstration of key concepts.

Phase II: Design, development, demonstration and delivery of prototype system.

N92-078

TITLE: Nondestructive Evaluation for Ceramic Matrix Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop the principles, concepts, design, and construction of prototype equipment for the nondestructive evaluation of ceramic matrix composite radomes before and after firing.

DESCRIPTION: Ceramics of suitable dielectric and mechanical properties are used by the Navy for radome applications. Ceramics reinforced by non-reacting whiskers and fibers are being developed for improved radome performance. Nondestructive testing techniques are needed to assist process development, parts fabrication, and product verification. Of particular interest are devices that can be transitioned to radome manufacturing facilities at the end of Phase II.

Phase I: Proposer must consider the physical properties of ceramic composites and secure test specimens for proof of concept testing and demonstration in Phase I. Devices that can simultaneously assess multiple properties, microstructure, and defects are sought. Measurement techniques based on optics, microwave, thermography, laser/ultrasound, and other safe, remote sensing approaches are acceptable.

Phase II: Construct and deliver a Prototype Instrument.

N92-079

TITLE: Measurement of Shipboard Coatings to Prevent Corrosion Failures

CATEGORY: Exploratory Development

OBJECTIVE: To develop a novel, non-destructive method for rapidly predicting coating failure of shipboard equipment in marine environments.

DESCRIPTION: In a corrosive marine environment, polymer and barrier coatings are used to protect exposed aluminum, magnesium, or steel alloy structures or electronic equipment. These coatings must provide corrosion protection over long periods hence damage of them can cause early maintenance problems or even catastrophic failure of structures or equipment. Laboratory coating studies or characterizations can provide estimates of useful life but individual coating effectiveness varies widely due to environmental conditions, coating quality, and processes used in their application. A method of examining organic coatings and paints on ships is needed to determine if they are beginning to fail, i.e., if their corrosion protective performance is decreasing. It is envisioned that shipboard inspections would be done periodically and weak coatings would be identified by changing instrument readings.

Phase I: Identify the methods and instrumentation needed to examine coatings. Limited testing of coatings should be reported to show feasibility.

Phase II: Develop the instruments and test procedures to rapidly determine the effectiveness of anti-corrosion coatings on shipboard equipment and structures. Perform shipboard or marine environment tests to determine efficiency of the system and provide confidence in its use.

N92-080

TITLE: Ocean Environment Sensor

CATEGORY: Advanced Development

OBJECTIVE: Development of an ocean environment sensor.

DESCRIPTION: Detailed knowledge of ocean environmental parameters is needed as an input to radar ducting and electro-optical sensor models used to predict the performance of shipboard surveillance systems. A requirement exists for a sensor that provides real time reports of ocean temperature, air temperature, and relative humidity to a surface ship from distances out to the horizon. Additionally, the sensor should measure wave slopes and provide wave directional information. The sensor may be expendable or employ remote sensing techniques. An expendable sensor should be easily deployable from ships and possibly helicopters, and be able to function for several hours.

Phase I: Conduct a feasibility and design study. Sensor performance requirements will be defined, and a complete system design will be formulated. This will include the sensor package, and in the case of an expendable sensor a deployment mechanism, data transmitter and receiver, and data display and analysis. A critical design review will be conducted and a final report issued.

Phase II: Fabricate and field test units, and define a production design. Preliminary testing will be conducted in a laboratory environment followed by at least two ocean trials. A critical design review will be conducted after each test. A complete system production design will then be finalized and final report issued. Phase III will consist of system production and operational testing.

N92-081

TITLE: Methods for Early Submarine Classification

CATEGORY: Exploratory Development

OBJECTIVE: To find methods for processing active sonar returns which will allow earlier classification of submarines.

DESCRIPTION: Recent theoretical advances have been made in identifying the spectral components of the echo return of wide band sonar signals reflecting from submarine-like targets. For example, bi-spectrum techniques and the Wigner-Ville distribution represents methods to minutely study the acoustic echo spectrum. It is conceivable that this spectrum is mathematically overcomplete, i.e., that some spectral components could be obtained from sufficient partial spectrum is available. Experimental studies are needed to determine the vibrational pattern of submarine models versus sonar frequencies from 3-60 ka. Surface vibrations of submarine models of about 2 cm in diameter will be measured and compared to its effect in theoretical acoustic echo predictions.

Phase I: A theoretical analysis of the submarine model acoustic echo spectrum for simple geometric shapes which uses the latest techniques in making predictions and displaying vibrational modes. Feasibility of using this analysis with measurements should be demonstrated.

Phase II: The construction and testing of several submarine models and the determination of methods for early classification of submarines.

N92-082 **TITLE:** Non-toxic Coating to Replace the Cadmium Coating Used on Naval Fasteners

CATEGORY: Advanced Development

OBJECTIVE: To replace the cadmium plating used on Naval fasteners with a non-toxic coating without degrading corrosion protection or bonding strength.

DESCRIPTION: A replacement coating and its application process for cadmium plating and its chromate wash are desired for fasteners made from low carbon and alloy steels. Cadmium is a toxic metal. Redistribution of cadmium within the environment is not desired. Replacement feature for feature is required; improvement in a feature at the expense of another is not viewed desirable at this time. In addition, instances have been reported with corrosion products bridging electrical gaps and causing significant electrical shorting problems.

Phase I: Address definition of the attributes of the cadmium plating and its chromate wash and select material and process candidates for evaluation and the criteria; including multiple retightening, salt fog, acid salt fog, alternate immersion, salt atmosphere, scratch test.

Phase II: Fabrication and initial evaluation of specimens will be addressed in Phase II as well as new candidates and processing modifications. Final evaluation of the candidate will be required at facilities at NAVSWC or the equivalent. Upon completion of the evaluations and documentation, independent Phase III transitions to hardware will begin (e.g., ECP preparation). Cost of the applied coating on an assortment of fasteners is a critical criterion.

N92-083 **TITLE:** Underwater Tactical Data Link

CATEGORY: Exploratory Development

OBJECTIVE: Develop an underwater tactical data link to link surface and underwater assets.

DESCRIPTION: An underwater tactical data link with the surface is desired to integrate and fully utilize all Navy assets. This would require a modest bandwidth underwater link with a range of up to a hundred miles. There are various issues such as propagation delay, signal attenuation, and multipath that must be addressed.

Candidate technologies for the data link could be acoustic, laser, remote RF-to-acoustic buoy or any other viable technique.

Phase I: Determine operational characteristics of the data link and the best technique. Problem areas would be identified and several methods of implementation will be studied. A final report will document all work and choose the most feasible technology.

Phase II: Implement the best technology from Phase I to construct and test a prototype. The final report should contain design analysis and details, complete specification, and test results and evaluation.

N92-084 **TITLE:** Specification Tree for Federal, Military and Industrial Standards

CATEGORY: Exploratory Development

OBJECTIVE: To develop a software tool and methodology to monitor changes in specifications and drawings

DESCRIPTION: Changes in specifications and drawing are not easily monitored by non-developing or non-controlling users.

Phase I: Define the needs for and attributes of a multilevel flow chart tool suitable for tracking macro changes in Federal, Military, and Industrial standards, such as termination, cancellation, succession, for assemblies through major combat or warfare systems. Phase I would also provide a working model.

Phase II: Determine computer requirements necessary for the hierarchical flow of interrelationships between the specifications and drawings, as well as direct access to the individual specification. A very user friendly tool is needed to limit training time and to encourage updating and use. Phase II will also address the need for the ability to monitor individual changes, such as notices for the covered specifications. Phase II will provide a software tool and documentation capable of flowing through five levels of both drawings and specifications, as well as implementing global search and replace features. Phase III would consist of marketing software and documentation to individual users.

N92-085

TITLE: Identification of Critical Design Components of a Real Time Complex Distributed System

CATEGORY: Exploratory Development

OBJECTIVE: To develop an expert system/simulation that will identify critical components (hardware/software) using the criteria of reliability, cost, fault tolerance, and performance in a proposed design of a distributed system.

DESCRIPTION: With the development of real time distributed systems in Navy weapons systems, a need has arisen to determine quickly whether a proposed architectural design encompassing both the hardware and the software will meet the design specifications of the system. The task will be to develop an expert system incorporating a rapid prototyping of the proposed design for simulation purposes to aid in determining if the proposed design meets the specifications. The specifications could involve reliability constraints on both the hardware and the software; performance considerations in regards to throughput, message handling, error recovery; and cost considerations. The user will be able to enter in these constraints and performance specifications as well as a proposed system design and an anticipated operating environment. The expert system will then, using both its knowledge base and simulation capabilities, determine critical components of the system. If potential problems are identified, the expert system may provide possible alternative designs to meet the specifications. The system will be flexible enough to allow various measurements (reliability, performance, cost, etc.) to be selected by the user from menus and/or define additional ones as needed. This expert system will be PC based either in a DOS environment or a MAC OS environment.

Anticipated users are any of the Navy sponsors involved in complex systems development. Applications are for command and control, weapons systems allocation, fire control, etc. Any system that is both heavily hardware and software based and where timing considerations for information sharing and processing is vital will benefit from this task. Benefits will result from cost savings, more reliable systems, and higher performance.

NAVAL UNDERWATER SYSTEMS CENTER

N92-086

TITLE: Multistatic Active Sonar: Contact Association and Data Fusion

CATEGORY: Advanced Development

OBJECTIVE: To develop automation for associating data and estimating the parameters of a Multi-Static Sonar (MSS) contact when the active transmission source is at a significant distance from the receiver.

DESCRIPTION: This automation must work in the presence of clutter, false returns, and other interference and must eliminate as much of the interference as possible. The MSS system consists of a low frequency high power source and multiple receive ships. The SBIR effort shall address only MSS information processing for a single ship; however, MSS contact information obtained from consorts shall be processed with own ship data. The issues include: associating contact returns from different type transmissions (e.g. CW and FM); associating returns from a contact which has been lost and re-acquired; associating MSS contact information from consorts; utilizing all MSS information available to provide the best estimates of contact characteristics (e.g. position, course, speed, class); eliminating false contacts (such as sea mounts), and clutter; and eliminating contact ambiguities (e.g. from wide, overlapping transmit beams or uncertainty in which transmit pulse caused a particular return).

The system developed under the SBIR effort will be required to process data recorded at sea, using an exo-byte tape recorder, and to interface to the MSS information processor, which was developed in "C" and runs on a SUN workstation. Measures of effectiveness and methods of testing are important to the overall effort.

The offerer must possess a SECRET clearance.

Phase I: Identify applicable automation; recommend methods for implementation; develop measures of effectiveness; determine methods for testing; plan for integration into MSS information processing; and demonstrate the automation in the laboratory.

Phase II: Develop the system to operate in real time, using recorded data and at sea, in parallel with the MSS information processing system.

Phase III: The Navy would recommend to commercial supplier(s) of MSS information processing systems the incorporation of a successful automation technique.

N92-087 TITLE: Energy Absorptive Resin Materials for Undersea Structure Radiated Noise Reduction

CATEGORY: Exploratory Development

OBJECTIVE: To develop energy absorptive structural resins for the fabrication of strong, stiff, and lightweight hull structures, propulsors, and isolation mount foundations, all of which are required to be acoustically inefficient structures.

DESCRIPTION: Advances in energy absorptive resin materials for composite structures are required to reduce the amount of acoustic energy transmitted to the seawater medium by excited underwater structures. Present state of the art involves the application of free or constrained layer damping materials to vibrating structures. The use of such additive treatments (rather than integrally damped structures) entails the penalty of reduced available volume and buoyancy.

Energy absorptive resin systems could be used to advantage in many variant forms. Highly damped structural resins could be used in composite material wet winding, resin transfer molding, and injection molding. Similar technology focused on syntactic foam materials could provide volume efficient, lightweight core materials suitable for sandwich construction of pressure hulls and bulkheads requiring energy absorptive properties.

The prime focus of this work should be chemical modification of existing structural resin systems (designed to enhance energy absorption without reduction of material strength or stiffness).

Phase I: This effort should demonstrate energy absorption in tests pieces that maintain the structural material properties of high strength resins. It is desirable to test for energy absorption over the widest possible band of frequencies; however, tests must cover the frequency band from 100 Hz to 4000 Hz.

Phase II: This effort would build on Phase I results by constructing a prototype 21" heavy walled tube, 48" in length with end fittings for closure or mating to similar tubes. The tube would be excited internally and evaluated on the basis of how much acoustic energy it radiates into the water medium and on its structural properties.

Phase III: The contractor would market successful materials to manufacturers of underwater structures. The Navy could be a customer for a limited amount of material for research purposes.

N92-088 TITLE: Low Frequency Spark Gap (Plasma) Transducer

CATEGORY: Exploratory Development

OBJECTIVE: Develop Low Frequency, High Level, Small Size Transducer Based On Spark Gap Technology.

DESCRIPTION: Given the current interest in low frequency sound generation, those systems which cannot allocate the size and weight constraints of traditional low frequency transducer types are in dire need of novel solutions to generating such signature. Therefore, it is necessary to investigate revolutionary methods at generating low frequency, high level signals from a relatively small envelope. One such technology that is worthy of renewed consideration due to advances in supporting technologies is the spark gap or "Plasma" transducer. The application may relate to sonobouys, countermeasure devices, mobile sources, laboratory measurement devices or towed or line arrays.

Phase I: Offer a complete transducer system design that would address lowest frequency attainable, realated source level, efficiency, power requirements and size. Provide a breadboard of the in-water spark gap element. Define all high risk areas.

Phase II: Optimize the spark gap element and provide a prototype of the complete system. Perform in-water tests to demonstrate system.

N92-089 TITLE: Solid State Optical Shutter

CATEGORY: Exploratory Development

OBJECTIVE: The primary objective is the development of a broadband, nonpolarizing, solid state optical shutter for the protection of optical sensors. The secondary objective is continuously variable optical attenuation of the shutter by means of voltage or current control. The ability to vary optical attenuation would permit the protected sensor to operate with increased dynamic range.

DESCRIPTION: The requirements for the primary objective of the solid state shutter development are the following. The shutter must operate in the visible to near infrared region of the spectrum with optical blocking capability of 7 orders of magnitude, that is, an attenuation equivalent to an optical density (OD) of 7. The device must have a risetime of 10 milliseconds or less with a clear optical aperture of 25 millimeters or greater. It must be optically nonpolarizing with a transmission in the "open" state of 75% or greater. It must be a failsafe device with the default condition being "closed" (i.e., optically opaque). The device must operate at

temperatures between -10C and 50C. Small size is essential: The desired design goal for the optical portion is 3 inches in diameter and 1 inch thickness.

The requirements for the secondary objective are the same as for the first. Additionally, the optical attenuation of the shutter must be variable from a minimum of 75% transmission to 7 OD (or greater). The attenuation should be predictably variable by means of voltage or current control.

Phase I: Devise the concept and design for a solid state optical shutter and conduct a proof-of-principle laboratory experiment.

Phase II: Development a working prototype solid state optical shutter meeting the requirements stated above.

NAVAL CIVIL ENGINEERING LABORATORY

N92-090

TITLE: Impact Mechanism(s) for Seawater Hydraulic Rock Drill

CATEGORY: Exploratory Development

OBJECTIVE: Identify and evaluate an impact mechanism(s) suitable for adaptation to a diver operated seawater hydraulic powered rock drill.

DESCRIPTION: A current model diver-operated seawater hydraulic rock drill uses a single poppet and kicker port to cycle a system consisting of a piston and anvil for providing percussive energy to the drill bit. The performance of this linear impact mechanism, which operates with seawater as the motivating fluid, has proven to be unpredictable and operationally unreliable. A new system is needed, with seawater as the working fluid, which can provide percussive energy necessary for rock drilling while being adaptable to a diver-operated tool.

Phase I: Evaluate a candidate impact mechanism(s) for required performance characteristics independent of its incorporation into the rock drill. This shall include design, fabrication, test and evaluation of a prototype impact mechanism(s). Design requirements include an impact frequency of 30-45 impacts per minute with energy of 6-7 foot-pounds. The test plan shall be sufficient to clearly demonstrate the feasibility of the concept and that it is suitable for adaptation to a diver-operated seawater hydraulic powered rock drill.

Phase II: Incorporate the successfully demonstrated impact mechanism developed in Phase I into an existing or custom designed rock drill for further performance evaluation. This work shall result in a complete prototype rock drill system which meets specified requirements, including a penetration rate of at least 3.5 inches per minute in 12,000 psi compressive strength rock for a 3/4-inch diameter drill bit.

N92-091

TITLE: Trench Cutting in Rock

CATEGORY: Exploratory Development

OBJECTIVE: Investigate, analytically model and demonstrate with laboratory scale physical model tests an innovative concept(s) for cutting trenches in seafloor rock.

DESCRIPTION: Current technology of mechanical rock cutting, such as using silicon carbide abrasives, results in high wear rates, frequent tool bit changes and low traverse speed. The need exists for a method of cutting long trenches one inch wide or larger to depths in excess of six inches in bedrock with a traverse rate of 2 ft/minute or greater. Typical rock that must be cut by the trenching mechanism includes basalt, greenschist, and granite. Technologies proposed must be applicable to automated operation while submerged in seawater. Rock cutting concepts must be accomplished with access to one surface of the rock only, and explosive techniques are not acceptable.

Phase I: A detailed report shall be produced which describes the concept and provides sufficient engineering analysis to substantiate its feasibility. Technologies identified must show the potential to be more efficient and effective than current industry practice. A test plan shall also be developed for physically demonstrating the concept in Phase II.

Phase II: Develop, test and evaluate a physical model of the concept(s) identified under Phase I. Model tests shall demonstrate the capability of the proposed system to cut rock while also providing data for determining specific cutting energy

and advance rates as a function of power input, trench size and type of material cut. A detailed report of the model test results shall include information required for full-scale development and testing of the proposed concept.

N92-092 TITLE: New Space Configurations for Reverse Osmosis Elements

CATEGORY: Engineering Development

OBJECTIVE: Develop new spacer designs for reverse osmosis (RO) spiral wound elements in order to reduce fouling while increasing the ability to periodically clean the elements.

DESCRIPTION: Commercially available RO elements employ a spacer material that separates two membranes to allow feed water to contact the entire membrane surface. There are indications that the current spacer configuration contributes to membrane fouling by forming "dead" areas of low flow behind spacer segments that contact the membrane surface, and are perpendicular to the direction of flow. Commercial users of the RO process provide extensive pretreatment to minimize fouling in their systems. Military RO equipment, however, provides minimal water pretreatment and are required to operate anywhere in the world. The military application therefore requires a spacer material that will accommodate poorer water quality than typical commercial uses.

Phase I: Design several RO element spacer configurations.

Phase II: Fabricate new spacer configurations and compare their effectiveness against current spacer designs in their ability to 1) keep RO elements from fouling, and 2) allow cleaning RO elements once fouled.

N92-093 TITLE: Miniature Navigation System for Divers and Small ROVs

CATEGORY: Exploratory Development

OBJECTIVE: Develop technologies for use in a self-contained system for navigation/positioning of divers and small ROVs.

DESCRIPTION: A current diver navigation method consists of an acoustic range-range system which requires the installation of two reference transmitters and that the diver carry a receiver/ processor unit. This system has a Circular Error Probability (CEP) of 3 ft. Applications exist for a small, easy to use navigation/ positioning system which could be used either by divers or by attaching it to a small (flying eyeball) ROV. The system should be completely self-contained and have a CEP of less than 6 ft with a normal mission duration of 2 hours. It should display for the diver (or ROV camera) a position, in X-Y-Z coordinates, referenced to magnetic north and the location from which it was initialized.

Phase I: The contractor shall develop and demonstrate the proposed system with proof-of-concept hardware and analysis. The prototype hardware will not be required to meet the less than 6 ft CEP, nor be miniaturized, nor operable underwater. However, accompanying analysis must show that, with applicable state-of-the-art components, the accuracy requirement could be met.

Phase II: Produce an engineering development model which would operate underwater, but would not be fully miniaturized. Phase II would include testing of the hardware in the ocean, on a range with benchmarks, to verify the accuracy of the system.

N92-094 TITLE: Downhole Propulsion Concept(s)

CATEGORY: Exploratory Development

OBJECTIVE: Develop and analytically model a new concept(s) for providing downhole propulsion in boreholes up to 4 inches in diameter. Validate the proposed concept(s) with laboratory scale component and system tests to determine power requirements, pulling capabilities and advance rates in various sediments.

DESCRIPTION: Downhole propulsion may be described as a process in which an automated mechanism pulls a pipe or cable through a borehole while simultaneously providing a method to develop the reaction forces necessary for forward advancement, such as by clamping against the wall of the borehole. The process would be used in conjunction with a downhole drilling mechanism such as that used for oil drilling or in coiled tubing drilling rigs. A need exists for a downhole propulsion system to pull lengths in excess of 10,000 feet of steel pipe or cable up to 4 inches in diameter through various types of consolidated soils and bedrock, while either eliminating or providing sufficient force to overcome the friction of moving the pipe/cable through the borehole. Electrical or hydraulic power for operating the downhole propulsion system could be provided from the surface drilling rig; however, novel powering methods may be included in the overall concept(s).

Phase I: A detailed report shall be produced, including a full description of the concept(s), operational principles involved and new technology proposed, as well as substantiating model analysis. A component and system test plan for providing

parametric data with which to evaluate the concept shall also be included. Pulling and reaction forces developed, advance rates in various borehole materials and power requirements of the system are specific items to be quantified in the engineering analysis and proposed testing.

Phase II: Develop, test and evaluate a laboratory scale model of the downhole propulsion system identified under Phase I. The model shall demonstrate the capability of the system to pull pipe up to 4 inches in diameter through a borehole in various sediments. The data collected shall also be used to determine power requirements for various downhole pulling situations.

NAVAL WEAPONS SUPPORT CENTER

N92-095 TITLE: Qualification of Reclaimed Explosives

CATEGORY: Exploratory Development

OBJECTIVE: To determine if reclaimed explosives or explosive ingredients (i.e. RDX, HMX, TNT) can be requalified for new weapons systems.

DESCRIPTION: See Phases I and II below:

Phase I: Conduct literature search into available technology to reclaim explosives from military munitions (removal and required processing) for subsequent reuse in new weapons systems. Explore sources of explosives and possible reclamation technology. Select reclaimed explosives or explosive ingredients from two or three sources to determine if material meets military specification for end use from both a chemical/physical properties and performance standpoint. Also verify material is safe to handle, process and transport. If material does not meet specifications, identify potential reprocessing procedures to bring material up to specification. Provide recommendations for Phase II evaluations.

Phase II: Perform lab scale studies to reprocess explosives to meet specification requirements. Perform bench/prototype evaluations to validate that reclaimed and rebled explosives meet chemical/physical properties and performance criteria established for weapons systems. Perform insensitive munitions testing on material if required for qualification of end item. Perform systems evaluation to verify reclaimed explosive handling/reprocessing (recrystallization, rebinding, etc.) operations meet safety and environmental standards.

N92-096 TITLE: Polymer and/or Metal Matrix Composite Materials for Thermal Management of Electronic Devices.

CATEGORY: Exploratory Development

OBJECTIVE: Improve thermal performance of Standard Electronic Modules (SEMs). Investigate the use of high modulus continuous graphite.

DESCRIPTION: Investigate the use of high modulus continuous graphite fibers in a polymer and/or metal matrix composites in irregular shapes other than flat plates. One shape to be considered is Standard Electronic Module (SEM) Format D Heat sink (MIL-C-28754). Other shapes may include varying thickness plates. Factors to consider may be thermal conductivity, coefficient of thermal expansion, density, and protective finishes.

Phase I: Representative samples of irregular shapes may have been used in Phase I.

Phase II: Phase II work should work towards fabrication and evaluation of actual SEM heatsinks (Format D and E, MIL-C-28754).

NAVAL OCEAN SYSTEMS CENTER

N92-097 TITLE: Protective Coatings for Containment of Liquid Metal Combustion

CATEGORY: Advanced Development

OBJECTIVE: To develop a coating process to protect metal parts used in liquid metal combustors from the effects of high temperature and hot corrosion. The goal is to extend the operating range and survivability of these parts used in advanced underwater vehicles powered by liquid metal combustion.

DESCRIPTION: The Navy is developing liquid metal combustion as the power source for the propulsion systems of several advanced underwater vehicles. Parts made from Hastelloy alloys are used in containment of the liquid metal reaction. Demonstrate refractory metal (tungsten, molybdenum, tantalum) and/or ceramic coatings on Hastelloy S substrates which protect the substrate from attack by liquid lithium at temperatures of 2,000-3,000°F.

Phase I: Optimize the coating process(es) to obtain the best performance, and parts coated for testing according to specifications provided by the Contracting Officer.

Phase II: Provide a breadboard demonstration.

DAVID TAYLOR RESEARCH CENTER

N92-098 **TITLE: Liquid Metal Wetted Flexible Metallic Brushes for Current Collectors**

CATEGORY: Research

OBJECTIVE: To develop liquid metal wetted flexible metallic brushes for current collectors

DESCRIPTION: The development of flexible metallic fiber wetted brushes will result in their use in liquid metal current collectors for transporting large currents in homopolar machinery for superconducting electric drive systems for Naval ships. The Electrical Systems Division of the David Taylor Research Center (DTRC) requires the development of advanced technology for flexible liquid metal wetted metallic fiber brushes or finger brushes for direct current homopolar machinery for the electric drive program. These fiber brushes together with the liquid metal will transport large currents in the current collector for long durations of time.

Phase I: will involve research in development of new metallic fiber brush technology and concepts.

Phase II: involve continuation of development of new types of brushes, methods of manufacturing and testing the brushes under high current loads. The brushes will be tested in conjunction with DTRC. One of the major development problems is obtaining easily changeable and maintainable brushes for machinery. The exact requirements for the fiber brushes will be supplied to the contractor by DTRC after award of contract.

N92-099 **TITLE: Development of Adaptive Multigrid Methods for Application to Steady and Time Dependent 3D Reynolds-Averaged Navier-Stokes Solvers (RANS).**

CATEGORY: Research

OBJECTIVE: Development of Adaptive Multigrid Methods for Application to Steady and Time Dependent 3D Reynolds-Averaged Navier-Stokes Solvers (RANS).

DESCRIPTION: An accurate and fast method for evaluating new naval ship designs, submarines in particular, with the predictive capability necessary to quantitatively rate the viscous vortical flows associated with a new hull/appendage/propulsor arrangement is required. This tool will be an integral part of the development of the capability to rapidly iterate new designs, in days instead of months, and will provide the means to assess the various vortical flow effects associated with a particular hull/appendage/propulsor arrangement. Specifically an efficient adaptive multi-grid method will reduce problem setup time from weeks to hours and computer processing time from days to minutes.

Phase I: Adaptive multi-grid algorithms will be developed in two stages Ia: Local grid refinement is to be achieved by relating the grid distribution adaption to the location of rapid changes in the flow fields which will be provided as input data from a separate RANS analysis. IB: Working closely with David Taylor Research Center (DTRC) the local grid refinement process will be integrated with an existing multi grid RANS code in such a way as to permit dynamic grid refinement concurrent with each time step of the RANS solution. Deliverables are 1. Fortran source code. 2. Assistance in the integration effort and a report describing effectiveness of the method and a detailed description of the process.

Phase II: The adaptive flow solver will be modified to provide best computational efficiency and accuracy when coupled with the various multigrid iteration sequences. As a minimum V cycle and W cycle multigrid sequences will be evaluated. The accuracy and computational efficiencies will be demonstrated when supporting the multi-million cell grid structures necessary to analyze the vortical flows created by a fully appended submarine. The criteria for accuracy will be the adaptive multigrid grid flow solver to provide the needed resolution of vorticity strength. Deliverables are 1. adaptive multigrid flow solver source code fully integrated with an appropriate DTRC RANS code. 2. A report describing the algorithms used and an evaluation of computational accuracy and run time performance.

N92-100 **TITLE: Investigation of the Hydrodynamic Lateral and Vertical Forces and Pitching and Yawing Moments Developed on a Submerged Vehicle with a Ducted Propulsor.**

CATEGORY: Research

OBJECTIVE: Develop a theoretical method for predicting the hydrodynamic forces on a submerged vehicle with a ducted propulsor at an angle of attack.

DESCRIPTION: There is a need for an accurate method for evaluating new designs of submerged vehicles which are propelled with ducted propulsors. Experimental data indicates that there are large hydrodynamic lateral and vertical forces and pitching and yawing moments that are developed on the ducted propulsor when the submerged vehicle is maneuvering. In addition, the ducted propulsor induces hydrodynamic forces on the afterbody and the control surfaces in the vicinity of the propulsor. These forces and moments must be calculated in order to evaluate the stability, control, and maneuvering characteristics of the submerged vehicle. There are theoretical and semi-empirical methods for calculating the hydrodynamic forces and moments developed on the hull and appendages for a submerged vehicle with a conventional open propeller. However, there are only approximate empirical methods for calculating the forces developed on ducted propulsors, and these empirical methods are based on a limited experimental data base. The tool that will be developed is to be an integral part of a computer code which will be used to make rapid iterations on candidate new designs for submerged vehicles.

Phase I: A theory will be developed for predicting the hydrodynamic lateral and vertical forces and pitching and yawing moments developed on a submerged vehicle with a ducted propulsor. The theory will predict the effect of an angle of attack on the convection of the boundary layer over the afterbody from the windward side of the hull to the leeward side, and the effect this has on the inflow velocity into the duct. The theory will predict the hydrodynamic forces developed on the propulsor and the forces induced by the propulsor on the hull and appendages in the vicinity of the propulsor for relatively small angles of attack. The investigator will prepare and issue a technical report that will clearly describe the physics of the flow around and through the duct and the theory for predicting the hydrodynamic forces and moments that are developed. The report will also compare the results of the calculations using the theory with appropriate experimental data.

Phase II: The theory will be upgraded, if necessary, based on the results of the comparison performed in Phase I. It will then be extended to predict the effect of relatively small pitching and yawing angular velocities. Calculations will be performed with the extended theory and the results will be compared with available experimental data. If the agreement between the theory and the experiments is satisfactory, the method will be upgraded to account for combined large angles of attack and pitching angular velocities or combined angles of drift and yawing angular velocities on the hydrodynamic forces and moments. It will also be extended to predict the effect of over and under propulsion on the effectiveness of the stern control surfaces and the forces and moments due to angle of attack, angle of drift, pitching angular velocity, and yawing angular velocity. A technical report will provide the theory and the results of calculations comparing the theory with appropriate data.

NAVAL SEA SYSTEMS COMMAND SUPPLEMENT

N92-101 **TITLE:** Development of Naval Ship Producibility Lessons Learned Database.

CATEGORY: Advance Development

OBJECTIVE: To develop a lessons learned database for Naval ship producibility.

DESCRIPTION: Frequently, previous design history, both good and bad is difficult or impossible to obtain in a timely fashion. This can result in designs mistakes being repeated or design improvements being lost or implemented only intermittently. This project is the development and population of an interactive database for documenting and tracking lessons learned regarding issues of design for producibility. This database should provide a means to document and track design decisions, the rationale behind those decisions, the political environment in which those decisions were made, and the expected benefit of that decision. The database must then allow for the tracking of feedback from the production facilities relating the impact of that decision to their efforts. Finally, there should be provisions in the database for a short lessons learned review highlighting pertinent key points such as manhours savings or cost, and unique conditions relative to the item. All of these sections should be wrapped in a tracking system to ensure that each section of the database is completed over the time span of the lesson. The ultimate objective of this effort is incorporate this information with the ship design database, providing on-line access to both design and design decision information.

Phase I: Develop the database object-role relationships using Nijssen's Information Analysis Method (NIAM) techniques. Develop a proof-of-concept database using the NAVSEA CAD 2 System relational database software.

Phase II: Develop system queries and populate the database.

N92-102 **TITLE:** Management Decision-Making Data Base

CATEGORY: Exploratory Development

OBJECTIVE: To identify the key parameters in program management decision-making and devise a means for collecting, structuring and analyzing decision-making data.

DESCRIPTION: Program managers face a variety of difficult decision tradeoffs concerning resource allocation to meet program objectives. Decisions that involve budget control, personnel levels, schedule deadlines and work quality often carry unforeseen, long-term tradeoffs. A management decision-making data base would allow managers to test their own decision alternatives against the past experience of many managers to determine what, if any, longer-term issues they may need to factor into their current decision-making processes. The ready availability of a means to examine potential longer-term consequences of immediate actions should help managers control program costs.

Phase I: The offeror will develop a methodology for data base development and will demonstrate its applications and validity by collecting, structuring and analyzing data for several test cases.

Phase II: The offeror will refine the methodology through further applications, complete the collection of a sufficient data base, package the results as an easy-to-use desktop software program and provide necessary instructional support in its use.

N92-103 **TITLE:** Shipyards Productivity Measurement

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a simple method that allows yard foremen and crew leaders to measure and report their own productivity in accomplishing a variety of shipbuilding tasks.

DESCRIPTION: Enhancement of shipyard labor productivity in construction, repair and re-outfitting is needed. A participatory measurement methodology that fosters cooperation between labor and management is desired. The methodology must provide: 1) feedback to crews concerning their productivity, 2) information to management concerning obstacles crews encounter in performing work, 3) ease of data entry and reporting, and 4) direction for continuing productivity improvement.

Phase I: The offer will provide a description of the proposed measurement system including details of how individuals using the system will record data and use reported information.

Phase II: The offeror will implement and test the measurement system on an experimental basis at a site to be designated.

N92-104 **TITLE:** Life Cycle Cost Models for Naval Ship Design

CATEGORY: Exploratory Development

OBJECTIVE: To develop tools to make engineering decisions based on life cycle implications.

DESCRIPTION: These engineering decision tools would include methods to quantify the cost impacts of producibility candidates in order to conduct trade-off analysis. The development of these models will also include consideration for training for ships force, maintenance activities and other life cycle factors incurred during the operational phase of a ship.

Phase I: Explore approaches for the development of engineering tools to aid in the decision making process. Propose modifications of ship acquisition basic construction cost estimating models and processes so that they apply more realistic parameters which drive cost.

Phase II: Develop improved cost estimating tools to encompass producibility and life cycle maintenance considerations based on the present state of the art for in-process ship design.

Phase III: Develop procedures and/or algorithms to project cost for life cycle operation and determine real cost-effective design parameters for future use.

N92-105 **TITLE:** Analysis of Strategic Technologies

CATEGORY: Exploratory Development

OBJECTIVE: To develop a methodology for analyzing strategic defense industrial technologies for the purpose of designing appropriate policies to encourage their development.

DESCRIPTION: Strategic technologies exist within many defense industries. The rate of technological advancement and innovation depends upon many factors, including generation of new ideas, problem solving ability, labor force skills and market forces. These

factors (and others) combine to accelerate progress in some technologies and impede progress in others. A method for collecting, structuring and analyzing industrial data is needed so as to discover how to increase the competitiveness of strategic technologies.

Phase I: The offeror will provide a description of the proposed analytical methodology, explain how it would be used to address the problem of technological competitiveness, and demonstrate a prototype application of the method.

Phase II: The offeror will complete the development of the methodology, apply it to a wide range of strategic technologies and show how the results can impact policy design.

N92-106

TITLE: Modeling Naval Ship Construction Delays

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate a simulation model that can be used to quantify the cost of shipyard construction delays.

DESCRIPTION: Delays during ship construction add unnecessary costs. A simulation model of the ship construction process should allow program managers to 1) understand the primary causes of delays, 2) quantify their impact on ship cost and schedule, 3) explore tradeoffs among cost, schedule and performance, and 4) assist in supporting management decision-making. The model should include feedback linkages that can create costly disruptions in the work progress.

Phase I: The offeror will provide a description of the model and demonstrate its ability to help analyze ship construction delays.

Phase II: The offeror will refine the model, provide the necessary data interfaces and apply the model to a number of past and current shipbuilding projects to demonstrate model validity.

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. 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/XTIP (SBIR Program Manager)
Andrews AFB DC 20334-5000

Do NOT submit a SBIR proposal to the AF SBIR Program Manager under any circumstances.

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.

All Air Force topics seek innovative solutions to the enumerated problems. Any level of R&D, whether Basic Research, Exploratory Development, Advanced Development or Engineering Development will be considered appropriate for any topic.

For each Phase I proposal, send one original and three (3) copies to the office designated below. Along with the original proposal, send two sets of red appendices A and B, which are not stapled or mutilated in any way. Be advised that any overnight delivery may not reach the appropriate desk within one day.

<u>TOPIC NO</u>	<u>ACTIVITY/ADDRESS</u>	<u>CONTRACTING AUTHORITY</u>
	(Name and number for administrative questions questions only)	(For contractual questions only)
AF92-001 thru 005	AEDC/PKP Bldg 100 Arnold AFB TN 37389-5000 (Capt Mark Briski, 615-454-6512)	Dowe Jones (615) 454-4423
AF92-006 thru 013	HQ AFESC/RDXM (SBIR Program Manager) Bldg 1120 Tyndall AFB FL 32403-6001 (MSgt Jim Davis, 904-283-6299)	Katherine McIntosh (904) 882-4294
AF92-014 thru 019	AFOSR/XOI (SBIR Program Manager)* Bldg 410, Rm A119 Bolling AFB DC 20332-6448 (Dr Dale Boland, 202-767-5013)	Harry Harlidsen (202) 767-4993
	* Hand delivery can be accepted after calling ahead to (202) 767-4969	
AF92-020 thru 030	AL/XPP (SBIR Program Manager) Bldg 125 Brooks AFB TX 78235-5000 (Belva Williams, 512-536-2838)	Don Ward (512) 536-9315
AF92-031 thru 036	ESD/XRR (SBIR Program Manager)* Hanscom AFB MA 01731-5000 (Lt Bruce MacDonald, 617-271-4718,	John Nunziato (617) 377-4889
	* No hand delivery accepted. * For overnight delivery, only if unclassified: ESD/XRR (SBIR Program Manager) 32 Hartwell Avenue Lexington MA 02173	
AF92-037 thru 054	RL/XPX (SBIR Program Manager) Bldg 106, Rm B-109	Capt James Owens (315) 330-7746

Griffis AFB NY 13441-5000
(Bob Falk, 315-330-2912)

AF92-055 thru 069 PL/XPPP Roger Shinnick
(SBIR Program Manager) (505) 844-4565
Bldg 592, Rm 24
Kirtland AFB NM 87117-6008
(Bob Hancock, 505-846-4418)

AF92-070 thru 080 PL OLAC TSTR Roger Shinnick
(SBIR Program Manager) (505) 844-4565
Bldg 8353, Rm 116
Edwards AFB CA 93523-5000
(Chris Degnan, 805-275-5014)

AF92-081 thru 085 PL OLAA XPG Roger Shinnick
(SBIR Program Manager) (505) 844-4565
Bldg 1107, Rm 240
Hanscom AFB MA 01731-5000
(Noreen Dimond, 617-377-3606)

AF92-086 thru 089 PL (WCO) OLAH Roger Shinnick
(SBIR Program Manager)* (505) 844-4565
P.O. Box 92960
Los Angeles AFB CA 90009-2960
(Capt Dave Good, 213-336-4187)

* Hand delivery accepted
PL (WCO) OLA, Bldg A2, Rm 2213B
2350 East El Segundo Blvd
El Segundo CA 90245

AF92-090 thru 099 BMO/MYSP Roger Shinnick
(SBIR Program Manager) (505) 844-4565
Bldg 523, Rm 305
Norton AFB CA 92409-6468
(Della Hinesley, 714-382-5371)

AF92-100 thru 108 WL/AAOP Terry Rogers
(SBIR Program Manager) (513) 255-5830
Area B, Bldg 22, Rm S-110
Wright-Patterson AFB OH 45433-6543
(Sharon Gibbons, 513-255-5285)

AF92-109 thru 114 WL/ELA Terry Rogers
(SBIR Program Manager) (513) 255-5830
Area B, Bldg 620, Rm C2069
Wright-Patterson AFB OH 45433-6543
(Dick Zacharias, 513-255-7668)

AF92-115 thru 122	WL/FIOP (SBIR Program Manager) Area B, Bldg 45, Rm 219 Wright-Patterson AFB OH 45433-6553 (Madie Tillman, 513-255-5066)	Terry Rogers (513) 255-5830
AF92-123 thru 136	WL/MLIP (SBIR Program Manager) Area B, Bldg 653, Rm 402 Wright-Patterson AFB OH 45433-6533 (Kay March, 513-255-7175)	Terry Rogers (513) 255-5830
AF92-137 thru 147	WL/POMX (SBIR Program Manager) Area B, Bldg 18A, Rm A-105 Wright-Patterson AFB OH 45433-6563 (Betty Siferd, 513-255-2131)	Terry Rogers (513) 255-5830
AF92-148 thru 149	WL/XPX (SBIR Program Manager) Area B, Bldg 146, Rm 122 Wright-Patterson AFB OH 45433-6553 (Gerry Cassidy, 513-255-4119)	Terry Rogers (513) 255-5830
AF92-150	WL/XP (SBIR Program Manager) Area B, Bldg 45, Rm 247 Wright-Patterson AFB OH 45433-6523 (Gerry Cassidy, 513-255-4119)	Terry Rogers (513) 255-5830
AF92-151 thru 156	ASD/XRX (SBIR Program Manager) Area B, Bldg 56, Bay 10 Wright-Patterson AFB OH 45433-6503 (Fred Strawn, 513-255-6673)	Michelle Rose (513) 255-6134
AF92-157 thru 176	WL/MN (SBIR Program Manager) Bldg 13, Rm 264 Eglin AFB, FL 32542-5434 (Jerry Jones, 904-882-4628)	Lyle Crews Jr (904) 882-4294
AF92-177 thru 181	AFSC/NAF (SBIR Program Manager) Bldg 52 Wright-Patterson AFB OH 45433-6503 (Dr Kervyn Mach, 513-255-1858)	Marty Pendergrass (513) 255-9637

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AF92-001 TITLE: Turbine Soot Emission Monitor

OBJECTIVE: Develop a quantitative, real-time monitor for soot emission of turbine engine exhaust.

DESCRIPTION: Evaluation of the effects of additives and component improvements on the production of soot is an anticipated part of future turbine engine testing programs at AEDC. Real-time feedback to test engineers during altitude engine test-cell evaluation programs is required. The current ASME type visual smoke number method is slow in response and qualitative. The problem is made more critical by the proposed switch from relatively clean burning JP-4 to JP-8. The latter tends to produce more noticeable soot. A quantitative, real-time soot monitoring system is required. The system must characterize the smoke emission in terms of the particle size distribution function. The measurement plane should be at the nozzle exit. The particle mass loading is expected to be within the range of 0-20 lbs./hour. Measurement of this loading is desired to be within 5% accuracy. Soot measurement in the particle size range of 0.005 - 0.20 microns is required. The effective pressure altitude in the test cell environment is from sea-level to 70 kft, at ambient temperatures of up to 160 °F, and acoustic levels of 150 db. Both intrusive and non-intrusive techniques are considered acceptable so long as operation or performance of the engine under test is in no way impacted. The operation environment would be typical of a non-afterburning turbine with Mach 1.0-2.0 and temperatures of up to 1200 °F. Phase I should result in a feasibility study and demonstrate the concept in a laboratory environment. In Phase II a prototype device capable of withstanding an altitude test cell environment will be designed and built.

AF92-002 TITLE: Cryogenic Infrared Source Array

OBJECTIVE: Develop a 128x128 infrared (IR) source array for sensor testing.

DESCRIPTION: Testing of Long Wave Infrared (LWIR) Focal Plane Array (FPA) based sensor systems requires the ability to produce a complex, dynamic target and background scene. The IR source array must be able to operate at a base temperature of 20 °K. The desired attainable target temperature is 400 °K with a minimum acceptable attainable target temperature of 300 °K. The array must be able to operate in a vacuum environment with pressures as low as 1×10^{-6} torr. The array should have elements distributed on no larger than 5 mil centers. The maximum allowable element to element crosstalk is 5%. The desired individual element temperature accuracy is $\pm 1/10$ °K with a minimum acceptable element temperature accuracy of 1 °K. The element should produce broadband radiation approximating a blackbody source. The minimum framing rate should be no less than 30 Hz. If the concept involves pixels that have persistence, the rise and decay time should be no greater than 2 milliseconds and the pixel radiance should not fall more than 1% between framing. If the concept involves pixels that do not persist, the framing rate shall be no less than 200 Hz and the energy delivered by each pixel should be equivalent to an integrating continuous source. These framing requirements allow the array to be compatible with LWIR FPA's. In Phase I technology to be used in developing the array will be defined along with specific information on the output and operation of the array, the anticipated infrared output and the operation of any control switching electronics at 20 °K. In Phase II a 128 x 128 pixel prototype of the array will be built and demonstrated at 20 °K.

AF92-003 TITLE: 2400 °K Gas Sample Cell

OBJECTIVE: Develop a spectrographic gas sample cell to simulate conditions at the exhaust plane of a hydrogen fueled SCRAMJET.

DESCRIPTION: A spectrographic gas sample cell containing hydrogen-air combustion products at the temperatures and pressures existing at the exhaust plane of a hydrogen fueled supersonic combustion ramjet engine is needed for the development and calibration of diagnostic instrumentation. Optical access to the sample volume along two perpendicular axes is required to allow operation of laser Raman property measuring instruments. There must be a clear optical path through the sample volume and out the other side on both of the perpendicular axes. Optical view ports (four total) shall have a diameter of one inch or greater. The viewport windows shall be of UV grade fused silica. The maximum distance from the sample volume to the access window shall be 24 inches. The sample volume shall have at least one cubic inch. The sample volume temperatures shall be controllable over the range of 1200 to 2400 °K and shall be uniform throughout the volume within ± 20 °K. The sample volume pressure must be capable of being controlled over the range 0.5 to 2.0 atmospheres. The cell atmosphere shall be air with up to 20% by weight of water vapor. Sample gas flow rate shall be 0 to 1.0 standard liters per minute. Phase I will result in a feasibility study of and a laboratory demonstration of a 2400 °K gas sample cell. Phase II should result in construction and check out of a prototype 2400 °K sample cell for delivery to AEDC.

AF92-004 TITLE: High Ambient Temperature Heat-Flux Calibration System

OBJECTIVE: Develop a heat-flux calibration system capable of operating at elevated temperature levels.

DESCRIPTION: A heat flux gage/sensor calibration system is required which can operate at temperatures up to 1,500 °F. The system should be capable of delivering constant heat-flux levels up to 1,000 Btu/ft² sec over a circular area with a one inch diameter. The calibration heat-flux level should be measured by standards whose calibration is traceable to the National Institute of Standards and Technology. The complete system must include an independent subsystem capable of heating a calibration block. There must be a minimum space for gages/sensors of at least 1.0 inch diameter for thermal equilibrium conditions at temperature levels at 50 °F increments up to 750 °F and 100 °F increments up to 1500 °F. The set point temperatures must be constant to within 2 °F for the range 75 < T < 500 °F, within 3 °F for the range 500 < T < 750 °F, and within 5 °F for the range 750 < T < 1500 °F. The source of calibration heat flux must be operated independently of the subsystem which controls the ambient temperature of the gage calibration block. Electrical power is available at 120 and 240 VAC single phase and 480 VAC three phase. If the system is designed for a vacuum there must be provisions for electrical power connections, at least twenty electrical signal connections, and at least five system temperature measurements. Phase I should prove the feasibility of the concept and provide detailed descriptions of the method and equipment for completion of the project. Phase II will result in design, construction and demonstration of a prototype system.

AF92-005 TITLE: Real-Time Subsonic Flow Vector Measurement

OBJECTIVE: Develop instrumentation to measure and display in near real-time local three-dimensional airflow velocity vectors.

DESCRIPTION: A system is required to make three-dimensional flow vector measurements in close proximity (6-36 in.) to full scale aircraft inlets in confined or freejet flows. Small sensors (1 in. maximum dimension) or non-intrusive (remote) sensors are required to minimize flow disturbances and to provide local measurements. Instruments currently used for similar steady-state measurements are generally unacceptable. These include combination total-static pressure probes for airspeed and cone or hemisphere probes for flow angles and "flying cruciforms" with an integral force balance which use lift coefficients generated by the cruciform elements to establish local flow angles and Mach numbers. The new instrument should operate over a Mach number range of 0.3 to 0.9 at static pressures of 0.5 to 14.7 psia and total temperatures of 100 to 200 °F. Flow angle range is from 60 degrees below horizontal to 20 degrees above horizontal in the vertical plane and +/- 15 degrees about the axial direction in the horizontal plane. Frequency response must be sufficient to display vectors at rates of change of Mach number up to +/- 0.1/sec and flow angle rates up to 10 degrees/sec. The system should measure Mach number to within +/- 0.02 and flow angle to +/- 1 degree during transient operation. Continuous operation up to 12 hours without servicing is required. The output signals must be usable as inputs to a closed loop control system for the vector magnitude and direction. A primary requirement is that the sensor(s) produce minimum disturbance or interference to the inlet flow field. Phase I should demonstrate the concept and Phase II should result in demonstration of a prototype system in a test cell at AEDC.

AF92-006 TITLE: In Situ Aquifer Restoration From Dense Solvent Contamination

OBJECTIVE: Develop a chemical/physical treatment process to remediate aquifers contaminated with dense chlorinated organics.

DESCRIPTION: Hazardous waste sites contaminated with chlorinated solvents present special problems to remediation activities. The dense organics sink to the bottom of the aquifer as a free phase product. This pool of solvent then slowly leaches into the surrounding aquifer, providing a long term source for contamination. Phase I is the development and proof of concept of a treatment system to remediate a 10 cubic foot test cell contaminated with trichloroethylene. It will also provide scale up and operating parameters for a Phase II effort. Restoration verification of the test cell will include soil analysis down to the parts per million level and water analysis down to the parts per billion level. Phase II, if approved, will be the operation of the treatment system at a contaminated Air Force selected site.

AF92-007 TITLE: Trichloroethylene Aqueous Phase Sensor

OBJECTIVE: Develop an inexpensive on-line sensor to quantitatively detect trichloroethylene (TCE) in water.

DESCRIPTION: Accurate detection of minute concentrations of trichloroethylene in groundwater are needed for well

field control units. The sensor will have to detect and transmit an analog signal to a central processor unit. The sensor must be able to detect TCE in the range of 5-1500 parts per billion.

Phase I is the development and proof of concept of operation of a laboratory scale system demonstrating the capabilities of the sensor to detect and quantify TCE in actual groundwater samples. Phase II, if approved, will be the test and evaluation of the sensor system in a well field at an Air Force selected site.

AF92-008 TITLE: Physical/Chemical Means of Facilitating In Situ Biodegradation of Groundwater Contaminants

OBJECTIVE: Develop innovative methods for facilitating in situ biodegradation of groundwater contaminants.

DESCRIPTION: The U.S. Air Force has identified over 3,600 contamination sites on Air Force installations under the Installation Restoration Program. The most commonly found contaminants include JP-4 jet fuel and various chlorinated solvents. Typically, treatment methods for contaminated groundwater involve pumping the water above ground and treating with a chemical/physical treatment process such as air stripping or carbon sorption. These methods are not destructive techniques; the contaminants are just transferred from one phase to another. The Air Force Engineering and Services Laboratory has field tested an enhanced in situ bioremediation method using a recirculating groundwater system, in which the groundwater is enhanced with nutrients and hydrogen peroxide. Problems were encountered with decreased aquifer permeability and rapid hydrogen peroxide decomposition. The Air Force has a need for an in situ method to physically contain the groundwater contaminants and facilitate their in situ biodegradation. The concept should involve the use of a flow through system of some sort and not a recirculating groundwater system where the groundwater is pumped above ground, enriched, and reinjected. During Phase I, the contractor will develop a concept using physical/chemical means to contain groundwater contaminants and facilitate their in situ biodegradation. This will consist of laboratory experiments to demonstrate the plausibility of the concept. Computer modeling may be accomplished in conjunction with the laboratory experiments to determine a strategy for controlling groundwater flow. The desired end product from Phase I will be an in situ method for containing groundwater contaminants and facilitating their in situ biodegradation that is proven at the laboratory-scale level. During Phase II, if approved, the contractor will scale up this concept and fully characterize its performance capabilities by field testing at a groundwater contamination site.

AF92-009 TITLE: Microcomputer Model for Assessment of Fuel Dumping Impacts

OBJECTIVE: Develop a microcomputer model to simulate the dispersion, evaporation, and groundfall of jettisoned aircraft fuel.

DESCRIPTION: Air Force environmental personnel lack accessible numerical tools for calculating the environmental impacts of fuel jettisoned by aircraft in flight. A user-friendly microcomputer model is needed that will estimate the location, areal extent, and magnitude (mass per unit area) of ground contamination resulting from the deposition of jettisoned fuels. The model should consider aircraft type, flight profile, meteorological parameters, and fuel characteristics in determining the fallout "footprint." Fuel-specific behavior, in terms of aerosol drop size distribution, settling velocity, and evaporation rate, should be treated for both JP-4 and JP-8 fuels. The model should facilitate addition of alternative fuels that may be developed in the future. Phase I should accomplish necessary review of previous work in this area, as well as production of a prototype ground contamination model with numerical output. Phase II should refine the model with addition of graphical output depicting aircraft flight path, wind direction, and ground level contamination contours. The final model should also contain a routine to estimate the time-dependent reduction of ground level concentration due to evaporation. The model should be delivered in both source and executable form, with full documentation to include a user's guide. Phase III could expand the model database to include commercial aircraft and "Jet A" fuel for marketing to the civilian community.

AF92-010 TITLE: Radar Masking of Third Generation Hardened Aircraft Shelter Doors

OBJECTIVE: Reduce the radar and infrared return signature of third generation aircraft shelter doors.

DESCRIPTION: The existing third generation hardened aircraft shelter doors have a metal superstructure that has a highly visible radar and infrared return signature. This signature makes these shelters detectable from radar sensing devices used by enemy aircraft. To reduce the ability of these shelter doors to be detected by radar and infrared sensors, a method needs to be developed to mask these signatures. This program, in Phase I, seeks the design of such a system to be retrofitted on the existing shelter doors in Europe and the Pacific. Phase II would require the development and

testing of such a system. The system should be operationally compatible, meaning it would not interfere with the current operation of the shelter doors. This system would have to be able to meet the performance standards without degradation from years of exposure to the surrounding environment. The preferred system would be passive in nature, not requiring the support of mechanical systems. Finally, the system should not enhance the visibility of these structures to the human eye.

AF92-011 TITLE: Active Firefighter Cooling

OBJECTIVE: Technology assessment for a low-cost, rugged means of providing cooling and breathing air for firefighters.

DESCRIPTION: This research includes a technology assessment, trade-off analyses, a system concept design and supporting system performance heat transfer calculations for a concept system that provides active cooling of firefighters, either through liquid air, cooled gaseous air, or some alternative cooling medium. Firefighter crash, rescue, fire suppression and hazardous material (HAZMAT) response operations generate extreme body high heat stress conditions. Combat or peacetime operations in hot climates will exacerbate heat-loading problems because of extreme temperature conditions. Body heat load analyses have been conducted on firefighter subjects that baseline the thermal environment and cooling requirements. Ideally, the proposed concept would generate breathing air as by-product to save the weight and bulk of a separate air supply. Leveraging of NASA HAZMAT suit liquid air pack (LAP) technology may be appropriate. Critical design considerations to be included are (1) rapid don and use of equipment at any time either on an emergency response vehicle or immediately at hand; (2) light weight (less than 30 pounds); (3) use in any body position (including inverted); (4) user friendliness and (5) reliability/maintainability. The concept design should be sufficiently detailed to permit evaluation for Phase II prototyping and proof of concept testing. In Phase I we expect to define the technology most advantageous for the advanced development of a firefighter body cooling system. In Phase II we will develop an intergraded system which maintains body core temperatures in the near-normal range under actual working conditions.

AF92-012 TITLE: Vehicle Navigation via Memory Resident Topographical Map

OBJECTIVE: Determine the location of a mobile vehicle using a memory resident topographical map as a guide.

DESCRIPTION: After attack on an airfield, an autonomous repair vehicle or team of vehicles will be dispatched to rapidly repair the bomb craters. Before these vehicles are sent to work, a topographical map of the damaged airfields will be loaded into the vehicle's memory. Each vehicle will be assigned specific craters to repair. Location and path to these craters will be passed to the vehicle before it starts out. A navigation technique is desired that relies solely on the in-memory topographical map and on-board sensors. These sensors may be cameras, range finders, electric compass or any autonomous device. Cost and number of required on-board sensors is an important consideration. The vehicle should arrive at its destination within 1/2 foot and 5 degree heading. While traveling 10 mph a deviation of 1 foot from the path is acceptable. Phase I will identify and define the innovative navigational system. Analysis and simulation will be required to support specified location and path tolerances. If possible, a demonstration of key concepts is desired. Phase II will center on developing and testing a prototype of the system. Phase III will involve fielding the system.

AF92-013 TITLE: Superconductive Magnetic Energy Storage (SMES)

OBJECTIVE: Assess feasibility of SMES use to meet AF stored electricity requirements.

DESCRIPTIONS: The use of stored electricity is minimal in today's Air Force, due to low AC/DC conversion efficiencies, power loss during DC storage, high cost, and high density/kw. Superconductive Magnetic Energy Storage (SMES) shows potential to meet AF power storage requirements with an overall efficiency approaching 94 percent. Phase I deliverable will be a concept of operation to include details on suggested design, component specifications, and estimated cost and payback for a 1 MW system. Phase II will validate concept through prototype construction and test. Phase III will transition to a manufacturing agency.

AF92-014 TITLE: Behavior of Hydrocarbon Fuels at Elevated Temperatures and Supercritical Conditions

OBJECTIVE: Conduct basic research experiments and modeling to address precombustion chemistry and fluid transport

behavior in stored and flowing hydrocarbon fuels at high temperatures and in the supercritical thermodynamic state.

DESCRIPTION: Future aircraft operating in the supersonic and hypersonic flight regimes will require onboard fuel to act as a heat sink, bearing thermal loads far exceeding those which are being experienced currently prior to combustion. The behavior of these fuels with respect to particulate formation, lubricity, viscosity, corrosion resistance, etc., will be a critical factor, not only for propulsion, but also for the overall design and operation of the complete aircraft system. Analytical capability will be needed to understand the chemistry and fluid properties of future hydrocarbon fuels and additives in order to address the related questions of aircraft/propulsion system design and fuel formulation. The anticipated result of the Phase I effort will be a demonstration of the feasibility of a novel experimental and/or theoretical approach to analyzing and solving advanced fuel thermal loading problems. A follow-on Phase II effort would be expected to implement the major critical aspects of this approach, and a Phase III effort would produce a functional prototype experimental and/or computational approach.

AF92-015 TITLE: Space Propulsion

OBJECTIVE: Improve the efficiency and payload capacity of space propulsion systems.

DESCRIPTION: Topics of interest are limited to atomic cluster formation in electrostatic thruster to increase thrust and reduce grid erosion. Research topics include ionization efficiency measurements and optimization, stability of cluster/electron mixtures and magnetic guiding. Phase I would focus on a theoretical study which would include concept description, feasibility analysis of cluster formation, ionization thrust/carrier gas ratio efficiencies, theoretical specific impulse, thrust calculations, and propellant specification. Phase II would move the research into an experimental regime. The system would be defined and experimentally verified. A subscale demonstration would be accomplished. Phase III would include a full scale demonstration and a flaw assessment.

AF92-016 TITLE: Multifunctional Nonmetallic Materials - Preparation, Processing, and Evaluation

OBJECTIVE: Develop new nonmetallic material chemistry for electronic, electro-optical, structural, and nonstructural applications.

DESCRIPTION: Advances in ceramic, glass, and polymeric materials are expected to come via structure control from the molecular level through the ultrastructure level (100 - 1000 Angstroms) to increasingly sophisticated hierarchical levels of structure. For the achievement of such structural sophistication, it is necessary to understand the design and function of hierarchical structures; to utilize this understanding, together with computational modeling based upon ab initio, semiempirical, or intelligent database methods to predict chemistry/structure/property correlations; and to fabricate the newly designed materials through the use of chemical, biological, or biomimetic synthesis and processing methods, together with a functional understanding of the mechanisms associated with the synthesis and processing. Materials of interest include those with nonlinear optical, magnetic, superconducting, and semiconducting properties. Sub-picosecond, nonresonant, or near-resonant nonlinear optical polymers, organics and inorganics, or combinations thereof are specifically required. Also of interest are approaches to properties which afford mechanical and environmental integrity in ceramic, polymeric, ceramic, molecularly reinforced, and carbon-carbon composite materials, such as optimization of strength, stiffness, and thermooxidative stability. Of particular importance are materials which exhibit concurrent combinations of properties, such as structural and electro-optical, for multifunctional applications. Device applications should be considered, especially where the material will serve as a self-contained functional entity. Novel chemistry for nonstructural materials is also needed. This includes temperature-resistant (greater than 675 degrees Fahrenheit) lubricants and fluids. Chemistry for fuels, such as endothermic fuels and their conversion catalysts, which can serve heat transfer and lubrication functions under supercritical conditions in advanced turbine engines, is also required. Phase I must provide sufficient material and/or concept feasibility for proof-of-principle. Phase II must make available both well characterized material and processing knowledge for high volume production.

AF92-017 TITLE: Rare Earth Doped III-V and Silicon Based Semiconductors for Optoelectronics

OBJECTIVE: Explore techniques to dope technologically important semiconductors with rare earth impurities for electro-optic device applications.

DESCRIPTION: The interest in rare earth or lanthanide doped semiconductors has led to numerous investigations over the past decade involving luminescence, life-time, and electrical measurements, doping through numerous techniques

(e.g., implantation, MOCVD, MBE), the fabrication of light emitting diodes, doping experiments in quantum well devices, and growth of semimetallic rare earth / Group V compounds on semiconductors. The interest continues in hope of producing DC-pumped rare earth doped solid state lasers, opto-electronic applications for silica and non-silica based fiber optics, impact devices, and the possible use of rare earth doped devices for frequency standards. In recent years erbium doped silica fibers have been successfully applied toward the amplification of optical signals in transmission over long distances; applications of integrating the fibers with active elements on III-V semiconductors are being considered. Other possible applications are rare earth ion laser materials, optically pumped by heterojunction emission in the host material; or materials demonstrating high ratios of inhomogeneous to homogeneous optical absorption linewidths, permissibly at cryogenic temperatures, for persistent spectral hole burning memories and tunable filters. The key to many of the studies has been the proper incorporation of the rare earth ion (e.g., Er, Yb, Tm, Pr, Nd, Ho) into the semiconductor host and to excite the internal 4f-4f luminescence transition not only for optically, but also electrically. The preparation of pure semiconductors by doping with rare earths continues to be a problem. There is a need to develop the capability to grow thick and high concentration rare-earth doped semiconductor layers such that fundamental experiments and device developments can be performed. Furthermore, for optoelectronic integration the growth technique necessitates good control of heterostructures and epitaxial layers and an overall thick total layer combination. For future productivity concerns, it is therefore advisable to consider growth of such structures by such methods as Metal Organic Chemical Vapor Deposition (MOCVD) or Metalorganic Vapor Phase Epitaxy (MOVPE). Phase I research should explore the development of productive growth techniques for doping technologically important semiconductors such as Group III-V and silicon-based (e.g., Si, SiGe, SiC) materials. The growth should demonstrate good control of growth parameters to allow for growing heterostructures and epitaxial layers with an overall thick total layer. Research for obtaining the appropriate rare earth precursor shall also be addressed in the initial phase of the effort. Development of new rare earth or even actinide precursors is highly encouraged, including research addressing toxicity issues. Appropriate characterization of the doped layers should be part of the initial phase. Phase II should demonstrate particular device structures. Emphasis should be on novel light emitting devices suitable for optical communications and data processing applications, or on materials useful for persistent spectral hole burning applications in optical memory and processing. Phase II would also allow for further material characterization of layers grown in both Phase I and II. Both phases should provide enough material or structures for proof of principle.

AF92-018 TITLE: Synthesis of Boron Based Single Crystal Wide Bandgap Semiconductor

OBJECTIVE: Explore techniques for the synthesis, characterization, and analysis of large crystal boron-based semiconductors.

DESCRIPTION: Boron phosphide is an attractive electronic material as a semiconductor with a wide band gap of greater than 2.0 eV. This compound semiconductor is also characterized by several outstanding properties such as a high melting point above 3,000 degree Celsius, a high decomposition temperature of about 1,139 degrees Celsius under 1 atmosphere of pressure, extreme hardness, and high oxidation resistance at high temperatures. However, the production of single crystals of this material has been very limited and difficult. Similarly, boron nitride may be of interest as an electronic material because of a bandgap of greater than 6 eV. Producing this material has also been difficult and the efforts have been very limited. Research is required to mature the growth technology of these two materials and possibly other boron-based semiconductors. In Phase I the growth of one of these boron-based semiconductors in single crystal form is to be demonstrated. Phase II will continued to address the growth of material and include material characterization and analysis of the crystals. Relatively large crystal areas would be demonstrated and the characterization would involve microstructure analysis, optical and/or electrical characterization. Development of device structures is highly encouraged. Both phases should provide enough material for proof of principle.

AF92-019 TITLE: Advanced Frequency Standards

OBJECTIVE: Develop better or more advanced frequency standards and methods of comparing those standards with currently known standards.

DESCRIPTION: Recent advances in trapping and cooling of neutral atoms or ions in electromagnetic, optical, or other types of traps give promise of leading to better and more stable frequency standards. In such traps atomic resonances can be made free of Doppler shifts, collisions, and other perturbations that broaden resonance lines. Since many atomic resonances are in the optical region, it is needful to develop methods of phase coherent comparison between the optical and microwave regions. In addition to the general subjects of trapped and cooled ions and atoms, the following topics are also in need of attention: confinement, surface interaction, and cooling of hydrogen atoms (relevant to the H-maser microwave resonance), cesium fountain experiments (relevant to microwave and optical cesium resonances), frequency

multiplication and division between optical and microwave regions, and high critical temperature superconducting microwave cavities. As this topic addresses a subject at the forefront of modern atomic physics and frequency research, rapid progress may not be possible for Phase I. However, it is expected that Phase I will clearly demonstrate the practicability of the proposed approach and establish a convincing Phase II research program.

AF92-020 TITLE: Human Systems/Subsystems Research

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance man's capability to function effectively and safely as an integral part of Air Force systems and military operations while increasing mission success. This includes the following: 1) human factors engineering, such as methods improving human/machine and human/computer interfaces or enhancing human physical or cognitive performance; 2) personnel protection/life support, such as crew escape in high Mach environments; 3) chemical/biological warfare defense, such as advanced personal protection and detection, identification and warning systems; 4) occupational/environmental hazards, such as identification of and protection from toxic materials and electromagnetic radiation; 5) personnel training and simulation, such as new computer-based technologies that improve the effectiveness and reduce cost of training systems; 6) aeromedical support, such as medical risk assessment and medical data collection, analysis and management; and 7) logistics support, such as logistics design and maintenance aids. Ideas are solicited that affect any or all of the operations, maintenance, and support roles of Air Force personnel.

AF92-021 TITLE: Human Systems Integration Problem Identification Program

OBJECTIVE: Develop an Artificial Intelligence (AI) computer program that will aid in identifying Human Systems Integration (HSI) problems in acquisition programs.

DESCRIPTION: Historically HSI issues, which include Manpower, Personnel, Training, System Safety, Hazardous Materials, and Human Factors Engineering, have contributed more than half of the cost of developing and fielding weapon systems. However, HSI issues and problems are not normally considered until late in the acquisition cycle when design changes are difficult and costly. The proposed computer program requires prototypical research in applying AI and fuzzy decision logic to develop an integrated approach for HSI analysis. The end product of the Phase II effort will result in a personal computer based tool that will help government agencies and/or contractors discover the HSI problems which either significantly degrade the mission effectiveness of a developing weapon system or significantly increase the cost of a developing weapon system. The proposed tool would guide users through a series of questions designed to lead them to identifying the significant problems that could be associated with the weapon system. Users could then take the necessary action to eliminate or ameliorate these significant problems. Although this program would be useful throughout the weapon system acquisition cycle, the focus would be on the early phases (Concept Exploration and Demonstration/Validation) when design changes are possible. The tool is envisioned to address a high level decision process required to integrate multiple expert judgments and to arrive at a consensus. The proposed personal computer program is thus envisioned to capture the experience and expertise used by analysts in conducting HSI domain specific analysis and to guide the user in the analytical thought process involved in integrated HSI analysis. The program could then serve to assist the user in narrowing down the HSI-related issues which would have a significant impact on the mission effectiveness and cost of a developing weapon system. Accordingly, the program would use artificial intelligence techniques (e.g., knowledge-based system technology, fuzzy logic), risk analysis and decision theory to provide a framework for investigating the HSI issues. The program should be designed to run on AF standard microcomputers, written in Ada, and be flexible to allow future potential interface with other HSI tools and databases. Phase I focuses on an innovative approach to defining system concept and functionality. Phase II would be designing, building and evaluating a prototype for a representative domain.

AF92-022 TITLE: Crew Protection Systems

OBJECTIVE: Enhance crew protection systems in Air Force operational environments.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Develop an airborne monitoring system for pilot incapacitation. Numerous subsystems have been developed for physiologically monitoring pilots while they are flying. At least 18 pilots have lost consciousness, crashed their aircraft, and died as a result of G-induced loss of consciousness, or G-LOC, since 1982. Likewise, over 70 Air Force pilots have been killed during peacetime due to crashes related to spatial disorientation. The system, ideally, should be noninvasive, one hundred percent accurate, and lightweight such that it can be retrofitted into aircraft with minimal cost and

downtime. In Phase I all work that has been done to date on such incapacitation monitoring systems should be assimilated, investigated, and those that appear the most promising developed. In Phase II the system should be developed, tested on a centrifuge (such as the Dynamic Environment Simulator centrifuge at Wright-Patterson AFB OH), and then flight tested. The end product will be a prototype airborne physiological monitoring system for pilot incapacitation.

b. Develop an overall control system for the COMBAT EDGE (Combined Advanced Technology Enhanced Design G Ensemble) equipment that can be interfaced with the aircraft's 1553 mux buss, which would allow such systems as the Automated Missile Evasion System (AMES) to drive the pneumatic system controlling the COMBAT EDGE ensemble. The Air Force is developing COMBAT EDGE, a new acceleration protection system for pilots of high G aircraft. This system currently incorporates the standard anti-G valve in combination with an oxygen regulator in order to deliver both anti-G suit counterpressure jerkin/vest and positive pressure breathing air supplies. A digitally-based Breathing Regulator Anti-G (BRAG) valve has been developed for this system but not tested to date. It does not interface with the 1553 mux buss of the aircraft. Such a system would be programmable and tailored to each pilot's G tolerance and comfort; by interfacing the system with the aircraft's flight control system, evasive maneuvers could be anticipated by the system rather than just reacted to, as they are now. The COMBAT EDGE is programmed to have several preplanned product improvements over the next 5 years; such a digital control system could be developed in parallel with other improvements. Testing could be accomplished on the Dynamic Environment Simulator centrifuge of the Armstrong Laboratory at Wright-Patterson AFB OH. Phase I will investigate the feasibility of interfacing the system. The Phase II product will be a prototype digital breathing regulator anti-G valve for positive pressure breathing ensembles such as COMBAT EDGE.

c. Effective voice communications, crew safety, and human performance in acoustic environments mandate optimum utilization and matching of the human operators with their systems and subsystems. Emphasis is on establishment of natural, intuitive interfaces utilizing innate abilities and requiring no learning/training for efficient operation. Intuitive interfaces facilitate operator task performance, significantly reduce workload, minimize operator fatigue, and improve personal safety. Intuitive interface technologies are conceived and developed individually, proven, and integrated with other technologies for application to both specific and generic situations. The development of natural audio interface technologies as well as measurement metrics are critical elements in these enhancements efforts. Basic and applied research opportunities are numerous in the human interface technology areas because they are so frequently overlooked in developmental efforts. Human audio interface technologies include, but are not limited to the following: 1) Auditory systems modeling and neural networks for robust signal processing of the speech signal; 2) Digital audio technology to allow advanced auditory technologies such as 3-D audio and interactive voice to be integrated into aircraft systems; 3) Voice communications countermeasures/counter countermeasures providing voice jamming and jam resistant technologies; 4) Noise exposure, hearing loss and sound protection principles, guidelines and devices; 5) Active noise reduction (electronic) development and applications to personal equipment systems and to occupied areas; 6) 3-Dimensional auditory display development and applications to spatial awareness and communications; 7) Analytical and measurement methodologies and models. Phase I end products will prove the feasibility of recommended improvements to human audio interface technologies. Phase II end products are methodologies and hardware to reduce effects of noise and to enhance voice communications effectiveness.

AF92-023 TITLE: Human Sensory Feedback in Air Force Telerobotics System

OBJECTIVE: Develop sensory feedback technology for intuitive human operation of robotic systems in hazardous environments.

DESCRIPTION: Concepts for human control of robots in hazardous unstructured Air Force environments combine the cognitive abilities of the human with the hardiness and heavy manipulation capabilities of robots. By capitalizing on the human judgment and the robot's ability to operate in conditions lethal to humans, the advantages of each system can be exploited. Human operator awareness (feedback) of the robot's work environment adds significant flexibility to mission capability. The challenge is to develop quality feedback from robot to operator. There are two specific challenges: (Specify subtopic by letter)

a) Fine manipulation using human-sized robotic hands requires human-sized exoskeletons for intuitive control. Force feedback to these small exoskeletons requires small-volume, high-efficiency, semilinear, actuator mechanisms. Actuators are needed to provide human range forces to exoskeletal systems used by operators of fine dexterous manipulators. Phase I will explore the feasibility of the concept. Phase II product could be miniaturized actuators;

b) Sensor technology advances now yield exceptionally high resolution measurements. A key element in

human-controlled robots is to provide quality feedback without overwhelming the operator with excessive detail. The challenge is to define reasonable limits of information feedback to the operator. Successful completion may require reductions in sensor resolution, smaller matrices, or the reduction techniques. Phase I should explore test methods and criteria which need to be developed to verify and validate the Operator-Robot Interface sensory feedback specifications. Phase II product could be an evaluation system which quantifies human sensory feedback efficiency.

AF92-024 TITLE: Helmet-mounted Visual System Components and Assemblies

OBJECTIVE: Develop helmet-mounted display device technology for man-machine interface research.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. A requirement exists for development of a photocathode/focal plane array material sensitive to a greater portion of the near-infrared spectrum. Critical parameters include cost, spectral response, sensitivity, resolution, and signal-to-noise ratio. Phase I will investigate approaches that consolidate the fusion of thermal and image intensification. Estimated size, weight, and cost of peripheral support equipment is critical to the advanced photocathode development strategy. A 25mm diameter cathode design is recommended as optimal. The minimum sensitivity requirement is 1000 micro-amperes per lumen, and the minimum resolution must exceed the current Night Vision Goggles (NVG) specification of 36 line pairs. The ultimate goal is to incorporate the advanced photocathode as the integral component that can replace the Aviator's Night Vision Imaging System (ANVIS) third generation photocathode. Correct form, fit, and function would be ideal, but not required. A Phase II product would incorporate the advanced photocathode in a helmet-mounted night vision device to give the aviator increased spectral response, sensitivity, field of vision (FOV), and resolution.

b. Miniature Cathode Ray Tubes (CRTs) presently are used to inject computer-generated data and/or sensor-based imagery into helmet-mounted optical systems. The disadvantages with this technology are low brightness, limited contrast and resolution, length and weight, and high voltage requirements. An improved display device is desired which is capable of presenting alpha-numeric and continuous scene displays. The displayed image must be bright enough to be viewed against a bright field. Phase I will consist of a feasibility study, conceptual design, and preliminary performance analysis. The Phase II program will design, fabricate, and evaluate a prototype device.

c. Design and demonstrate a helmet-mounted virtual image display. A virtual world employs an electronically generated all-aspect virtual image display (VID). A VID is similar to the aircraft mounted head-up display (HUD) but mounted on the helmet so the information displayed is always within the viewer's field-of-view. By taking into account the viewer's line-of-sight, the VID becomes an interactive control/display system within a panoramic display. This new virtual interface system concept requires a helmet-mounted VID that permits displaying superior graphics and pictorial information. This Phase I effort will design, using innovative hardware/technology, a helmet-mounted VID for supporting virtual Man-Machine Interface (MMI) research activities. Two monochromatic (or color) image sources are required in order to display a true three-dimensional world. Whether monochromatic or color image sources are used, achromatized display optics will be required. Initially, the resolution requirement for the VID is video graphics adapter (VGA) compatible; eventually, the virtual environment will include high-resolution engineering workstation Computer-Aided Design (CAD) graphics. The proposed VID display approach should have a plug-in capability for future image source improvement products and optics should be free of geometric distortions, i.e., pincushion, keystone, etc., so that predistortion of the input images is not required. The goal for field-of-view is 120-degree horizontal (H) by 90-degree vertical (V) with at least 40-degree stereo overlap region; the minimal requirement is 80 (H) by 60 (V) with at least 40-degree stereo overlap region. The system must be lightweight and sufficiently rigid to qualify for centrifuge usage (up to 6G) as an out-the-window scene simulator. The Phase II will assemble three fully functional laboratory breadboards for performance verification.

AF92-025 TITLE: Improvements in High Altitude Life Support Equipment and Diagnostic Technology

OBJECTIVE: Develop low resistance breathing system components; hypobaric, evolved, gas-measurement techniques; and ebullism protection garmentry.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Flow resistance offered by current USAF aircraft oxygen systems limits the rate at which breathing gas is delivered to the crewmember. High breathing resistance adds work stress, discomfort and distraction to an already high workload, stressful, flight environment. High inspiratory resistance may produce reduced G-tolerance by reducing the effectiveness

of anti-G respiratory straining maneuvers. It may also contribute to episodes of hypoxia and abnormal respiratory gas exchange. Identification of the flow resistance contributed by each of the component parts of currently deployed oxygen systems will enable us to identify the components which are the best candidates for redesign. Current systems fall short of meeting the standards set down by the Air Standardization Coordinating Committee for aircrew breathing systems. Suggested design changes and prototype low resistance components are needed to advance future development of these systems toward meeting these standards. Phase I efforts would identify the flow resistance in each of the components and suggest design changes for the components which are significant contributors to breathing resistance. Phase II would produce a brassboard low-resistance breathing system, from the regulator to the oronasal mask, for standard aircrew operations.

b. Operations in both advanced, high altitude aircraft and in space have the potential for accidental human exposure to hypobaric environments in which the ambient pressure is less than the vapor pressure of water. Under such conditions the water in human tissues may vaporize, causing considerable expansion of the affected tissues. Body containment garments, in combination with positive pressure breathing systems, have been suggested as one possible means of protecting aircrew in these environments. Such a garment would be designed to passively restrict the swelling of enclosed tissues in the event of accidental depressurization. The envisioned garment, which would be incorporated into the aircrew clothing ensemble, should be lightweight, comfortable, and allow adequate freedom of movement. Phase I efforts will identify and evaluate existing and emerging garment materials and conduct proof of concept demonstrations with the most promising materials. During Phase II a variety of prototype garments will be designed, fabricated and tested to produce a design specification suitable for full-scale development efforts.

AF92-026 TITLE: Electromagnetic Radiation Effects and Measurement Devices

OBJECTIVE: Develop human body exposure/response algorithms and monitor interfaces associated with electromagnetic radiation.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. A need exists for numerical algorithms which can calculate the response of the human body to ultrashort microwave and laser pulses. The modern occupational environment is such that a worker may encounter novel electromagnetic fields produced by either microwave or laser devices. The safety of these electromagnetic fields is determined, at least in part, by the amount of energy deposited into living tissues by these fields. When the environmental fields are constituted by continuous wave radiation, the amount of energy entering various living tissues and organs can be estimated using numerical algorithms that run smoothly on modern digital computers. However, when the environmental fields are pulsing in nature, the calculations become much more difficult because of the dispersive nature of human tissue. Dispersion means that each frequency component in the pulsing field is treated differently by the living tissue. There is no numerical algorithm known to us that properly calculates ultrashort pulse propagation in strong dispersive irregularly shaped objects such as the tissues and organs of the human body. The Phase II will result in software algorithms for use by safety, health and regulatory agencies.

b. Although a probe and system for temperature measurement in Radio Frequency Radiation (RFR) fields are commercially available, there is no interface to standard laboratory computers. The computer interface will provide an easily implemented method for accurate temperature measurements which are used for two purposes in RFR experiments: 1) The temperature of the preparation is, of course, needed to document experimental conditions; 2) Initial temperature increase at the onset of RFR is used to determine specific absorption rate. The interface will be constructed using standard hardware components and have associated software written for its use. It is anticipated that the connection to the probe will be an appropriate analog-to-digital converter. However, a search must be performed to identify devices which facilitate communication with IBM PC compatible computers. Phase I will be a search for appropriate technology to allow computer interface between commercially available temperature measurement systems and standard computer systems. Initial designs will consider direct connection of a converter to the computer, such as the Intersil ICL7109. The search will also identify the most appropriate sensor board for a PC expansion slot. Phase II will produce an interface between temperature probe and computer.

AF92-027 TITLE: Hazardous Waste Research

OBJECTIVE: Develop sampling and analysis techniques to improve the control and monitoring of hazardous waste.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Air Force bases are required by current laws and regulations to monitor base wells and aquifer systems for organic contamination. Current techniques involve collecting a sample and sending it to a laboratory for analysis. Time required for analysis as well as chemical changes and losses during this time period are of extreme concern. Possible instrumental systems that could be investigated include the following: Raman Spectroscopy, Forier Transform Infrared Spectrophotometer, Gas Chromatogram/Mass Spectrometer, and Liquid Chromatography, all possibly using some sort of fiber-optic sampling system. During Phase I develop a prototype instrument that has the capabilities to detect parts-per-billion contaminant levels of chlorinated solvents in potable waters and show it's application to a field monitoring type utilization. In Phase II further develop this instrumentation into a portable, field type instrument that could be set up at a base well to monitor daily contaminant levels of chlorinated solvents.

b. Current methodologies of environmental analyses for organic species, such as pesticides and herbicides, generate large volumes of hazardous waste solvents which have characteristics that make them hazardous, cause storage and disposal problems, and cause potential exposure risks to analysts. Current approved technologies include extracting environmental samples with large amounts of organic solvents and concentrating the extracts into a small volume. For Phase I demonstrate viable alternate analysis techniques for pesticides and herbicides that drastically reduce the amount of waste solvents generated. Such techniques may employ some sort of solid phase extraction or special enclosed, low volume solvent extraction. During Phase II develop the best of those demonstrated methodologies and provide recommendations to appropriate federal agencies for approval of such methodologies as acceptable methods.

c. Current techniques for identification of organic components in hazardous waste solutions is very time consuming. Analysis time of these complex samples becomes a problem when there are many samples to be analyzed. Bases can only legally store these wastes for a short period of time and need quick chemical analyses to characterize the waste before disposal. In Phase I show the development of such instrumentation is possible, and demonstrate such quick and sensitive analyses. For Phase II develop such instrumentation, and implement the methodology so that the usable system will handle standard check solutions as well as actual base-waste samples.

AF92-028 TITLE: Enhanced Handling of Stripping, Cleaning, and Metal Surface Treatment Wastes

OBJECTIVE: Minimize generation of hazardous waste from paint stripping, aircraft cleaning, and metal surface treatment operations.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Develop a regenerative, closed-system, control technology to reduce hazardous constituents from rinse water from spray-down during aircraft paint-stripping and cleaning operations. During Phase I determine the feasibility of developing a small-scale, on-site, treatment process for reducing or eliminating the hazardous waste characteristics of the waste component in the rinsate used in paint stripping and cleaning operations. In Phase II produce a prototype that will reduce both miscible and nonmiscible components from the rinse water. The prototype will have the treatment capability to remove/reduce metals, particulates, and other compounds or elements whose presence in the rinse water renders the rinsate as hazardous waste under 40 CFR 261. Any amount of treated water that cannot be regenerated should be dischargeable into the sanitary sewer as nonhazardous and inert waste.

b. Develop a control system to remove metals and breakdown organics and inorganics from spent aircraft metal parts treatment chemicals. This will include but not be limited to chemicals that treat chromium, cobalt, nickel, aluminum, steel, titanium, and magnesium alloy parts. For Phase I develop a small-scale, on-site, treatment process for eliminating or reducing the hazardous waste characteristics of the metals treatment solutions. During Phase II construct a prototype which is capable of removing metals and nonmetals in order to obtain a nonhazardous and chemically stable solution. The treated solution should be dischargeable into the sanitary sewer as nonhazardous and environmentally benign waste.

AF92-029 TITLE: Computer-Based Technologies for Advanced Training Systems

OBJECTIVE: Develop advanced computer-based technologies for advanced training systems.

DESCRIPTION: Computer-based technologies hold significant promise for enhancing the efficiency and effectiveness of advanced training systems. This research will investigate and demonstrate the use of advanced computer-based interface and authoring technologies to support the design, development and delivery of instruction. Within this topic we invite proposals which address one of the following areas: (Specify subtopic by letter)

a. Enhanced Human/Computer Interfaces for Intelligent Tutoring Systems (ITSs). Poor design of user-friendly interfaces seems to be a limiting factor in many of today's computer-based training aids. Recent advances in human-computer interaction (HCI) technology provide a variety of approaches to the design of input/output mediums in software and hardware development. Digital video interactive displays, touch-sensitive input screens, speech synthesis, speech recognition, virtual world interfaces and many other interactive display concepts can have a significant impact within the ITS environment. Phase I, therefore, should cover the specification, design, and implementation of a proof-of-concept ITS built in an Air Force domain which takes advantage of these advanced human interface and display technologies. Software should run on the Air Force standard Desktop Three microcomputer or on a computer equipped with an 80386 processor. Programming language should be ADA. Phase II will extend the existing range of the prototype ITS and extract from the design experience a methodology and toolset for rapid integration into any software/hardware compatible ITS for potential dynamic training applications.

b. Digital Video Interactive (DVI) Technology. More so than ever before DVI technology makes possible affordable technical training that is both scenario and simulation-based. This capability should contribute to greater efficiency in the production and delivery of courseware for computer-based instruction (CBI). Additionally, DVI technology should aid in increasing learner comprehension as well as retention and transfer of learning to the work place. This research is to design, develop and evaluate a DVI-based work environment for CBI authoring. The work environment may comprise single or multiple work stations for graphical, textual, and video productions. Phase I will produce the concept and functional characteristics of the work environment. Phase II will involve actual construction and testing of the multimedia DVI work environment.

c. Automated Guidance for Designing, Developing and Delivering Computer-based Training (CBT) Courseware. As computer hardware and software have become more sophisticated, designing and developing effective courseware has become an increasingly complex problem. An automated tool which has the capability to incorporate existing theories of instruction, learning, and knowledge into instructional strategy designs is desired. The environment should be capable of guiding novice instructional designers through the process of developing instruction prescribed by the particular instructional strategies. The end result should be improved quality and efficiency in courseware development and decreased student time under instruction. Phase I will develop the concept and functional characteristics. Phase II will build, test and evaluate an experimental model.

AF92-030 TITLE: Human Issues in Computer-aided Acquisition Logistics Support (CALS) Technology Implementation

OBJECTIVE: Facilitate CALS technology implementation in Air Force agencies by addressing required human, organizational, and cultural considerations.

DESCRIPTION: Computer-aided Acquisition and Logistics Support (CALS) is a DoD and industry initiative to transition from the current paper-intensive weapon system acquisition and support process to a largely automated and integrated mode of operation. The CALS goal is the application of computer technology to the creation, management, and use of technical data from weapon system concept, through design, manufacture, operational use, and logistics support, to retirement and disposal. Emphasis on CALS technology development has accelerated, but technology alone will not achieve the CALS vision. Ultimately, any such technology must be successfully incorporated into and accepted by the organization it is designed to serve. This transition has proven notoriously difficult and has often resulted in unintended organizational and human consequences. Thus, there is a pressing need for knowledge-based strategies for inserting advanced technologies into existing organizations and for predicting the effects, both negative and positive. CALS implementation via Air Force Logistics Centers (ALCs) and System Program Offices (SPOs) represents a timely opportunity for addressing this widely recognized problem. Relevant considerations would include possible cultural and organizational barriers to CALS implementation in ALCs and SPOs, strategic alternatives for overcoming such barriers, and projected net effects of a recommended strategy (or strategies) on productivity and other organizational consequences. Phase I requires investigation to define the nature and scope of the problem, identify promising solution strategies, and propose an approach for evaluating such strategies. Phase II requires execution of research proposed and development of a solution incorporating the above relevant considerations. There would be products resulting from Phase II:

- (1) Performance metrics which will allow accurate assessment of performance and productivity gain (or loss) from the implementation of CALS technology. A potential metric might be a variant of the Goldratt Theory of Constraints;
- (2) Modeling and simulation tools which will allow assessment of the impacts of CALS technology on Air Force processes. Such simulations would provide decision makers with data to choose among alternative

- implementation strategies;
- (3) A demonstration of the methods, metrics, and tools in an actual ALC or SPO environment.

AF92-031 TITLE: Command, Control and Communications Systems/Subsystems

OBJECTIVE: Develop innovative concepts for increasing warfighting capabilities of the Air Force command, control, and communications (C3) systems.

DESCRIPTION: Proposals may address all aspects of AF C3 systems/subsystems not specifically given in other SBIR topics. Proposals may cover any of the following AF C3 missions: strategic C3I for fixed and mobile command centers; post attack assessment intelligence; C3 systems for AF mobility and special operations forces missions; air, missile and space integrated tactical warning/attack assessment C3; worldwide C2; all AF ground based and airborne early warning systems; theater missile defense; all AF communication systems and C3 countermeasures and electronic warfare. This topic offers great flexibility to bidders to propose solutions addressing AF problems. Past submissions included 1) advanced communication systems, 2) manufacturing productivity tools, 3) air surveillance systems, and 4) relocatable target detection systems, 5) mission support systems (MSS) planning tools. Phase I should accomplish the initial analysis and develop an implementation demonstration plan for Phase II. Phase II should accomplish the demonstration or prototype development. The proposal title used should reflect the work to be accomplished. AF managers evaluate proposals on their merits and applicability to Electronic Systems Division C3 programs.

AF92-032 TITLE: Tactical Command, Control, Communications and Intelligence (C3I) Systems and Subsystems

OBJECTIVE: Develop innovative concepts and initiatives for Air Force tactical C3I systems and subsystems.

DESCRIPTION: Topic centers on increasing the warfighting capabilities of the Tactical Air Force (TAF) in the areas of command, control, communications and intelligence. The area covered in this topic is primarily improvement within the airborne and ground Tactical Air Control System (TACS). 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). New concepts can also be explored addressing technology's impact on future systems in terms of operational capability, logistics, mobility, etc. Phase I should accomplish the analysis and develop an implementation demonstration plan for Phase II. Phase II should accomplish the demonstration or prototype development. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF92-033 TITLE: Centralized Fault Diagnostics and Correction for Dispersed Mobile Operations

OBJECTIVE: Develop a centralized fault diagnosis and correction capability for geographically separated network of data processing nodes.

DESCRIPTION: This task seeks to define a capability to perform on-line diagnostics and correction from a central location within a multi-node configuration of C3 elements. The approach must assume the use of a long-haul communication network to run diagnostics and implement corrections. At a minimum it should include capabilities to do the following:

- (1) Evaluate the health of the long-haul communications links, local area networks and automated data processing devices.
- (2) Provide appropriate error statistics on communication links and fault isolate malfunctioning devices to the lowest replaceable unit.
- (3) Provide on-line debug and correction of software problems.

The task should define the functionality, both software and hardware, and provide a system design required to maintain a notional configuration. A notional multi-node configuration should be developed to serve as a background for the design. Communications should include ground-to-air radio, satellite and land-line links. The demonstration system should make maximum use of COTS software and hardware. Major consideration should be given to meeting the requirements of Open System Architecture (OSA) standards including the use of Ada for developed software and UNIX based operating systems. In addition, the demonstration workstation/processor should be of the high-end variety to provide sufficient MIPS, a windowing capability and color graphics. Special emphasis should be placed on the user/system

interface aspects of the capability such as display presentation of diagnostic information. Phase I will accomplish the design analysis and prototype implementation plan. Phase II will implement the prototype and accomplish the demonstration.

AF92-034 TITLE: Remote Detection of Mobile Missile Launchers

OBJECTIVE: Utilize existing and near term capabilities to develop and demonstrate a technique for locating mobile missile launchers.

DESCRIPTION: Detection of mobile missile launchers before they have launched their missile(s) represents a difficult threat. Either strategic or tactical missile systems are possible elements of the hostile arsenal. Remote detection methods are needed to effectively locate and identify missile threats scattered over hundreds of square kilometers of terrain. Launchers may be moving, non-moving, located in all types of terrain and foliage, buried, or located with decoys requiring discrimination techniques. The Air Force is interested in the application of rapid multi-spectral algorithms or other potential detection methodologies to accomplish location day or night in clear and cloudy conditions. Techniques that combine various sensor images to identify mobile and fixed targets would be acceptable. Space and airborne (manned or unmanned) surveillance platforms should be considered. Phase I should delineate types of data to be used, method of collection and processing, and a plan for proof-of-concept. Phase II will include a demonstration of the promising technique(s).

AF92-035 TITLE: Command, Control, Communications, Countermeasures (C3CM) Measure of Effectiveness Concept and Decision Making Tool

OBJECTIVE: Develop an automated Mapping/Targeting aid system for measuring the effectiveness of C3CM warfighting strategies.

DESCRIPTION: In modern warfighting theory, a Command, Control, Communications, and Countermeasures (C3CM) strategy should be used to employ operations security, deception (exploitation), jamming and destructive means against an adversary. A credible concept on how to measure the warfighting benefits of a comprehensive C3CM strategy is needed. The incorporation of such a concept into an existing decision aid tool could greatly enhance the use of these strategies. Phase I will develop a credible C3CM measure of effectiveness (MOE) concept, recommend a mapping/targeting aid and develop top level flowcharts showing how the C3CM MOE concept will be incorporated. Phase II will accomplish this modification of the selected automated mapping/targeting aid system to allow the demonstration of an integrated C3CM measure of effectiveness tool.

AF92-036 TITLE: Software Supportability

OBJECTIVE: Develop Logistic Support Analysis (LSA) to specifically address software supportability.

DESCRIPTION: LSA is the selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other integrated logistic support (ILS) objectives through the use of an iterative process of definition, synthesis, tradeoff, test, and evaluation. MIL STD 1388-1A is a single, uniform approach by the Military Services for conducting those activities necessary to (a) cause supportability requirements to be an integral part of system requirements and design, (b) define support requirements that are optimally related to the design and to each other, (c) define the required support during the operational phase, and (d) prepare attendant data products. Although MIL STD 1388-1A addresses systems, it is primarily hardware oriented and needs to be expanded to include software supportability. Phase I will develop specific language for MIL STD 1388-1A tasks and subtasks which will: a. focus on integrating software development processes with hardware designed and produced according to an LSA program, b. focus on systems integration of new, or modified commercial, hardware and developed software. In addition a Phase II implementation/demonstration plan to develop data elements, output summaries, data item descriptions and other data pertaining to software to be included in MIL STD 1388-2B, DoD Requirements for a Logistic Support Analysis Record, will be described. Phase II will accomplish the implementation and demonstration.

AF92-037 Title: Adaptive Integrated Electronic Focal Plane Processor

OBJECTIVE: Develop an optoelectronic chip for real-time processing of input images. This chip must be adaptive to compensate for changing characteristics of the input image and to perform multiple processing functions.

DESCRIPTION: Current Optically Addressed Spatial Light Modulators (OASLMs) allow the intensity of an input laser beam to control the polarization of an output array (cf liquid crystal, deformable mirror, ferroelectric-liquid-crystal). Thus when a second beam impinges on the back side, the percent reflected (or the amount of phase delay added) depends upon the intensity of the input beam at that corresponding location. However, these devices are not capable of performing real-time pre-processing of input images for operations such as edge enhancement, or noise suppression. To overcome this limitation, simple circuit elements can be added to the focal plane. However, to successfully perform the intended operations for a broad class of input images and signal to noise variations, some means of real time pixel by pixel control of electronic gain and thresholding is needed. This control can be provided optically if auxiliary detectors are added to each pixel. Quadrant detectors are one example that work well. In order to illuminate each of these detectors with minimum optical crosstalk, some form of optical signal spatial separation, for example a lens array, must be permanently integrated onto the chip. Such an integrated opto-electronic focal plane processing chip would revolutionize optical signal processing and optical computing and can be realized by combining existing technologies, specifically OASLMs, VLSI and microlens array technology. Phase I would demonstrate the feasibility of the idea by fabricating at least three 16 x 16 arrays with pixel sizes approximately 200 microns. Numerous control circuitry and interconnects could be provided in order to allow experimental identification of the most efficient algorithms for performing specific pre-processing operations. In this phase, the lens arrays need not be integrated on the same chip. During Phase II, 3 full scale 256 x 256 chips with integrated lens arrays would be constructed. Pixel sizes in this phase should be in the 30-50 um range. Each of the 3 chips will incorporate different interconnect and control circuitry optimized to perform one specific processing operation. The specific circuitry processing algorithms to be used will be determined by evaluation of the Phase I devices.

AF92-038 TITLE: Novel Wafer-Level Hetero-epitaxial Integrated Photonic Structures

OBJECTIVE: Demonstrate new wafer-level techniques for building heteroepitaxial structures leading to integrated photonic devices and optical circuits.

DESCRIPTION: Although significant advances have been made for photonic devices at the discrete component level, integration of these same components in a circuit may result in a decrease in performance due to process incompatibilities. This increasing demand for compatible photonic components has necessitated the development of advanced epitaxial materials, device and circuit process techniques in the III-V materials system. In particular, the availability of advanced InP-based technologies is essential for continued development of photonic components for communications systems. The goal of Phase I of this initiative is the demonstration of heteroepitaxial III-V materials preparation techniques that can support the next generation of advanced photonic components for lightwave communications. In particular the program should focus on epitaxial growth techniques that can lead to superior photonic device and circuit integration and improved manufacturability of these materials. Phase II will implement the materials preparation techniques developed in Phase I, develop device fabrication techniques that will complement the materials technologies and begin fabrication and testing of photonic devices and circuits using these developed techniques. In Phase III, growth and device fabrication processes refined in Phase II will be used to define manufacturable photonic devices for commercial applications. It is expected that both the processes and the device concepts established in Phase I and II will be applicable to commercial and military speed-of-light communications systems where either optical or electrooptical control of data is required.

AF92-039 TITLE: CAD Modeling of T/R Modules

OBJECTIVE: Develop a Computer Aided Design (CAD) Software Model of a Transmit/Receive (T/R) Module that can do both Baseline Design and Electromagnetic Susceptibility Analyses.

DESCRIPTION: A CAD simulator code is needed to determine electromagnetic environmental effects' susceptibilities of multiport T/R modules that use interconnected sets of MMIC and digital circuit chips. Circuit simulators used for contemporary microwave CAD can handle only baseline designs of individual circuit chips, whereas a complete T/R module contains several interconnected and electromagnetically susceptible chip sets. Phase I will investigate ways to combine the CAD circuit models presently used for the constituent chips of a T/R module set. These include both linear and digital circuit functions as well as the associated pads, vias, interconnects, parasitics and nonlinearities. The challenge

is that the desired models should include capability to simulate baseline performance and determine attendant susceptibility. A detailed design plan for developing a simulator code to design a T/R module as a "system" is requested. Phase II effort will implement and build the selected design in software and will perform the validation testing. Phase III effort envisions tailoring the code to the design of commercial HDTV and satellite communications circuits.

AF92-040 TITLE: Combined Thermal/Mechanical/Electrical Reliability Assessment of Electronic Devices

OBJECTIVE: Develop a technique or a process to determine the combined thermal, mechanical, and electrical responses of electronic devices and assemblies when subjected to military environments.

DESCRIPTION: When electronic devices and assemblies are subjected to thermal and dynamic test environments for reliability assurance testing, the material within those devices experiences temperature changes and mechanical strains and stresses. A structural failure may occur and cause the device to malfunction or, most likely, the electronic characteristics may change causing poor or inconsistent performance. A thorough failure and performance assessment would be made if electronic devices and assemblies could be modeled and analyzed such that thermal and mechanical responses are coupled with changes in electronic characteristics. The tremendous variety of physical configurations imposes very difficult modeling and analysis challenges for this effort. Phase I of this effort will investigate potential modeling and analysis techniques to evaluate the reliability of electronic devices and assemblies using MIL-STD test conditions and prescribed failure models. Failure models can be material temperature limits, strain and stress limits, and tolerances on electronic parameters. Phase II will develop a data base, computerize the modeling and analysis tasks, and develop the user interfaces in order to make this reliability assessment process useable and practical.

AF92-041 TITLE: Superconductive Technology For Microwave/Millimeter Wave Antenna Systems

OBJECTIVE: The development of superconductive components for monolithic antenna systems.

DESCRIPTION: Recent accomplishments in low and high temperature superconductivity offer the possibility of significant new advances in monolithic antenna technology from microwave to the submillimeter wavelength regimes. Innovative research proposals for the applications of superconductivity include but would not be limited to monolithic microwave, millimeter, and submillimeter integrated circuits for signal generation, reception, control and processing in phased array applications. Examples of components include oscillators, mixers, filters, isolators, circulators and antenna feed structures. Electronically variable ways to control power, amplitude and phase or time delay of large wideband phased-arrays are of interest. Innovative wideband, monolithic, phased-array antenna elements are needed which are compatible with thin-film superconducting feeds, are efficient radiators and at the same time provide thermal isolation of the superconductive feed circuits from ambient free-space temperatures. Research to develop sub-systems such as monolithic integrated receivers and frequency synthesizers is required. A/D converters, shift registers and signal processing circuits operating in the giga- to multi-gigahertz regime are desired to advance the state-of-the-art of digital phased-array antenna control. A Phase I contract will involve analysis of theoretical background, and preliminary experiments and tests to clearly demonstrate the technical feasibility of the proposed development concept. A Phase II contract will require the development, test, analysis and conclusive proof of the concept. Under Phase III non-federal capital will be used for commercial application of the technology.

AF92-042 TITLE: Quantum Enhanced Vacuum Tube Technology

OBJECTIVE: Implement advanced materials into high power vacuum tube transmitters.

DESCRIPTION: High power, high frequency electromagnetic waves remain the exclusive domain of vacuum tubes. Semiconductor technology has not, and it now appears, will not be able to achieve the operational parameters that tubes now deliver for telecommunications. The very high mobility of vacuum transport is a property that has not been observed in any semiconductor system. Vacuum tubes, however, are not without detracting features. They are increasingly inefficient at a very high frequency where they are needed most. Recent advances in "Micro Vacuum Tube Technology" suggest that quantum well structures will permit low temperature operation of the electron emission source (cold cathodes). The minimization of waste heat at the cathode translates directly to reduced geometries for all the active elements in tube device. The smaller geometries, in turn, enable higher frequency operation. Sources are sought for production of advanced microtube designs, including processing improvements that will incorporate advanced quantum structures. The goal of the effort is to produce high efficiency, high frequency, high power tubes for satellite telecommunications.

AF92-043 TITLE: Hypsographic Cultural Data Integration

OBJECTIVE: Develop techniques to register DFAD and remotely sensed imagery data to DTED using geomorphic models.

DESCRIPTION: Various forms of digital cartographic and imagery data are combined with Digital Terrain Elevation Data (DTED) for multiple purposes, including simulation and modeling. However, the variations in the sources of the data, data types, data scales, and data accuracies make a simple matching of geographic coordinates unsatisfactory at times. Geomorphic models (G models) extracted from DTED can be produced that identify natural linear features such as ridgelines and drains. Phase I will investigate techniques to match G models, and thus DTED, to Digital Feature Analysis Data (DFAD) and remotely sensed imagery. Phase II will develop the best approach into a transportable piece of code to be integrated into appropriate software suites. In Phase III, this technique could easily be applied to non DMA data for commercial purposes.

AF92-044 TITLE: Automated Librarian

OBJECTIVE: Develop a natural language system capable of performing fully automated indexing, cataloging and retrieval of free text document collections.

DESCRIPTION: Subject analysis of free text documentation in large military data bases requires much manual effort and is an information processing and correlation bottleneck. The technical innovation is to construct a computer process that can accurately identify, summarize and retrieve the intellectual content of large unconstrained free text documentation collections. The most desirable goal, and a feasible one, is a system that could fully automate the functions of indexing, catalog summarization and natural language queries (using example text) which presently can only be performed by a librarian. The system should also autonomously generate a knowledge base established by it's own text processing experience. This knowledge base must dynamically adapt to changing natural language patterns facilitating the indexing, cataloging and retrieval of library holdings. The technology for the system should be based on a combination of signature analysis/statistical techniques similar to these found in natural networks and classic knowledge base expert system techniques. The finished system could be used everywhere the correlation and fusion of text information is an overburdening labor intensive task. DOD examples include Intelligence Data Handling, Logistics, and R&D. Other uses include Law Enforcement, Investment Banking and Libraries. Phase I of this effort will develop a working prototype demonstrating the feasibility of the automated librarian. Phase II will construct an operational version developed specifically for a selected DOD application. Phase III will pursue commercial applications software for generic library use.

AF92-045 TITLE: Phosphorus Purification for High Speed InP Circuit Technology

OBJECTIVE: Develop high purity 7N elemental phosphorus for integrated circuit (IC) grade InP technology.

DESCRIPTION: InP crystal processing has developed to a point where large diameter wafers of high quality will soon be available commercially. There are, however, several problems that must be overcome before this technology is widely accepted for high speed integrated circuits. The speed of current InP based devices is limited by impurities contained in elemental phosphorus. An order of magnitude of purification must be achieved in order to render phosphorus as pure as the arsenic sources available for GaAs technology. Silicon and sulfur must be eliminated from phosphorus source materials. In the effort to achieve undoped semi-insulating material, a deep trap, similar to EL2 in GaAs, has been reported to exist at low concentration levels in InP, but its existence cannot be exploited in the presence of overwhelming phosphorus impurities. The Phase I objective is to identify processes that will lend themselves to industrial scale purification. A prototype purification of 100 gram p samples shall be conducted and the processed phosphorus evaluated. Phase II will demonstrate kilogram scale purifications which will be verified in a controlled set of crystal growth experiments using the new source to grow InP semi-insulating material.

AF92-046 TITLE: Thin-film Magnet Structures for Non-Reciprocal Microwave Devices

OBJECTIVE: Design, build and test a planar, non-reciprocal microwave device (circulator, isolator, etc.) that is magnetically biased using thin-film permanent magnet structures.

DESCRIPTION: Presently, microwave non-reciprocal components, such as circulators and isolators, are magnetically

biased using bulk permanent magnets. Recent advances in the deposition of rare-earth permanent magnet films and ferrite films on GaAs have made feasible the fabrication of MMIC-compatible circulators and isolators. Incorporation of a monolithic circulator into a Transmit-Receive (TR) module, hundreds of which are required for an active-aperture radar, would result in considerable weight and space savings over present TR modules. In Phase I, the contractor will demonstrate the ability to deposit high energy product thin-film permanent magnets that have appropriate remanent magnetization and coercivity to bias the non-reciprocal device, onto a substrate that can serve as a host for both the permanent magnet biasing structure and the non-reciprocal device. The contractor will also design a planar non-reciprocal microwave device and thin-film permanent magnet biasing structure. In Phase II, the device will be fabricated and tested, and further design, fabrication, and test iterations will be performed as necessary to demonstrate a microwave non-reciprocal device that is monolithically integrable with other MMIC devices such as amplifiers, phase shifters, etc.

AF92-047 TITLE: Measurement of Patterns of Ultra Low Sidelobe Level Antennas

OBJECTIVE: Develop and demonstrate an anti-multipath scatter system for accurately measuring patterns of low sidelobe antennas.

DESCRIPTION: To meet the requirements of many missions, it is necessary to accurately measure the patterns of high gain antennas having extremely low sidelobe levels. Antenna test ranges often contain objects that scatter or reflect UHF/SHF waves from the transmitting antenna into the receiving antenna, thereby creating a multipath channel. Very large measurement errors of low sidelobe regions can result from this multipath propagation. Development of a system to operate in real time with antennas under test on an azimuthal/elevation pedestal to suppress indirect (multipath) components and permit accurate pattern measurements is required. The system should utilize a reasonably small bandwidth and be able to suppress multipath by 20dB to 40dB in real time for a 100 wavelength antenna that is mounted on a pedestal rotating at an azimuthal rate of up to 30 degrees per second. This system is to operate without any additional antennas and without modification to the antenna positioner. It will display and record in real time the time delay and amplitude of each multipath component for every orientation of the antenna under test. Goals for multipath measurement accuracy are plus or minus 1 nanosecond for time delay and 0.2dB for amplitude. The measurement accuracy goal for low sidelobe levels is plus or minus 1dB in the presence of a multipath component 20dB stronger than the direct component at the antenna output. The goal of Phase I is to demonstrate the feasibility of the proposed anti-multipath system. The goal of Phase II is to develop a prototype system to be interfaced with an existing antenna range set-up to demonstrate the proposed anti-multipath capability.

AF92-048 TITLE: High Performance A/D Converter

OBJECTIVE: Develop an Analog-to-Digital Converter (ADC) with Large Dynamic Range and High Sampling Rate.

DESCRIPTION: Future radar systems will utilize digital beamforming to meet advanced performance requirements. Here the individual signals received by the array antenna elements will be converted from analog to digital format for further digital processing. A bottleneck is the presently available commercial A/D converters which do not meet the requirements as to sampling rate (20 - 100 MHz) or dynamic range (16 - 18 bits) nor do they offer small size, low power consumption and low cost. Recent engineering developments in a number of solid state technologies (superconducting, optical, GaAs among others) offer the promise of improved A/D converter development. For instance, the new Rapid Single Flux Quantum (RSFQ) (K.K. Likharev and V.K. Seminov, IEEE Trans. on Appl. Superconductivity, vol 1, p3, Mar 91) architecture for superconducting circuits is a case in point. Phase 1 of this effort will investigate techniques (superconducting or other) to increase the performance of A/D converters and propose a complete design. Phase II will fabricate, test and deliver a set of two-four prototypes.

AF92-049 TITLE: Neural Network Antenna Controller

OBJECTIVE: Develop a software neural network capable of learning to control a linear phased-array antenna.

DESCRIPTION: Current phased-array control techniques are unable to adapt to antenna element degradations and failures to still produce an optimized radiation pattern. A neural network could learn, by observing the effects of different element attenuator and phase-shifter settings on the antenna's radiation pattern, the relationships between the output radiation patterns of the antenna and the input attenuator and phase-shifter settings that combine to cause them. Once this mapping is achieved, it should be possible to use the neural network to 1) form and steer the main beam, 2)

place nulls in the pattern at certain angles, and 3) maintain sidelobe levels below certain radiation levels. Furthermore, if the network is allowed to continually monitor the antenna's input settings and output radiation and re-train when inconsistencies occur, the neural network should be capable of re-learning the behavior of a degraded antenna and using this new behavior to optimize the antenna's remaining performance capabilities. This would both improve overall performance during missions and increase the antenna's available mission lifetime between major repairs. Phase I of this effort would design, develop, and test one or more software neural networks capable of controlling a provided software model and simulation of a 16-element linear antenna. This antenna model has 11 binary inputs for each element (6-bit attenuators plus 5-bit phase-shifters), a variable number of output pattern points (from 90 points up, based on the desired pattern granularity), and is capable of both perfect and degraded behavior. Following a successful Phase I demonstration, Phase II would integrate a similar software neural network model into the control software of a testbed phased-array antenna and then train the network on the control of a working linear aperture at an antenna measurement site.

AF92-050 TITLE: Design Approach for High Performance Computing

OBJECTIVE: Evaluate different approaches for designing parallel software for high performance computer architectures.

DESCRIPTION: High performance computing is characterized by its great diversity of applications, of hardware architectures, of computation models, of control regimes, and of programming languages. The never-ending quest for greater computer speed leads to processors working in parallel to solve a single computation task. Air Force systems in the 1990s will most likely consist of several novel architectures, networked together. Developing a large-scale system across several high performance computers will be very risky using today's methods, and the resulting software will be a nightmare to maintain. To make high performance computer technology easier to use, a strong foundation in enabling technologies is needed for dealing with both parallel and sequential software, an integrated set of parallel exploitation tools and methods for designing, coding and testing software. Advanced techniques such as visualization and algorithm animation need to be tapped to help improve the quality of software and make its development more productive. This effort seeks to evaluate and recommend design techniques that are architecture-independent, demonstrate the suitability of chosen design approaches for different classes of high performance computers, describe how the design representations will be downloaded to different high performance computers and outline a research plan to develop automated design tools for implementing the best technique. A final report should document the results of this effort and include a development plan for implementing the design approach. For Phase II, the development plan will be refined and implemented. The end product will be a prototype software package which assists in designing software for parallel implementation on target high performance computers.

AF92-051 TITLE: Reusable ADA Software Fault Tolerant Components

OBJECTIVE: Develop and demonstrate the application of an Ada repository of reusable components used to implement software fault tolerance in systems that can be assessed in terms of their improved reliability.

DESCRIPTION: Software Fault Tolerance (SWFT) mechanisms are usually built into a system when it is determined that reliability requirements cannot be sufficiently tested by conventional methods. Once implemented, it is difficult to assess the effectiveness of SWFT mechanisms in terms of improving the overall reliability of the system. At least four areas of deficiency exist with respect to the given problem: (1) lack of a taxonomy for SWFT Ada components (e.g., recovery block scheme and N-version software redundancy components, such as acceptance tests, watch-dog timers, voters, exception handlers), (2) lack of a repository of reusable SWFT Ada components which inherently possess test and reliability assessment mechanisms for both themselves and the overall system in which they are used, (3) lack of a repository management system for the addition, retrieval, modification, and querying of SWFT components with respect to a guiding taxonomy, and (4) lack of automated tools to capture and present the test and reliability assessment data generated by SWFT components employed within systems under test. The intent of this effort during Phase I is to (1) define a taxonomy for SWFT Ada components, (2) investigate the feasibility of developing SWFT Ada components which possess test and reliability assessment mechanisms and developing automated tools to capture and present the data generated by such mechanisms, (3) investigate the feasibility and trade-offs involving adapting an existing repository management system and developing a specialized repository management system for the management of repository components with respect to the developed SWFT component taxonomy, and (4) demonstrate the technology developed in a sample SWFT system. A final report documenting the results of the Phase I work and Phase II plans/recommendations shall be delivered at the end of Phase I along with all software developed/used during Phase I, as appropriate. Phase II shall include the additional development of reusable SWFT Ada components, a SWFT Ada

repository management system, and automated SWFT test/reliability assessment tools, with consideration for extending this technology to support additional life cycle phase activities.

AF92-052 TITLE: Supercomputer Data/Knowledge Bases

OBJECTIVE: Investigate very large multi-media supercomputer data/knowledge bases using intelligent data superhighways designed with massive bandwidth to alleviate I/O data contention and/or bottlenecks.

DESCRIPTION: The advent of powerful data supercomputers has made it possible to process in parallel very large amounts of data/information from a variety of multi-media sources that include speech, video, image/graphics, and natural language. However, the actual integration, data flow, storage and accessibility of this data is inhibited by input/output constraints; accessible, reliable, secondary stores; and traditional computing bottlenecks. High data rates needed to match supercomputing processing speeds will require data superhighways capable of intelligently reconfiguring data streams to supply at full capacity tera-op data computing engines. Techniques that need investigation include ways to store and represent data using holographic objects/images, data compression algorithms, multi-dimensional data structures, temporal data views, fuzzy and/or incomplete data notations, and neural data associations. Architecture considerations include reusable data caches, very large main and/or optical memories, redundant optical mass stores and new computers. Phase I will investigate and design an appropriate mechanism for developing large supercomputer data/knowledge bases. Phase II will propose prototype development of a very large data/knowledge base for supercomputer database processing architectures.

AF92-053 TITLE: Ultra-Wideband Elemental Radiators

OBJECTIVE: Develop an elemental radiator (e.g., a dipole or notch) with maximized bandwidth, plus maximized gain or minimized scattering cross section.

DESCRIPTION: The usefulness of ultra-wideband (larger than 5:1) pulse radiation is currently being studied in a wide range of possible applications, including covert communication, target discrimination, and the properties of materials. An elemental radiator (e.g., dipole, slot, horn, or notch) is needed that can serve as a primary source or as an array element. While instantaneous ultra-wideband performance is of primary concern, the electronic selection of simultaneous multiple spot frequencies (or narrow frequency bands) within the total bandwidth is also of interest. What methods will optimize the gain and/or scattering cross-section? Practical circuit solutions for various applications should be studied both theoretically and experimentally, with emphasis on design criteria and cost estimates. Finite resistance effects need to be accounted for, and testing of wideband performance should be included in Phase I. In Phase II the gain measurement of the antenna, together with the wide-banding circuit, should be made, and an elementary radiator will be studied other than the one chosen in Phase I. Also, a non-linear alternative to the active circuit studied in Phase I is to be explored.

AF92-054 TITLE: Special Purpose Residue Number System FFT Processor

OBJECTIVE: Develop a Fast Fourier Transform (FFT) processor based on the Residue Number System (RNS) for communications and surveillance applications.

DESCRIPTION: There is a need for increased speed and precision in FFT processors. The main obstacle to achieving increased speed and precision in a binary implementation is complex multiplication. The RNS offers a potential solution to this problem in two distinct ways. First, multiplication in RNS is implemented by the parallel operation of read-only memories (ROM). Second, number theoretic transforms in RNS allow complex multiplication to be implemented with only two parallel real multiplications. The main difficulty with an RNS implementation of the FFT is the need for an efficient implementation of the scaling operation. For Phase I develop an algorithm and architecture for an RNS based FFT processor that exploits the advantages of RNS in the area of complex multiplication. The use of factored look-up tables and other number theoretic techniques will be explored to further advance the residue multiplication. The design should be fully pipelined for maximum speed and should also offer a practical solution to the scaling problem. The application of core functions to the scaling problem will be investigated. A tradeoff analysis of FFT design parameters such as length, precision, and radix will be performed. For Phase II build a prototype processor using commercially available ROMs and RAMs. Preliminary design information will be provided for implementing the developed RNS processor in custom application specific integrated circuits (ASICs) in CMOS and GaAs technology.

AF92-055 TITLE: Evaluation Techniques for Adaptive Optics Control Systems

OBJECTIVE: Develop testing methodologies for adaptive optics control systems that are reasonable to implement and produce definitive stability and performance data.

DESCRIPTION: Adaptive optics systems for wavefront control are important for many future systems. They are required in imaging systems to remove distortions caused by the atmosphere. They are required in laser propagation to insure a good quality beam is transmitted through the atmosphere. The design of these systems uses many, perhaps well over a hundred, actuators which dynamically shape a mirror surface to compensate for the atmosphere. These actuators require an equal number of control loops to maintain their position. Further, these control loops are coupled to each other due to the mathematical equations used in the loops and due to the mechanical coupling of the mirror surface. The area of multiple-input-multiple-output (MIMO) control theory is directly applicable to this hardware implementation. The techniques of Singular Value Decomposition (SVD) have been developed to help designers evaluate the design of a MIMO system. The problem is that techniques to systematically test this type of system have not been developed. The Bode Plot has been the most used tool for single-input-single-output (SISO) control design and testing for the last 40 years. However, this approach is not feasible for testing large MIMO systems for two reasons: (1) it takes too much to implement and run hundreds of simple tests, and (2) the Bode plot does not yield stability measures for coupled MIMO systems. The need is to develop testing techniques and testing hardware that can be used to evaluate an adaptive optics system. The solution must develop performance measures and stability measures that unambiguously describe MIMO system performance. Phase I will demonstrate that the contractor completely understands the techniques necessary to measure stability and performance of a MIMO system, specifically an adaptive optics system. The contractor will use simulation tools to show that a math model of a system can be tested and evaluated using the contractor's proposed techniques. The contractor should be able to conceptually describe the required testing hardware and demonstrate the performance and stability tools at the end of Phase I. Phase II will build a MIMO system in hardware, and build the testing hardware to demonstrate the performance of the system. An adaptive optics system can be reasonably demonstrated with a beam, or plate, to represent the mirror, with small piezoelectric actuators, to represent the mirror actuators, and with displacement probes, to represent the wavefront sensors used in adaptive optics systems. With careful design this laboratory hardware can be a good and inexpensive representation of an adaptive optics system. The contractor shall then design and build the test hardware to fully characterize this surrogate system. The final product of Phase II will be a report showing the proposed tests and the test hardware to measure stability and performance margins for the systems. Phase III of this effort should be a natural extension of Phase I and Phase II. The techniques of testing MIMO systems should be marketable to persons involved with astronomy, adaptive optics, structural control, aircraft control, and many others. If a good testing approach is developed in Phase I and demonstrated in Phase II the contractor should have a very marketable technical base.

AF92-056 TITLE: Advanced Diode Laser Structures in Mid-Infrared Material System

OBJECTIVE: Design, fabricate and demonstrate advanced diode laser structures, emitting in the 2-5 micron range, preferably at room temperature.

DESCRIPTION: Recently, improvements in (A1) GaAs semiconductor diode laser coherent output power and beam quality have been achieved by utilizing advanced diode laser structures. Typically, simply diode lasers are cleaved-facet, edge-emitting devices in which the coherent output power is limited by gain stripe width and catastrophic facet damage. Advanced structures, such as 1) grating surface emitters (GSE), both distributed feedback (DFB) and distributed Bragg reflector (DBR); 2) on-chip unstable resonators; 3) non-regenerative diodes in external resonant cavities; 4) master oscillator/power amplifier configurations (both monolithic GSE and discrete edge-emitting designs); and 5) antiquided, leaky, wave arrays have led to increased coherent output power by avoiding high intensities on device facets and/or coherently coupling several lower power emitters together into a single, high power beam. These advanced structures have mainly been integrated with (A1) GaAs lasers emitting at less than one micron. Basic diode laser structures are also being developed to emit in the 2-5 micron (mid-infrared (IR)) range utilizing materials such as InGaAsSb, Pb-salts and HgCdTe. Although excellent results have been achieved, it is readily apparent that the potential utility of these mid-IR sources for Air Force applications will be greatly enhanced via the development of advanced laser structures. Phase I of this effort shall study the implementation of advanced diode laser structures in "mid-IR" materials. Study of new and innovative structures, in addition to those mentioned above, which address the dual requirements of high power and good beam quality, is highly encouraged. Identification of basic limitations preventing implementation of an advanced structure will be one of the goals of this study. Following the identification of a viable structure, all growth, fabrication, and materials processing requirements necessary to implement the structure's various components will be addressed. Any unique optics necessary to implement the design shall also be identified. Phase II will implement the Phase I design and develop a mid-IR diode laser source. This development will include either the growth or purchase of the epitaxial wafers,

and the processing, test and characterization of the devices. The test results and mid-IR devices will be deliverable at the end of the Phase II period. The technology development has direct impact on the critical Air Force problems of Strategic Relocatable Targets, Secure Optical Communications, and Opto-Electronic Warfare. Other Air Force and commercial applications of this technology include optical communications, heterodyne detection and high resolution molecular spectroscopy.

AF92-057 TITLE: Ultra-Fast, High Power Switching Techniques

OBJECTIVE: Develop robust, long-life, high-speed switches for high-power broad-band, electromagnetic-field generation.

DESCRIPTION: New requirements in the Air Force have produced the need for high-power, broad-band, electromagnetic field generation. Traditional methods are limited and do not meet future requirements for long life, high rep-rated, high power applications. Study is required into new methods of arbitrary waveform generation including the use of high pressure noble gasses and/or high flow liquid insulators as new, fast high power switching systems. Also, the use of standard technology components in new innovative arrangements should be considered. Phase I efforts would include the investigation and preliminary design of such high performance switching techniques. Phase II work would consist of transitioning this technology into Air Force High Power Microwave systems.

AF92-058 TITLE: Supercomputer Environment for Parallel Distributed Processing Neural Network Algorithms

OBJECTIVE: Develop a supercomputer-based environment for research into massively parallel neural-network algorithms for large-scale, computationally intense, problem domains.

DESCRIPTION: A large percentage of computational research deals directly with iterative and non-linear process for recognizing patterns. Many laboratories have a need to use parallel distributed processing (PDP) techniques on large scale problem domains with immense data transmission and processing requirements. Current supercomputer centers offer high speed processing technology that cannot provide the researcher with actual time analysis of the results. This single effort could serve all centers/labs by developing a useable environment for testing massively parallel signal processing and pattern recognition in noise filtering, image reconstruction, pattern recognition, and image compression/decompression. Such an environment would provide massive parallel processing combined with the speed of the hardware for real/actual time experiment analysis. The Phase I effort will consist of research, development, and laboratory demonstration of a limited environment for signal processing/control and pattern recognition using high speed highly parallel neural network processing techniques. The environment to be developed should be user oriented, modifiable, and efficient in applying a broad range of PDP techniques/algorithms for comparison to conventional, time-consuming, serial algorithms. For demonstration, Phase I could address any or all of the following: pattern recognition, signal reconstruction, noise filtering, speckle image reconstruction, and image compression/decompression. Use of PDP algorithms for the iterative and non-linear nature of these problems can produce highly accurate results in much less time than the conventional serial algorithm approaches. Applicable algorithms include Perceptron, Adaline and Madaline, Linear Associator, Hopfield, Back-Propagation, Counter-Propagation, Bi-Directional Associative Memories, Recirculation, Functional-Link, Spatio-Temporal Pattern Recognition, and Boltzman Machine. Phase II will conclude with an extensive demonstration of an environment on a Cray-2 for solving various filtering, recognition, compression, decompression, and signal reconstruction problems using an extensive suite of PDP algorithms and data configurations. The environment should be capable of producing a file containing the selected PDP algorithm and the algorithm weight matrix which could then be used for designing VLSI hardware. Phase III could include applying the testbed environment in several Air Force and National Laboratories, Universities, and Research Centers.

AF92-059 TITLE: High Speed Data Acquisition System

OBJECTIVE: Develop low-cost high speed (1 - 5Gs/s) digitizing board for data acquisition systems used in recording array.

DESCRIPTION: The Phase I effort will be directed towards the development of a low-cost detection and data digitization system for the evaluation of fast single event signal pulses. These pulses range from a few millivolts to tens of volts in amplitude, having a risetime of sub nanoseconds to tens of nanoseconds. The time of occurrence of a single event is known to be between 0.3 and 3 microsecond accuracy. An initial application will be observing and measuring 10 to 100 terawatt CX-ray pulses with large arrays of X-ray detectors. At this time, high speed digitizers of greater than 1

Gs/s are either very expensive or non-existent, but advances in this technology are anticipated in the near future. During Phase I, a prototype digitizing board with the following characteristics will be developed and tested:

- (1) The board will be built to VXI bus standards.
- (2) The sampling will be 4 Gs/s or greater.
- (3) There will be a hardware/software switch for variable input impedance.
- (4) The vertical resolution will be eight bit or better.
- (5) The data transfer rate will be greater than 1Mbyte/second.

This proposed investigation and development is unique and innovative due to the very fast sampling rate requirement, the use of VXI standards, and the encouragement for possible use of a new sampling technology. Phase II will be comprised of the development of a multichannel VXI based system. Based on the results of the Phase I prototype development, a set of digitizing boards will be incorporated into a multichannel digitizing system. All hardware and software controls appropriate to the specific needs of the high energy plasma physics research initiative will be incorporated at that time. Phase III will be the use of this system as an integral part of research efforts relevant to spacecraft survivability in nuclear burst environment, electronic warfare and the weapon system environment, and controlled fusion using pulsed high power. Once this type of board is developed, it will be very useful in digitizing data in a variety of other types of research settings, including such things as high power microwave.

AF92-060 TITLE: Fractal Modeling of Spall Characteristics

OBJECTIVE: Develop a fractal model of the distribution of spallation products which is based on the physical processes of spall.

DESCRIPTION: The growing amount of space debris in earth orbit poses a threat to the survivability of space platforms as well as to all short term space activities. Models of the distribution of spallation products have been developed in an effort to reduce the number of orbiting fragments resulting from hypervelocity collisions in orbit. These models are based on purely geometric grounds and under the assumption that the nucleation sites for structural failures are randomly and uniformly distributed throughout the material that is impacted. Recent models based on the scale-independent characteristic of fractals have been successful in the simulation of crystal aggregation, electrical discharge channel propagation, and the nucleation and growth of cracks. Phase I efforts will be directed towards developing a fractal model(s) of the distribution of spallation products which incorporates the physics of spallation, and challenges the assumption of uniformly and randomly distributed fault nucleation sites. The physical processes considered in the model(s) should discriminate between the effects of ductile and brittle spall. Phase II efforts will involve the testing of the model(s) created in Phase I. These tests will consist of simulations, employing Monte Carlo techniques for example, to quantitatively develop the model(s). The model(s) will be compared to the available experimental data so as to determine a figure of merit and make appropriate corrections if necessary. The model(s) will also be evaluated for the abilities to describe various fragmentation phenomena and predict the changes in the fragmentation distribution resulting from changes in the parameters of the colliding bodies. Phase III will involve the possible use of the model(s) from Phase II in applications for a variety of fragmentation phenomena, such as high-power short-pulsed laser interactions with various materials, as well as all types of high energy impacts.

AF92-061 TITLE: Approach/Design of High Gain Broadband Antennas; Fast-Risetime Applications

OBJECTIVE: Develop innovative approaches in design of high-gain antennas suitable for radiating high-power broadband pulses with sub-nanosecond risetime.

DESCRIPTION: Achieving high-gain radiation of sub-nanosecond risetime pulses poses severe problems in antenna design. Conventional high-gain antennas generally utilize resonant elements that necessarily restrict operating bandwidth to an unacceptably narrow range. Design of high gain systems for broadband operation is impossible using frequency-domain design methods, since these are not applicable to transient conditions. Thus, high-gain antennas for broadband use must be approached in a fundamentally different way. Innovative techniques such as variational calculus, heuristic searches, genetic algorithms and perturbational methods are ways to approach the problem. Phase I work should identify and investigate new and innovative approaches to the design of high-gain broadband antennas. Viable approaches identified and formulated in Phase I will be implemented in Phase II, and applied to the practical development of high-gain antennas for broadband fast risetime applications.

AF92-062 TITLE: Instrumentation to Measure Multiple Hypervelocity Particle Impacts

OBJECTIVE: Develop and demonstrate an instrumentation system to quantify results due to disintegration of a hypervelocity (greater than 1 km/sec) projectile(s).

DESCRIPTION: Phase I provides an approach for measuring hypervelocity projectiles upon impact. Simulation research in orbital debris and kinetic energy weapon (KEW) results is a serious problem during data acquisition. After hypervelocity impact, small secondary particles cannot be accounted for using current simulation facilities. To improve the accuracy of such testing, a system is needed to analyze hypervelocity multiple impacts. Data collection should include time and position of impact. This capability will build on previous meteorite sensor research and will allow for more rigorous testing, validation of our current impact codes, and research into multiple impact damage. Phase II provides development and testing of measurement technique. Phase III transitions results to Phillips Laboratory and the National Aeronautics and Space Administration.

AF92-063 TITLE: Hypervelocity Collision Scaling

OBJECTIVE: Develop scaling relationships between impacting hypervelocity particle parameters and resulting collision characteristics.

DESCRIPTION: Hypervelocity particle impacts pose a threat to the survivability of space-based platforms as well as to all operations in space. The parameters of the particles encountered in space are beyond the current operating capabilities of laboratory accelerators. The Air Force has a need to understand the scaling relationships between impacting particle parameters and the resulting effects on the impacted space platform. This is needed in order to scale current collision models for higher parameter values of the impacting particle. The specific parameters of interest are the velocity and size of the particle. Phase I efforts will be directed towards developing scaling relationships for particle sizes greater than 0.1 mm, and velocities approaches 16 km/sec. The examination of the Long Duration Exposure Facility (LDEF) since its retrieval from orbit indicates that hypervelocity particles of the type specified above do in fact impact the leading edges of space platforms. Phase II efforts involve the testing of the scaling relationships developed in Phase I. The tests will include the comparison of Phase I results with LDEF data and possibly with accelerator experiments. Appropriate corrections and modifications will be made according to test results. Phase III will involve the transition of Phase II results to various groups involved in kinetic energy impact research and development.

AF92-064 TITLE: Wide Bandwidth Diagnostics and Instrumentation

OBJECTIVE: Develop electric and magnetic field probes providing undistorted time domain measurement/observation of electromagnetic impulses.

DESCRIPTION: At the present time there are no free field probes which can provide for the undistorted measurement of electromagnetic impulse radiation fields. The time duration of electromagnetic impulses that are of concern for measurement and/or observation range from 100 pS to 10 nS. The necessity for making these measurements is required for research, development and evaluation of impulse transmitters for ultra wide band radar, impulse weapons and EMI vulnerability work. This technology is essential to Critical Air Force Problems in the area of Electronic Warfare and in Defense Critical Technologies in the areas of Sensors, Signature Control, Weapons Systems Environment, and Pulsed High Power. Phase I will require the creative efforts of electromagnetic radiation and propagation experts to develop from basic theory a design approach and configuration theoretically suited to meet the objective. Phase II will develop, fabricate, test and refine the probes, techniques and possibly analytical software to meet the stated objectives.

AF92-065 TITLE: Low-Temperature High-Output ThermoCouple

OBJECTIVE: Develop thermocouples for very low temperature measurements in cryogenically cooled experiments.

DESCRIPTION: Phase I identifies potential methods for measuring temperature changes at cryogenic temperatures with greater device output power. The Air Force has a need to measure temperature rises in various material samples which have been cooled to 77k, 20k, 10k, etc, under adverse conditions such as large electromagnetic or x-ray environments in a vacuum. Present technology does not provide a sufficiently large output signal for measuring changes of a few degrees. Size is a factor due to the requirement to field in a limited test space. For example, attaching thermocouples to samples on the Air Force cryogenic interrogation chamber located at Maxwell Laboratories, San Diego,

CA. Phase II fabricates and tests candidate designs for ongoing Air Force experiments. Phase III transitions this technology to the Air Force satellite survivability community and to civilian users.

AF92-066 TITLE: Thermal Management for Advanced Electronic

OBJECTIVE: Explore innovative methods in removing heat from wafer scale integrated circuits which are, or will, be developed for space systems.

DESCRIPTION: It becomes increasingly clear that future electronics systems will require innovative packaging solutions to enable space systems to meet size, weight, and power requirements. Commonly, these approaches are called wafer scale integration (WSI); some of the WSI products have been termed "multi-chip modules" (MCMs). As chips are brought closer together, the area and volume power (and, therefore, heat) density increases. Eventually, the densities of WSI will be such that the resulting heat generated during operation cannot be removed fast enough with conventional heat-sinking schemes to sustain an equilibrium. Two solutions are possible: (1) use super-dense WSI only in systems which require steady-state operation for SHORT periods of time, or (2) use non-conventional heat removal techniques. The former solution is not acceptable for any space systems that must operate for more than a few minutes. Therefore, it is necessary to consider new heat removal approaches. In Phase I, the effort will evaluate techniques that can provide significant improvements compared to the thermal management techniques used in current monolithic and hybrid WSI systems. Solutions which are tractable for space systems are essential. Innovative solutions will be encouraged if not required (e.g., micro-encapsulated, integral direct liquid cooling systems; anisotropically conductive substrates, etc.) No technology-dependent assumptions should be made (e.g., all-CMOS), but the response should distinguish solutions based on required heat removal levels. In Phase II, the practicality of such techniques for use in military and space systems must be demonstrated. A functional system shall be constructed in the phase which will demonstrate the ability to remove high amounts of heat (the exact amounts will be established based primarily on Phase I analyses). The demonstrated system must be capable of operation under severe thermal, mechanical, and radiation environments. Furthermore, the constructed system shall demonstrate the feasibility of heat removal by simulating the electrical power loading of "typical" electronic systems and then demonstrating thermal equilibrium of this system in operation. Potential Phase III efforts would consist of development projects of interest to government and industry (for example, highly compressed workstation engines, or a high performance, multi-node parallel computer for space application).

AF92-067 TITLE: High-Performance, Radiation-Hardened, Analog Electronics

OBJECTIVE: Apply emerging concepts in advanced electronics packaging to systems with high-performance analog components.

DESCRIPTION: Research in the advanced packaging of digital electronics systems indicates that dramatic increases in component densities are needed for tomorrow's space systems. Analog systems will undoubtedly follow the same trends. At the highest densities, however, the packaging techniques used for digital systems (for example, wafer scale integration) may prove inadequate without special consideration of the higher noise sensitivities and the continuous time-dependent (non-discrete) behavior of analog systems. Phase I will address solutions to the size, weight, power, and performance requirements of future advanced spaceborne systems, with the primary focus on analog system applications. In Phase II, a low-power, high-performance miniature analog system will be constructed. This system will take advantage of the research performed in the first phase. Phase III will most likely be realized as a natural extension of the technology development demonstrated in Phase II. Example applications include a massively parallel analog signal amplification/post processing and massively parallel analog-to-digital conversion substrates. These applications would allow the real-time processing of large numbers of signal channels directly from the focal plane array of an imaging sensor.

AF92-068 TITLE: Hyper-Dense Chip Connection Systems

OBJECTIVE: Construct electronics systems in three dimensions in densities better than that of untreated silicon integrated circuits themselves.

DESCRIPTION: It becomes increasingly clear that future electronics systems will require innovative packaging solutions to enable space systems to meet size, weight, and power requirements. In Phase I, the effort will establish solutions to package electronics systems of arbitrary size and complexity. Solutions which improve the size and weight performance of systems even over that obtained by placing individual integrated circuit chips side by side and one atop another are desired. The solution shall address the following:

- (1) Very high density chip connection technology (beyond that afforded by conventional wirebonds);
- (2) Maximum frequency/minimum power performance due to integrated circuit device enhancements;
- (3) Packaging which will meet Class S performance levels and yet provide significant input/output bandwidth (beyond 500 I/O for a two inch square package).

In Phase II, the Phase I solution must be refined and demonstrated. A functional system shall be constructed in the phase which will demonstrate the feasibility of the "hyper-dense chip connection" concept. The demonstrated system must be capable of operation under severe thermal, mechanical, and radiation environments. Furthermore, the constructed system shall demonstrate the feasibility of heat removal by simulating the electrical power loading of "typical" electronic systems and then demonstrating thermal equilibrium of this system in operation. Potential Phase III efforts would consist of development projects (such as high density/capacity solid state recorders, high-performance single node computation engines, and massively parallel, scalable computer systems) for the industry and military needs which would directly benefit by the transition of the concepts developed in the early phases of the effort.

AF92-069 TITLE: Superconducting Wafer Scale Interconnects

OBJECTIVE: Demonstrate the application of superconductors as interconnections in space-based systems.

DESCRIPTION: For space-based electronics systems, size, weight, power, performance, and survivability are important considerations. Fortunately, the tendency in electronics technology development is to provide higher density components, which in turn lead to smaller and lighter weight systems. Even on the systems level, new packaging technologies are being applied to increase component densities (e.g., Wafer Scale Integration). As systems get more complex, the interconnection density increases. In some systems, the connection density requirement is already pressing the limits of conventional materials. Within several years, superconducting materials will be required to support the finer linewidth geometries necessary to achieve vastly increased connection density capabilities. Phase I will investigate superconducting interconnects, and it will demonstrate the advantage of superconducting interconnections compared to those composed of conventional conductors. The Phase II will fabricate test substrates with multi-layered interconnections. The substrates will demonstrate the geometries required to perform low-loss interconnections with a minimum factor of five improvement over that achieved with conventional conductors (e.g., copper). The successful completion of this phase would naturally extend to many promising Phase III opportunities (for example, direct, low-noise and low-loss interconnection of a high density -- 512 x 512 -- focal plane array).

AF92-070 TITLE: Pultrusion Processing of Composite Material Hardware for Space Systems

OBJECTIVE: Establish feasibility of innovative manufacturing techniques for fabrication of Air Force space structures.

DESCRIPTION: Most structures in present Air Force spacecraft are derived from machined aluminum components. As a result designers have failed to fully explore the superior material properties that are available using composites. This is due in part to the cost and complexity of conventional composite manufacturing techniques. Greater use of composite materials is needed to enable more ambitious missions to be undertaken, all of which require large, precision-built, space structures. A reduction in overall structural component weight would realize significant launch cost savings in this area. Pultrusion is a low-cost automated manufacturing technique capable of producing constant high quality cross-section structures. Commercial pultrusion composite parts manufactured using this process have demonstrated significant cost and performance advantages when compared with conventionally produced composite parts. However, pultruded parts have yet to be significantly applied to space structures because manufacturing techniques need to be improved to produce thin gage (0.2 to 1mm thick) components. The purpose of this program is to provide an impetus to use advanced composite materials, utilizing the thin gage thickness concept (superior strength and stiffness) to achieve reduced weight and volume savings in proposed Air Force space hardware. Feasibility of innovative manufacturing concepts will be established in a Phase I program. The Phase II program will further demonstrate the results of the Phase I program by fabricating structural components and putting them in a prototype space structure for testing. Successful development of such innovative manufacturing concepts could lead to wide-scale commercial benefits involving

the application of thin gage composite materials to spacecraft, commercial aircraft, as well as marine and automotive equipment.

AF92-071 TITLE: Modular Piezoelectric Damping Elements for Flexible Structures

OBJECTIVE: Integrate recent vibration suppression hardware technology into an innovative modular patch for use wherever it is needed.

DESCRIPTION: This patch would contain sensors, actuators, control hardware, and power conditioning electronics necessary to perform local vibration suppression. The anticipated interface to the host structure would be standard power lines and a data line to monitor and change, if necessary, the control law. The innovation of this program would be the ability to inject vibration suppression technology wherever it is needed. Many proposed and ongoing DOD and SDI space systems for the 1990s and beyond have very precise pointing and shape control requirements. There has been a great deal of success in developing hardware with the necessary sensing and actuation technology to meet these requirements. These efforts have centered around piezoelectric materials as sensors and actuators for active vibration control. These same piezoelectric materials also provide an excellent tunable passive damper when shunted with a tunable resonant LRC circuit. The focus of past efforts has been to prove the technology, and the assumption has generally been made that the technology will be integrated into systems at the design phase. Consequently, there has not been a lot of effort to develop modular, small, lightweight self-contained systems which could retrofit the technology onto a system in need of vibration suppression. The active suppression system could be used for large amplitude vibration suppression, and the passive vibration suppression system could be used either when less vibration suppression is required or in the event of an active system failure. This patch would also have a predictable failure mode. Phase I of the SBIR task would be to develop two competing designs for the "piezoelectric patch" based on passive and active piezoelectric technologies and to evaluate the merits of each design. Phase II of the SBIR would consist of fabricating the chosen concept prototype and testing the qualifications.

AF92-072 TITLE: Suspension System For Dynamic Testing of Space Structures

OBJECTIVE: Develop a general-purpose suspension system for simulating on-orbit boundary conditions in dynamic testing of very low frequency structures.

DESCRIPTION: A system is needed for simulating the unconstrained boundary conditions of orbit in ground vibration testing of a variety of highly flexible (low frequency) structures. Existing approaches introduce undesirable mass, damping and stiffness into the test article-suspension device system, reducing the effectiveness and validity of any ground tests. The proposed suspension device or system must be capable of providing vertical rigid-body suspension frequencies low enough to isolate highly flexible structures without adding unwanted mass, stiffness or damping. The suspension device or system must also allow unconstrained vertical test article motion in a large enough envelope to perform meaningful vibration tests, and must be able to operate in a vacuum chamber without significant loss of performance. Phase I will include construction and testing of a single point suspension device or system for proof-of-concept demonstration. Phase II will develop the concept into a full system using multiple devices of the same basic design.

AF92-073 TITLE: Nickel Hydrogen Battery Improvements

OBJECTIVE: Develop Innovative High Performance NiH2 Batteries for Air Force Space Applications.

DESCRIPTION: Air Force satellites will be using NiH2 batteries for the foreseeable futures. Presently NiH2 batteries have energy densities of 20 and 40 Whr/Kg in low earth and geosynchronous orbits, respectively. Improved performance batteries are required to enable envisioned future Air Force space missions. Innovative proposals for improved/advanced NiH2 batteries are therefore solicited. Energy densities twice current state-of-the-art is the desired goal. Other aspects of the NiH2 battery performance which require improvement/advancement for Air Force satellite missions include higher volumetric energy density (Whr/cc), greater depth of discharge, and increased cycle life. Submitted proposals may address any of the above identified parameters or other significant aspects of NiH2 battery operation. Phase I should produce a complete analysis of the concepts feasibility, a prediction of performance characteristics, and a design of a

proof of principle model. Key laboratory level testing which helps substantiate analytical predictions is highly desirable. In Phase II, the model should be fabricated and tested under appropriate conditions to simulate realistic operational performance. During Phase II, flightweight prototype batteries should be designed, fabricated and tested. Testing should include sample life testing.

AF92-074 TITLE: Prototype Storage and Delivery Device for Cryogenic Solid Oxygen Propellants

OBJECTIVE: Develop a cryogenic container capable of storing and delivering cryogenic oxygen solids into a combustion chamber.

DESCRIPTION: Cryogenic solid propellants may provide revolutionary advances in rocket propulsion. Solid oxygen and a mixture of energetic oxidizers with solid oxygen are relatively easy to form and store for long periods of time. If these cryogenic oxidizers are to be useful for rocket propulsion, a storage and delivery device needs to be developed that will have the following characteristics:

- (1) Capable of condensing gaseous oxidizers directly into the solid state at a temperature less than 50K (-223 degrees C) with a usable lifetime of at least one hour.
- (2) Able to store at least two grams of cryogenic solids.
- (3) Having optical inspection windows to determine the content of the storage container.
- (4) Designed to deliver cryogenic material into a combustion chamber.
- (5) Made of materials compatible with strong oxidizers, such as ozone.
- (6) Able to avoid the liquid state in the transfer method, especially when ozone is a component of the cryogenic solid mixture. The transfer of liquid into the combustion region is acceptable only if a method of safely transferring liquid ozone is developed.
- (7) Controllable flow rate into the combustion region. The pressure of the transferred material must be greater than atmospheric pressure.

Phase I effort involves design of a system with the above characteristics. Phase II effort involves building the designed device and testing it with a 50/50 mixture of oxygen and ozone stored at temperatures less than 50K.

AF92-075 TITLE: Liquid Crystal Polymer Cryo Composite Tank

OBJECTIVE: Develop a composite cryogenic fuel storage tank, without metal liner, using liquid crystal polymers.

DESCRIPTION: Traditionally, cryogenic tankage has been made out of metals such as aluminum or stainless steel with standard safety factors of 4:1. Such tankage is heavy, requiring extensive thermal management (i.e. reliquification, multilayer insulation (MLI), or extensive thermal blankets). For ground based systems, such approaches are adequate for most applications. However, for flight weight systems (usually designed around 1.25-1.75 safety factor) the weight and thermal management of the system is still a critical factor that can make such systems impractical for long term storage in space. The purpose of this effort is to demonstrate that by using liquid crystal polymers, the weight and thermal management problems can be minimized because of the high strength and low thermal conductivity. During the Phase I effort, a prototype flight weight tank design is to be produced. The tank should be made from as many nonmetallic parts (i.e., bosses, tubing, fittings, struts, liner, expulsion diagram, and a fuel acquisition device) as practicable. The manufacturing processes can vary between extrusion, protrusion, casting, ribbon or fiber winding, or any combination to complete the task. The design should be accompanied with adequate real data to quantify the improvement in thermal management as compared with an aluminum tank. A cost and weight savings and improved mission profile analysis will be provided for this tank. In the Phase II effort, a laboratory prototype tank will be fabricated and tested. The testing of the design will be at a government facility (i.e., Phillips Laboratory). In addition to testing the mechanical and thermal performance of the prototype, the tests will be compared with theoretically generated data to test appropriate simulation programs. In Phase III, the contractor will pursue commercial applications with manufacturers who produce tankage for satellites and rockets.

AF92-076 TITLE: Innovative Arcjet Design

OBJECTIVE: Develop a new arcjet which has a 20 percent increase in specific impulse and efficiency over existing ammonia arcjets.

DESCRIPTION: Chemically powered orbit transfer vehicles can only deliver 40 percent of the initial low earth orbit mass to geosynchronous orbits. Electric rocket engines can double the mass delivered to geosynchronous orbit. These high performance engines use one-half to one-third the propellant of chemical engines and this reduction in propellant mass enables a corresponding increase in payload. The most technically mature electric rocket is the low impedance ammonia arcjet. However, its performance is limited to a maximum specific impulse of 820 seconds and an efficiency of 35 percent. This project will develop a low impedance arcjet capable of operating with an efficiency not less than 45 percent and a specific impulse not less than 1000 seconds using a storable propellant. Phase I will design the new arcjet using innovative concepts such as, but not limited to, alternate electrode configurations, regeneratively heated propellant feed systems, and utilizing methane or other light storables as the propellant. The goal will be to obtain at least 45 percent efficiency and 1000 seconds specific impulse at a power level of 10 kilowatts. Phase II will fabricate and test this new thruster on a thrust stand to verify its performance and determine its life time. Proposals will be judged upon understanding of the problem, demonstrated expertise in the field, and innovative approaches.

AF92-077 TITLE: Structural Resin Transfer Molded Solid Rocket Motor Cases

OBJECTIVE: Develop innovative structural resin transfer molded materials application methods and fabrication processes for medium to large solid rocket motor cases.

DESCRIPTION: The emphasis on lower life cycle cost, high reliability and ease of maintenance has shown the solid rocket industry that new technologies and new ways of thinking must be used to address these issues. A component of particular concern is the motor case. Current filament winding techniques for the medium and large size motor cases rely on numerous manual operations which result in high component reject rates. Low cost composite case fabrication processes must be investigated to determine the feasibility of applying them to future ICBM systems. Recent work at OL-AC PL indicates that the new generation of engineering plastics (liquid crystalline polymers), coupled with the structural resin transfer molding (SRTM) techniques can yield a reliable, low cost motor case. During the Phase I effort, a feasibility study for applying the liquid crystalline polymers and structural resin transfer molding fabrication techniques to a given OL-AC PL case design shall be performed. Feasibility shall be demonstrated by fabricating three structural resin transfer molded cases. During the Phase II effort, a detailed study of current and future structural resin transfer molded (SRTM) materials and techniques shall be conducted for medium and large solid rocket motor cases. Current and future SRTM limitations for this application will be identified. The contractor will fabricate several motor cases using the various materials. These cases will be hydroburst tested at the OL-AC PL hydroburst facility. c. In phase III, the contractor will present this work to the various solid propulsion contractors.

AF92-078 TITLE: The Optimization of Lithium Solid Polymer Electrolyte Cells

OBJECTIVE: Develop the next generation of lithium solid polymer electrolyte batteries, and examine and define their failure mechanisms.

DESCRIPTION: There is a need to increase energy and power densities for power storage devices on space missions. The average costs per kilogram of placing a satellite into Low Earth Orbit (LEO) and Geosynchronous Orbit (GEO) are \$8K and \$47K per kilogram, respectively. The need for decreasing payload weight is obvious. Solid state lithium polymer electrolyte cells can provide approximately ten times the energy density of current space power cells (Nickel-Cadmium and Nickel-Hydrogen). In addition, the operating temperature range of these lithium cells is greater than the current cells in use. However, overcharging and overdischarging of lithium cells can lead to cell failure. Presently, the body of data available on cell failure mechanisms is very limited. Understanding of cell failure mechanisms could lead to more robust cell designs. The Phase I will effort be to engineer and construct a prototype secondary solid state lithium polymer electrolyte cell, of sufficiently consistent morphology, such that reproducible energy density, power density and voltage characteristics are achievable. Based on the evaluation and testing of these prototype cells, any other cell criteria which can be optimized to yield a more robust design, as well as enhanced cell performance, should be defined. During

Phase II based on knowledge obtained from Phase I studies, the contractor will engineer and construct a bipolar secondary cell that incorporates these new improved characteristics. This cell should exceed the typical performance values for bipolar secondary hi-polymer electrolyte cells. The contractor will test and evaluate the performance of the bipolar secondary cells. All designs, engineering criteria and performance testing results will be delivered to the USAF.

AF92-079 TITLE: Innovative Methods for Eliminating Combustion Instability in Liquid Rocket Engines

OBJECTIVE: Develop innovative approaches for suppressing or eliminating unstable burn in liquid engines.

DESCRIPTION: Liquid rocket engine development continues to be plagued by the frequent occurrence of combustion instability. Current methods of suppressing such instabilities through the addition of baffles and acoustic cavities, require time consuming empirical cut and try procedures, and design compromises. New and creative approaches for controlling and eliminating combustion instability in liquid rocket engines are sought. The following examples are presented to stimulate ideas and are not meant to be limiting in their scope. In solid rocket motors, certain types of instabilities can be suppressed by the addition of small amounts (approximately 1%) of additives. The use of fuel or oxidizer additives in liquid rocket engines to control instability does not appear to have been explored. A creative and innovative search for compounds which can favorably alter the combustion of liquid propellants is warranted at this time. Since spray and droplet break-up, and droplet vaporization are relevant phenomena, additives which modify surface tension and or vapor pressure should have a significant effect on the combustion process. In addition, other compounds may play a favorable role similar to that of tetraethyl lead antiknock suppression in internal combustion engines. Active control is currently used or considered for a number of combustion applications to impact both performance and stability. Active control of the injection/atomization process should provide new avenues to explore in the quest for improved liquid rocket engine stability. During the Phase I effort, the feasibility of potential approaches would be examined and an experimental procedure for demonstrating their effectiveness would be conceived and designed. In the Phase II effort, laboratory scale tests would be conducted to explore the effectiveness of proposed approaches. The effect of promising suppression techniques on engine and system performance would be examined to ensure there were no deleterious effects. Reliability and maintainability issues would be considered at the propulsion system level. Cost effectiveness would also be addressed. In Phase III, the contractor will pursue commercial applications with propulsion system contractor.

AF92-080 TITLE: Non-Imaging Concentrator

OBJECTIVE: Develop a non-imaging optical concentrator to enhance 1,000:1 concentration ratio of 1500 KW off-axis Parabolic solar space reflectors.

DESCRIPTION: The Phillips Laboratory is planning to use a solar concentrator, in conjunction with guidance and control devices, to direct solar energy into a hydrogen solar engine to heat the propellant inside a cavity, expand the gas, and exhaust it out a propulsive nozzle to produce thrust. Two 100 ft. x 135 ft. off-axis parabolic reflectors will concentrate 3000 KW (1500 KW each) of solar energy into a thruster cavity, located at the two reflectors' focal point, approximately 90 feet from the mirrors. Mis-focused solar energy is normally the reason that an optimum ratio cannot be achieved. When this occurs, the mis-focused energy spills out of the thruster cavity and either is lost, bounces off unprotected materials and equipment, or is absorbed; often with destructive results. The focus of this project is to develop a subscale, secondary solar concentrator which will maximize the "system" concentration ratio, given a primary concentrator size; while minimizing the secondary concentrator mass, it will still have a significant impact on the guidance and control systems. A prime, space environment requirement for the secondary concentrator demands design simplicity and manufacturing ease to interface with the total solar concentrator-thruster concept. The Phase I project will be used to determine the most suitable candidate (optimal) concept for further development and a preliminary design of the chosen concept. Phase II of the project will consist of a preliminary design, a detailed design, and the fabrication of a small scale (1/4) dimensional version; which will fit into or onto the rhenium tube cavity thruster (at the Solar Lab Facility, Phillips Laboratory) and in front of the fluxmapper system. The project interface requirements will be defined at the beginning of Phase II. The cavity of the present thruster is 8 inches in diameter. Experiments will be performed and data compared with the results of previous experiments to determine efficiency increase and concentration ratio.

AF92-081 TITLE: Lidar (Laser Radar) Detection of Space Debris

OBJECTIVE: Study the concept of using a lidar sensor for space-based measurements of space debris.

DESCRIPTION: Innovative concepts are sought for the development of a lidar system to make space-based measurements of space debris. Damage to spacecraft and orbital platforms by space debris is of growing concern to the Air Force and other agencies. Space debris levels are continuing to increase with each new space launch and with collisions between existing debris. This is of particular concern at certain favored low earth orbits which are used by defense satellites and the shuttle. Extensive passive optical and radar measurements are being made, but these are not particularly sensitive to debris of smaller sizes. Even very small millimeter size debris can be extremely damaging at orbital velocities, as demonstrated by the pitting of the shuttle viewports. In-situ measurements of space debris are sought by using the proposed lidar system to obtain statistically useful data to help validate current space debris models. The Phase I effort will be to study the feasibility of the concept given the current and expected, near-term, state-of-the-art, lidar technology. The Phase II effort, if awarded, will seek to develop sensor designs which may meet the proposed objectives, identify specific required key technologies, and identify and address high risk factors through further study and/or development. The fabrication of a scale brassboard system leading to the final design of the space qualifiable hardware for launch will be considered. Candidate approaches should consider use of compact, solid-state, laser transmitters utilizing efficient laser diode-pumping. Tradeoff studies of the merits of using different detection schemes such as coherent, incoherent, quadrant detectors, or focal plane arrays should be done. It is anticipated that the lidar sensor would be launched by a Pegasus or similar class launch vehicle which will determine the lidar size, power, and weight constraints. A number of vendors offer generic instrument platforms that are compatible with the Pegasus and should accommodate the proposed sensor.

AF92-082 TITLE: Passive Microwave Imaging Through Smoke and Obscurants

OBJECTIVE: Develop a passive sensor for the remote identification of military targets and backgrounds in the presence of obscurants.

DESCRIPTION: The USAF has a requirement to assess the effects of aerial bombardment in the presence of clouds and smoke. It is desirable that such a surveillance system be passive. The recent demonstration of a passive microwave airborne sensing capability, i.e., a synthetic aperture radiometer, at 22 cm wavelength by the University of Massachusetts is the impetus for the present proposal. If synthetic aperture radiometry can be extended to much shorter wavelengths, e.g., 3 mm or less, then angular resolution of 0.1° or less can be achieved with an antenna array of suitable size to be mounted on an aircraft; this will yield spatial resolution of 3 m (10 ft) or better from an altitude of 1760 m (5000 ft). The meteorological problem is that wavelengths of a few centimeters or less are increasingly affected by attenuation in clouds and precipitation. Phase I will develop the proof-of-concept of the approach and will include such issues as radiometric sensitivity as a function of wavelength and meteorological environment as well as target and background emissivity and contrast as functions of wavelength. Phase II will be the design of the system using the approach and the fabrication of a prototype system for independent test by the Air Force. Phase III will lead to preproduction prototype.

AF92-083 TITLE: Targeting/Tracking Lidar System

OBJECTIVE: Investigate a system containing a lidar w/infrared camera which will detect, track, and characterize targets in the lower atmosphere.

DESCRIPTION: A typical lidar system transmits pulsed laser energy into an atmospheric region of interest and measures the light backscattered from along the path of the laser pulse. The backscatter contains neutral density particle and aerosol information as a function of range from the lidar system. Lidar systems operate at any number of ultraviolet, visible, and infrared wavelengths, and either stare to record the temporal behavior of the atmosphere as it passes or rapidly scan a region to obtain an atmospheric snapshot. Scanning or staring systems, especially those operating at nonvisible wavelengths, are not well suited to locate and track targets or atmospheric features which subtend relatively small solid angles as viewed from the lidar system. The problem is further aggravated if the target is in close proximity to other strong backscatter sources; ie. adjacent clouds or ground clutter. An innovative system is required which has maximized capabilities to locate, track and characterize or identify atmospheric targets in the lower atmosphere up to and

including cirrus altitudes. The instrumentation called for in this solicitation is one such innovative approach which combines lidar technology with that of passive infrared imagery. Initial trials indicate an infrared sensor is the ideal device to locate and facilitate the tracking of a target both day and night. The lidar can remotely probe the target to determine its range and attempt to define and characterize it. A possible configuration might include a passive infrared video camera providing a steerable field of view with a crosshair index which can be trained on a target. A coaligned lidar system will then also be trained on the target. Another configuration might have independent pointing for the camera and the lidar. By selecting a lidar system in the wavelength passband of the camera, the laser beam will appear as a pointer within the camera field of view and can be positioned independently. Targets of interest include atmospheric features from stratified cirrus clouds to low altitude aerosol and/or pollutant clouds. Desirable system features include the following: 1) day and night ground based operation; 2) IR video camera with a multiple focal length lens system to optimize images from 1 to 15 km.; 3) pulsed lidar system (min. prf. = 10 pps. and max. range resolution = 150 m.); 4) modest laser energy and receiver telescope appropriate for backscatter signals from cirrus clouds at a 15 km. range; 5) pulse to pulse laser energy monitor and calibrated detector system; 6) variable aperture receiver telescope to avoid detector saturation from near field or very bright targets; 7) lidar data system for near real time data processing, integration, storage, and display; 8) ease of system operation; especially pointing which relates to minimizing the system weight and size. The minimum data requirements include the following: 1) targeting, video recorded target verification and extent, field-of-view azimuth and elevation and the temporal behavior of these parameters; 2) tracking, lidar target range, density, azimuth, elevation, and the temporal behavior of these parameters; 3) characterization, lidar target characterization via multiple wavelength backscatter and/or backscatter depolarization etc. The multiple wavelength aerosol characterization can be achieved with a wavelength doubling crystal or a tunable laser. Polarization and other reasonably simple lidar techniques should also be used to identify particular aerosols. Phase I should be a feasibility study based on innovative remote sensing concepts and technology combinations leading to an optimized functional design of a Targeting/Tracking Lidar System, and Phase II should result in a detailed hardware design followed by fabrication and testing of the lidar system.

AF92-084 TITLE: MeV Electron Source for Space-Based Ionospheric Modification and Diagnostics

OBJECTIVE: Design an MeV electron accelerator for use on space platforms in support of ionospheric modification and diagnostics programs.

DESCRIPTION: Previous experiments with electron beams in space have been limited by practical considerations to relatively low particle energies (typically much less than 50 keV). However, recent developments in electron beam technology suggest that moderately powerful (5 MW), relativistic (5MeV) electron accelerator units could be developed for mounting on payloads suitable for research rockets and satellites. Such a development would provide a means for triggering and investigating a new realm of plasma phenomena predicted by theory. These include the creation of dense columns of free electrons and positive ions in the ionosphere, lower mesosphere and upper stratosphere, which could scatter electromagnetic radiation. Such a capability could lead to the development of new diagnostic techniques to investigate ionospheric properties such as electron attachment, recombination, and diffusion times; winds and shears in the lower ionosphere and upper atmosphere; and the determination of atmospheric constituents and pollutants, including their relative concentrations. In addition, a space-based MeV accelerator would provide the means for significantly modifying regions of the space and missile environment. Envisioned are such applications as providing layers or local regions of ionization to efficiently reflect or scatter radio waves, such as by the creation of a diffraction screen for HF/VHF transmissions; inducing electrical discharges from the upper atmosphere to the lower ionosphere (upward lightning); and producing optical and other emissions that could provide a means for identifying and quantifying atmospheric constituents in the upper atmosphere. Projected requirements for a pulsed, high energy electron source are as follows: electron energy, 3 to 5 MeV; peak current, 40 to 100 mA; peak power, 140 to 500 kW; pulse length, 3 to 10 microseconds; pulse repetition rate, 5 to 10 Hz. The relativistic electron source must be designed into a super compact package so that it can be flown on sounding rockets and small satellites, being limited in size to about 3 ft in length by 1.5 ft in diameter (corresponding volume of 5.3 ft (3)) and in weight to less than 300 lbs, excluding power source, such as batteries. It must be able to withstand the rigors of operation in the upper atmosphere and space environments. In Phase I, the feasibility of building such an electron accelerator will be assessed and a preliminary design be prepared. In Phase II, a prototype electron accelerator will be constructed and tested. If the tests are successful, the prototype will be considered for an actual field experiment.

AF92-085 TITLE: Advanced Technology for Satellite Microwave Water Vapor Retrieval

OBJECTIVE: Explore the feasibility of employing meteorological model constraints improving the accuracy of water vapor profiles inferred from satellite microwave sounders.

DESCRIPTION: The operational approach to the retrieval of water vapor profiles from the Defense Meteorological Satellite Program (DMSP) microwave sounders is based on a statistical regression which confines the profile to the local climatic variance. The water vapor profiles are used in various meteorological models which in themselves can provide additional information on the variation of water vapor which can enhance the accuracy of the final water vapor profiles. The specification of water vapor with considerable horizontal and vertical resolution anywhere on the globe is required for the effective utilization of modern Electro-Optical (EO) systems employing tactical decision aids and optimal tactical operations planning. For Phase I investigate the feasibility of a technique which corrects raw microwave data for recognized errors, exploits retrieval techniques to maximize the information obtained and incorporates meteorological models to improve the accuracy of resulting water vapor profiles. During Phase II produce a computer demonstration or numerical simulation to verify Phase I.

AF92-086 TITLE: Stratospheric Ozone Perturbation By Sub-Micron Al₂O₃ Particles

OBJECTIVE: Determine the effect sub-micron Al₂O₃ particles have on stratospheric ozone.

DESCRIPTION: The exhaust of ammonium perchlorate/aluminum-based solid-propellant rocket motors (SRMs) contains hydrogen chloride vapor (HCl) and alumina particles (Al₂O₃). These materials are emitted directly into the stratosphere during the ascent of launch vehicles propelled by SRMs. HCl is known to be destructive to stratospheric ozone and its impact can be determined with currently available radiative-transport models of the stratosphere that incorporate homogeneous, vapor phase chemistry and physics. However, the role of sub-micron Al₂O₃ particles has not yet been well characterized. Experimental research is to ascertain the nature and importance of heterogeneous chemical processes that might occur on the surfaces of sub-micron Al₂O₃ particles that remain dispersed in the lower stratosphere. Data concerning both indirect effects on anthropogenic chlorofluorocarbons (CFC) that photolytically liberate chlorine radicals to destroy ozone, and direct reactions of both ozone and chlorine family members at active sites on the particulate surface is needed. Phase I of the research effort will address the indirect effect and must answer the following question: How are the rates and reaction products of chlorofluorocarbon photodissociation altered by adsorption at surfaces of sub-micron Al₂O₃ particles? Kinetic experiments must be performed to evaluate the rate constants and product composition arising from surface photodissociation of the most commonly used CFCs. The experiments should include a proper treatment of effects that are caused by saturation of surface adsorption. Research during Phase II must identify the principal surface reactions of Al₂O₃ with ozone and with chlorine family members. Reactions that occur on sub-micron Al₂O₃ surfaces in both the presence and absence of solar radiation must be considered. Rate constants for the most significant chemical reactions should be experimentally determined and any heterogeneous catalytic effects must be investigated and quantified. The experimental data must then be analyzed to evaluate the overall ozone depletion potential (ODP) of SRM particulate emissions.

AF92-087 TITLE: Imaging Based Optical Switching

OBJECTIVE: Develop Imaging Based Optical Switch.

DESCRIPTION: In a non-blocking, square-matrix switch sized N inputs/outputs, one needs N(2) number of cross points. In 1950's, Dr Clos of Bell Laboratories used a staged sub-matrices scheme to reduce the number of cross points to approximately N(3/2). An optical switch based on imaging techniques can reduce the number of cross points needed to essentially zero. The Fourier properties of coherent light propagation makes a phase shift in one focal plane to spatial translation in the opposite focal plane. As a result, the wave propagation itself provides the switching. One can apply this principle to transmitting and receiving arrays. This application creates a new generation of switches. This type of switch supports gigabit data rates in a compact form with essentially no cross points. Phase I of this research needs to determine feasibility of this approach. One would solve the two dimensional equations dealing with plane of multiple sources. With the solved equations, one needs to simulate propagation results of steady mark/zero condition for each active source within array. After understanding the results of steady source, one would simulate propagation results of all

sources within array being at pseudo-random transitions. Results of equation solutions and simulation will fully define feasibility and the needed architecture. Phase II of this research needs to complete a working prototype. One will use the results of the Phase I to construct a prototype, starting with selection of lenses, sources, phase shifter, and receiver sets. Afterwards, one would construct a small array. With array completed, one would complete initial tests with static data to verify the shift to translation characteristics from transmitting plane to receiving plane. With a successful static test, one would complete the prototype by increasing data rate from static state to breakpoint. As a result, the prototype will demonstrate performance and provide data to adjust the developed governing equations.

AF92-088 TITLE: Measurement of Currently Unfulfilled/Partially Satisfied Environmental Data Parameters

OBJECTIVE: Develop optimum satellite techniques to measure unsatisfied or partially satisfied environmental data parameters.

DESCRIPTION: This effort should concentrate on the enhancement, improvement, or development of techniques to measure the prioritized environmental data parameters listed below. These parameters are derived from requirements in the Defense Meteorological Satellite Program (DMSP) System Operational Requirements Document (SORD). The parameters can be categorized into atmospheric, oceanographic, terrestrial, and solar/geophysical elements:

Atmospheric:

1. Clouds (Coverage/Type/Layers/
Radiative Characteristics)
2. Vertical Temperature Profile
3. Absolute Humidity (Moisture Profile)
4. Winds (Hor. and Vert. Components)

Terrestrial:

1. Soil Moisture
2. Snow Cover
3. Landlocked Ice Cover

Solar/Geophysical:

1. Electron Density Profiles
2. Neutral Density (60 km-100 km)
3. Solar Radiation Imagery/Flux

Oceanographic:

1. Sea Ice (Cover Thickness, Age, Leads, Polynyas, Icebergs)
2. Sea Surface Temperature
3. Sea Surface Tomography (Ocean Mesoscale Features and Geoid)

Phase I should address a conceptual design, development or feasibility analysis of innovative techniques (e.g. algorithms, sensors, models) to develop an optimum data collection subsystem. The technique should be aimed at improving satellite measurement of any or all of the above listed parameters. The Phase I design should study the feasibility of satisfying the chosen parameter(s) in an efficient and cost-effective manner. 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 will include further development of the Phase I concept into development of a prototype (working laboratory model) of the optimized system.

AF92-089 TITLE: Computer-Efficient Models of Thermospheric Density and Composition

OBJECTIVE: Develop computer models of the neutral thermosphere which are faster and more accurate than those currently available.

DESCRIPTION: In spite of modeling efforts by large organizations, and vast improvements in the speed of digital computers, the accuracy of satellite orbital predictions in low earth orbit has not improved significantly in 20 years. Errors in the thermospheric density models at altitudes of 90 to 1000km are believed to be the cause of this problem. Currently available computer-efficient models are of two types: spherical harmonic models such as Hedin's MSIS and Killeen's VSH; and static diffusion models such as those developed by Jacchia and Slowey, which employ analytic approximations. The VSH model, which is derived by fitting spherical harmonics to the output of a first-principles Thermospheric-Ionospheric General Circulation Model, provides horizontal winds in addition to density and composition. An empirical model of neutral winds has also been developed by Hedin using techniques employed in the MSIS model. The main difficulty with first-principles models and fast models derived from them is that they require knowledge of all

the sources and sinks of energy, some of which are rarely measured or unknown. For example, the Thermospheric-Ionospheric General Circulation Model and the VSH model lack the semiannual variation, though it has been in empirical models for 30 years. Empirical models have the ability to fit the actual data, even when the physical cause is unknown. They also have the speed needed for operational use. Analytic models have the added advantage that they can fit features which vary rapidly with latitude, such as the density variations associated with the dayside cusp. A recent examination of computer-plots of densities produced by the above mentioned models suggests that none of them contains the density bulge beneath the dayside cusps. Atmospheric features in a fast-running model which included a wind vector could reduce the discrepancies between measurements and models. The density structures below 200 km caused by tidal dissipation are another important feature which not all model contain. Recognized short-comings in the accuracy of empirical models include the following: (a) The resolution is of the order of 20-30 degrees, thereby not accounting for sub-grid scale phenomena; (b) proxy indices are used for solar EUV and auroral heating; (c) the models are based strongly on fits to specific data bases; and (d) a minimum of physics and dynamics is incorporated. Regarding speed, total density requires calculation of temperature profile, based on environmental inputs, and subsequent summation of each constituent mass density at each altitude increment. We solicit innovative thermospheric models which possess improved accuracy and speed and are suitable for use on digital computers. Phase I should develop an approach to improving the accuracy and increasing the speed of existing models. The feasibility of this approach should be demonstrated. Phase II should demonstrate a prototype model which has the improved performance predicted in Phase I.

AF92-090 TITLE: Innovative Guidance & Navigation Sensors and Processing

OBJECTIVE: Develop alternative guidance and navigation update schemes and sensor fusion processing techniques to minimize currently encountered complexity and costs.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Current strategic grade inertial instruments are complex and very expensive. As a result, strategic guidance and navigation systems relying solely on inertial instruments for navigation are difficult to acquire, maintain, and service. If this reliance on purely inertial reference is reduced, a potential savings in cost and complexity arises. Several techniques have been proposed to this end, including stellar, radar, and satellite navigation updates. Phase I should attempt to propose additional unique and innovative schemes or sensors. These concepts should have little or no dependence on externally alterable or vulnerable references. Phase II should include further definition and analysis of these topics.

b. Inclusion of non-inertial navigation update sensors into ICBM guidance suites increases the performance requirements on the processor. Efficient algorithms are required to incorporate navigation updates, making the best use of processor capability. Several parameters are of interest, including update timing, relative accuracies of inertial and non-inertial sensors, and processor throughput requirements. Phase I should attempt to develop a sound approach to the problem and demonstrate feasibility of the solution. Phase II should involve further investigation, exploratory testing, or simulation.

AF92-091 TITLE: Reentry Plasma Phenomenology

OBJECTIVE: Develop new models and validate existing models for turbulent flow-field boundary layers of hypersonic vehicles.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. New concepts for mapping or imaging mass and electron densities of turbulent flowfield boundary layers remains a challenge for acquiring a data base to explore RF degradation under these conditions. Laminar flowfields physics has explored non-turbulent flows with much success. With advances being made in maneuvering reentry vehicles, a thorough understanding of this phenomenology is required for improving communications and guidance. Much of the ground testing of this phenomena takes place in shock tunnels with short experimental durations which calls for time resolved diagnostics. Survivability or low cost repeatability in a shock tunnel environment is necessary for acquiring data over a series of ground tests. Ideally, a 3-D time resolved tool would provide an in depth understanding of turbulent boundary

layer conditions. Phase I should investigate one or more advanced diagnostics or innovative concepts and include technical feasibility and performance improvement analysis. Phase II should consist of actual data acquisition and mapping of models at ground test facilities.

b. Turbulent flow during reentry produces modulation of the plasma produced in the boundary layer of the hypersonic vehicle. This plasma modulation can degrade the ability to perform target finding missions, perform a position update or even communicate due to decorrelation of the microwave signals. The degree of plasma modulation and the spectral content of such modulation during turbulent boundary layer flow needs to be investigated. Additionally, the effect that this plasma modulation has on electromagnetic transmission over the frequency bands from S-to Ka-band should be addressed. Phase I would determine the feasibility of the effort and Phase II would develop the analytic techniques necessary.

c. A number of both flight and ground tests have been done over the years to measure the plasma conditions during reentry and to address electromagnetic transmission through this plasma. However, in a number of cases these data have not been thoroughly analyzed to determine all of the elements necessary to compare these data with flowfield/plasma models. This data base needs to be analyzed in depth and sufficient information obtained to validate existing state of the art flowfield codes. The validation of these codes and, where necessary, development of additional correlations is a part of the effort. Phase I would consist of determining what tools should be employed and Phase II would provide a thorough analysis to produce the data base.

AF92-092 TITLE: Electromagnetic Transmission Through Plasma

OBJECTIVE: Develop techniques to facilitate transmission of optical and radar signals through the plasma layer of a hypersonic maneuvering vehicle.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Techniques are sought which would provide information to a reentry vehicle that an interceptor has been launched and is on target for the given reentry vehicle, and which would determine the *interceptor launch and trajectory*. Development of the technique must include the effects of the reentry conditions (flowfield, high temperatures, antenna ablation and/or plasma) on the sensor techniques studied. Phase I would assess the types of techniques which may be applicable. Phase II would entail the development of a method which would provide sufficient information of a potential intercept.

b. Innovative methods are sought to perform Global Position System (GPS) updates both prior to launch and during flight of hypersonic maneuvering vehicles. These methods would provide a necessary trajectory update for hypersonic maneuvering vehicles. The methods investigated should be sufficiently rugged to survive launch and reentry conditions. They should also be small enough with sufficient power to be easily installed in a hypersonic vehicle. The noise sources and their impact on accuracy for such a GPS update should be addressed. Phase I should examine possible methods and Phase II should analyze one of the methods.

AF92-093 TITLE: Develop Second Generation Primary and Reserve Batteries for Strategic Missile Applications

OBJECTIVE: Develop innovative designs and materials in second generation silver-zinc batteries with increased energy density and improve voltage regulations.

DESCRIPTION: The requirement for reduced battery weight and volume in advanced strategic missile applications has resulted in the need for higher energy density reserve batteries. Although reserve lithium thionyl chloride batteries offer very high energy densities, safety and reliability have become significant issues. The advantages provided by high rate reserve lithium batteries are often negated by additional safety and operational concerns. For example, a requirement for effluent gas containment and neutralization is necessary to protect missile assets during abort. In addition the traditional approach has been the use of a centralized instrumentation power supply, either reserve or manually activated. This has stimulated the development of progressively higher energy density batteries to meet this requirement. Since power has been consolidated in a central supply, safety and reliability can become an issue, especially for high energy density lithium

battery systems. One approach is to develop high energy silver-zinc batteries. Another approach to mitigating these concerns is to provide instrumentation power via smaller, lower power, dispersed primary batteries. Each component in such an instrumentation and telemetry system would contain its own primary power supply and cabling. The use of primary batteries would simplify functional testing and reduce safety and reliability concerns relative to the centralized power system. Silver-zinc batteries have many advantages over lithium batteries such as high reliability, prior successful use in other strategic missile applications, and reduced safety concerns. Improvements in current state of the art silver-zinc technology would allow increased energy density and improved voltage regulation which would therefore make the technology more viable for strategic missile applications. Phase I will identify new battery designs and concepts in silver-zinc batteries or alternate battery types. Emphasis during Phase I will be placed on how design innovations and the use of new materials can improve energy density and improve voltage regulation. Phase II would be to select the most promising design(s), to perform material compatibility verification tests and to validate the design(s) by prototype tests.

AF92-094 TITLE: Innovative ICBM Communications

OBJECTIVE: Develop improved communications technologies for ICBM launchers and launch control centers.

DESCRIPTION: Communications between ICBM launchers and their launch control centers must meet requirements such as operation through nuclear environments, survivability against direct nuclear attack and unattended operation in some cases, and high reliability for long endurance and high confidence message delivery. Future launchers and their control centers may be either mobile or fixed. For mobile elements an additional requirement is that transmissions should not reveal location to enemy forces, such as satellites. Cost is a key consideration for all applications. Innovative concepts, architectures, equipment and technologies are needed to respond to these requirements. Phase I work should include preliminary analyses, evaluation of options and a definition of the Phase II effort. Phase II could include more detailed analysis of concepts or technologies studied during the Phase I and concept demonstration or testing. Two technologies of immediate interest are a horizontally polarized VHF antenna for meteor burst communications and a fast response transmit/receive switch that switches in 1 msec, and switches 4 kilowatts at 50/100 MHz and 1 kilowatt at 400 MHz. Other areas of interest include the following:

- (1) Ground wave, sky wave or troposcatter antennas which survive nuclear attack and can be installed within the fenced area (approximately 250 by 150 feet) around a missile silo. Small antennas could be an integral part of the silo;
- (2) Radomes for SHF/EHF satellite terminals which can survive nuclear attack and support post attack communications;
- (3) Conformal or low profile antennas which do not degrade the hardness of current or future hard mobile launchers. All antennas must support noninterruptable/minimum interrupt links between launchers and launch control centers. Ranges of interest are 50 to 400 miles;
- (4) Advanced technology, mobile or transportable, low-cost ground relays to increase survivability and range of launchers to control center links through networking techniques.

AF92-095 TITLE: Prefabricated Missile Silo Structures: Blast Attenuation, Egress, and Design/Deployment Concepts

OBJECTIVE: Investigate innovative techniques for achieving high-hardness missile silo structures utilizing rapidly deployable prefabricated components.

DESCRIPTION: Arms control constraints may drive the U.S. to highly survivable basing which will require very high system hardness at reasonable system cost. One approach to achieving high hardness is the use of natural and/or artificial attenuating overburden materials for silos and vertical or horizontal buried hard shell structures. For rapid launch response, overburden must be quickly removed to allow egress. One possible method of reducing deployment cost is to employ a buried hardened launcher capsule in which the capsule is prefabricated in a factory and assembled on-site. Innovative approaches are sought in the following areas: (Specify subtopic by letter)

- a. Concept definition of innovative attenuating schemes leading to very high system hardness (60 Ksi and greater) and preliminary analysis to show level of feasibility. Phase II will involve more detailed analysis of most promising options followed by small-scale feasibility test(s).

b. Methods of removing various depths (20 to 40 ft) of protective overburden. Techniques may include pressurization, explosives, mechanical, or combinations of methods. Phase I will involve definition of innovative concepts for egress and preliminary analysis to show feasibility. Phase II will involve more detailed analysis of promising solutions along with scale tests to show feasibility.

c. Innovative Concepts of construction, materials, modularization, and field assembly of prefabricated launcher capsules. Phase I will involve definition and cost evaluation of concepts and procedures. Phase II will involve detailed design applicable data base development and evaluation of the most promising concepts.

AF92-096 TITLE: Improved Radiation Hardness for ICBM Electronics

OBJECTIVE: Develop radiation hardened parts; Electro-Optic precision voltage reference & power IC's; plus software tools allowing inexpensive parts design on different substrates.

DESCRIPTION: Specific areas include the following: (Specify subtopic by letter)

a. Investigate/evaluate/develop guidance system precision voltage reference using LEDs Power/Voltage Fiber Optic (FO) Cabling, Electro-Optic (E-O) amplifiers, optical Phase Locked Loops (PLL), etc. This approach using higher frequencies and fiber optic technology can provide for a much higher capability for operating in the Nuclear/Post Nuclear environment. Phase I will identify new voltage references using the different available technologies. Phase II would select promising design(s) to build and test.

b. Hardening a strategic system for operate-through requirements depends on integrating the TREE (Transient Radiation Effects on Electronics) and EMP (Electromagnetic Pulse) phenomena. To combine the present tools available would enable evaluation of synergistic effect and an optimum design solution. Phase I will identify the program modules required and do preliminary coding. Phase II will integrate the software modules and perform validation runs.

c. Study the commercial single chip power control electronics and determine the trades involved to obtain hardened low volume power supplies. Phase I will identify single chip power control electronics and determine the trades involved to radiation harden them. Phase II will build and test the most promising design(s).

d. Interface Trap Formation is a fundamental part of CMOS radiation response. To date no models have predicted the measured response. Developing a model and verification with experimental data is critical to the use of CMOS in future system. Phase I will consolidate test data available and develop a program to verify proposed model performance. Phase II will initiate the program developed in Phase I and perform testing as required.

e. Radiation hardness of bipolar integrated circuits is linked to the transistors cut-off frequency (f_c). High f_c devices are being developed by a self-aligned process that forms a very small base structure. This process needs to be evaluated for future hardened electronics. Phase I will evaluate High f_c devices for Rad hard applications. Phase II will build and test the most promising devices.

AF92-097 TITLE: Internal Measurement of Spherical Surfaces to 5 x 10⁻⁶/Inches Radial Deviation

OBJECTIVE: Develop automated gauge for measurement of Inertial Measurement Unit (IMU) Power Shell Interiors to 5 x 10⁻⁶ inches deviation from prescribed radius.

DESCRIPTION: The housing for the inertial guidance unit of the Peacekeeper and Small Missile is formed by two hemispherical beryllium shells approximately 10-11 inches in radius. The capability of these shells to form a perfect spherical cavity to a deviation from constant radius not exceeding millionths of an inch is critical to the proper operation of the inertial guidance system. There is a need for an automated gauge to continuously measure the internal radii of these hemispheres along a 180° great circle passing through the physically marked zenith of the hemisphere. Such a measurement must be accomplished at 5° increments around the circumference (base) of the hemisphere. The deviation from prescribed radius along each of the resulting 72 great circle measurement routes shall be displayed in both Cartesian and Polar form in a fashion that will facilitate location of any defect on the measured surface. In addition to

measurement of deviation from a constant radius along the 180° great circle path, the instrument shall also compute and record the diameter of the base (equatorial plane) of the hemisphere as defined by the beginning and end of each specific great circle path. In addition, the instrument shall calculate the deviation from prescribed arc length as measured from the zenith to the intersection of the equatorial plane on each side of the physically marked zenith. Readout of the instrument will be in real time and be displayed on video monitor and available on hard copy. The internal surface of the beryllium hemispheres is generated by lapping and is approximately 10 microinches Root Mean Square (RMS). Measurement accuracy must be 5×10^{-6} inches or better. A Phase I SBIR activity will result in definition of the design for the gauge and report generator together with demonstration of the gauge concept. In this regard, a non-contact gauge is highly preferred over a contact gauge. However, accuracy, reliability and maintainability are mandatory and should guide design philosophy. The Phase II activity will result in construction and validation tests of a prototype production gauge and report generator.

AF92-098 TITLE: Replace Refrigerant R-12/R22 Based Cooling Systems for Missile Guidance Systems

OBJECTIVE: Identify innovative coolant systems that are not CFC based systems utilizing environmentally acceptable coolants.

DESCRIPTION: Chlorofluorocarbons (CFCs), and Methyl Chloroform are two major sources of Atmospheric Chlorine that are devastating the ozone layer. CFCs will probably be completely banned by the year 2000. Both of these chemicals are widely used flushing/degreasing agents in the production of metallic and electronic DoD material. In addition, closely related materials, Freon R22 and R12, are used in air conditioning systems. Many missile systems use these chemicals in the equipment that maintains the temperature humidity envelop required for steady state field operation of tracking, launch, guidance, security and storage related electrical and electronic systems, electro-mechanical, and mechanical components and the crew's living quarters. Banning of CFCs creates the need to redesign the environmental control systems to be capable of utilizing an environmentally acceptable coolant system which will provide the necessary operational conditions. Phase I SBIR activity will consist of selecting candidate environmentally acceptable coolants and respective systems and a final recommended system. System designs and operating characteristics will be identified and compared to CFC R12 & R22 based systems. Phase II SBIR activity will finalize the selected design, construct and test a prototype evaluation unit.

AF92-099 TITLE: New Reliability Model Varying The Dormancy Factor

OBJECTIVE: Develop innovative reliability/logistic models for utilization in determining potential spare parts requirements, considering the dormancy factor.

DESCRIPTION: The current Reliability/Logistic modelling software does not allow logistic analysis for calculating Mean Time Between Failure (MTBF) when dormancy is included in the Reliability formula. There is a need for a means to enter dormancy as a constant when figuring out the number of spare parts required. Components requiring a MTBF analysis experience a dormancy period before they are utilized in the field. A new reliability model should enable a logistic analysis to treat dormancy in relation to the MTBF analysis so the process of calculating the number of required spare parts will be simple, accurate, and reflective of the true field scenario. Phase I SBIR activity will result in a MTBF/dormancy program with strategic/tactical missile hardware. The program should be user friendly allowing for the dormancy factor to be varied. If the program cannot be written in the time allotted for Phase I, some form of evidence of the potential of the requirements being met should be exhibited. Phase II activity would involve program completion/application of the model and training of necessary Air Force personnel.

AF92-100 TITLE: Performance Enhanced Navigation Using Neural Network Technology (PENANT)

OBJECTIVE: Explore neural network technology for improving the consistency of aircraft navigation system solutions.

DESCRIPTION: Operational navigation/reference systems are extremely complex and require integration, management and/or diagnostic functions to be performed within the sensor subsystems, at the sensor output level, at the system level, and at the pilot level. Over the last few years, much effort has been expended on technical efforts which address better

ways to perform these functions. These development efforts have met with varying levels of success. Technical deficiencies still exist in the areas of Kalman filter robustness and navigation system fault detection and isolation. Enhancing the performance of these functions would result in improved consistency of the navigation solution, better enabling combat aircraft to successfully complete missions even under instrument meteorological conditions (i.e., at night and in weather). Proven benefits of neural network technology suggest that this field may prove beneficial for improving the performance levels of these navigation/reference system functions. Among these advantages are the capability to detect and adapt to new classes of failure signatures, the capability to exploit massively parallel computing architectures, the ability to recall information based on content, and the ability to generalize from previous examples. Thus, this study will focus on applying neural network technology to such integrated navigation system functions as Kalman filter related diagnoses (e.g., measurement assessment, residual monitoring, covariance limiting), fault detection, isolation and compensation for individual sensor failures, discrepancies, and degradations as well as system level failure/degradation detection. The emphasis of this program will be to assess the feasibility of applying neural network technology to perform navigation system integration, management, and diagnostic functions within a combat aircraft multisensor navigation suite. The PENANT program is to achieve statistically significant improvements in the consistency of the reference solution. The safety of flight goal is less than or equal to 1.3 aircraft losses per 100,000 flight hours due to integrated reference system failures. This goal is based upon a review of the current state of the art as represented by the F-16 System Wide Integrity Monitoring analysis of outer loop flight control. Phase I of this program will consist of an assessment of neural network approaches, the strengths and weaknesses of each, and an examination of all levels of functionality within an advanced multisensor navigation suite. The purpose is to select representative navigation system functions which show the most potential for improved consistency/reliability if performed by neural network methods. Function(s) will be selected for application of neural network(s) and comparison with traditional techniques. Phase II will consist of in-depth analysis of the selected function(s), the identification of appropriate neural network techniques, the development and training of the identified neural network(s), and evaluation of the capability of the neural network to perform the selected function(s). Phase III will allow the contractor to develop software modules tailored to individual users' needs (i.e., specific operational aircraft and subsystems).

AF92-101 TITLE: Formal Mathematical Methods for Sensor Management

OBJECTIVE: *Determine mathematical algorithms for allocating sensor resources in multisensor data fusion processes.*

DESCRIPTION: Future avionics systems will employ multiple sensors, advanced computing capabilities, and an integrating architecture that will promote mission effectiveness by improving situation awareness and decreasing pilot workload. These broad system goals are achievable only when sensor observations are available from which to create a unified picture of object position and identity. This estimation process, called multisensor data fusion, leads ultimately to an accurate situation assessment. A sensor management function is present to automatically coordinate and prioritize requests for sensor service from the various system components. Also, the sensor manager must allocate the sensor service load to produce the best observations possible while dealing with problems like these: time-varying demands for service, objectives that change with mission phase and unpredictable enemy actions, overlapping sensor capabilities, restricted emission regions, and variable sensor performance arising from physical randomness and perhaps enemy countermeasures. The interaction of the forward multisensor fusion process and the controlling sensor management function constitutes important feedback loop within this system. Phase I will examine the viability and structure of various formal or semiformal mathematical techniques that could satisfy the sensor management function in the feedback process just described. Semiformal structures are those that permit some very limited heuristic or symbolic processes as part of the overall algorithm. However, the emphasis of this effort is on formal numeric methods and the extent to which they can be applied. Representative methods that could be investigated include formal control theoretic techniques, methods from utility theory and operations research, methods such as those used for the weapon-target assignment problem, information-theoretic methods, neural nets, and task-directed concepts. Measures of performance shall include computational efficiency, among others. Motivating scenarios shall be representative of tactical Air Force aircraft operations such as occur in deep interdiction missions. The end product of Phase II of this work will be sensor management algorithms appropriate for embedded applications, fully developed, tested and documented. Phase III is envisioned to provide software products coded in Ada for real-time application.

AF92-102 TITLE: Multiple, Integrated, Electronically Steered Arrays (ESA) Radar Performance Enhancements Through Adaptive Processing

OBJECTIVE: Evaluate Electronic Countermeasure (ECM) and ground clutter suppression capabilities of space-time air-to-air radar architectures.

DESCRIPTION: The operational effectiveness and survivability of future advanced USAF fighters will be greatly dependent upon the situational awareness afforded by the air-to-air radar. These aircraft may employ low observable (LO) technologies, advanced launch-and-leave missiles, and face LO threats which dictate fire control radar designs that may require multiple, integrated, ESA or even conformal radar architectures. A critical and pacing ingredient of these advanced architectures will be the need for side coverage, which due to aircraft installation considerations, may result in a relatively small planar or conformal aperture to supplement the primary forward looking aperture. Attainment of significant detection and tracking ranges, in difficult ECM and ground clutter interference environments, will be technically challenging. First, the low resolution radiation pattern of the small side aperture, together with the large side hemisphere Doppler frequency gradients, will result in mainbeam clutter spreads that create large target blind velocity intervals. Second, the side array power/aperture product necessary to search extensive solid angular sectors at the required ranges will be difficult to achieve. The pulse compression techniques, used to obtain high average power with low peak power X-band transmit/receive module active arrays, can yield excessive eclipsing losses and large target blind range intervals. These blind velocities and ranges combine, via multiple pulse repetition frequency (PRF) waveforms, to form a composite range-Doppler blind zone map that may be substantially less than the desired 100% clear. Third, the all-aspect angle medium PRF look-down waveform results in the presence of directly competing (same Doppler frequency as target) diffuse sidelobe clutter, which can readily mask small missile and low radar cross-section (RCS) threats. Fourth, significant reduction in threat RCS will result in a corresponding reduction in target signal-to-sidelobe jammer ratios unless adaptive sidelobe cancellation (ASLC) is employed. And finally, the presence of sidelobe clutter can greatly degrade the performance of conventional ASLCs, and conversely, ASLC operation will serve to raise the antenna sidelobe levels thus further aggravating the sidelobe clutter problem. With the tremendous increases occurring in digital signal processing technology, sophisticated airborne radar adaptive processing is rapidly becoming practical and affords the potential of solving the above technical challenges. The Phase I activity will systematically investigate exploiting space-time adaptive processing (STAP) radar architectures for mitigation of the limited aperture/mainbeam clutter spread, reduced range-Doppler map visibility, sidelobe diffuse and discrete ground rejection, and joint ECM/clutter interference suppression problems. The scope of the effort includes formulating and evaluating novel side array manifold schemes that, in conjunction with innovative receiver channelization concepts, offer the potential for a practical implementation. The Phase I output will consist of a STAP algorithm design, radar architecture definition, and digital computer simulation performance predictions including "on aircraft" effects. The Phase II effort will demonstrate an in-house STAP jammer, and main and sidelobe clutter mitigation (goal of two orders-of-magnitude over conventional techniques) in near real-time. Some breadboard digital array signal processors and appropriate radar receiver/antenna hardware/emulations and tactical environment simulations will be used. Phase III will provide the contractor with the ability to commercialize this adaptive signal processing to other DOD applications. For example, the signal processing developed under this topic could be implemented for future enhancement modifications to aircraft radar systems.

AF92-103 TITLE: 1.5 to 5 Micron Wavelength Tunable Continuous Wave Optical Parametric Oscillator (OPO)

OBJECTIVE: Develop a continuous wave (CW), single frequency, OPO tunable in the 1.5 to 5 micron band.

DESCRIPTION: To date, the overwhelming majority of coherent laser radar work has used either CO₂ gas lasers at 10.6 micron or solid-state Nd:YAG lasers operating at either 1.06 microns or the second harmonic of 0.53 micron. Although some researchers have investigated a few other discrete wavelengths for laser radars (particularly around the 2.0 micron region), no one has ever demonstrated a laser radar with the ability to tune continuously over any appreciable wavelength region. The ability to tune in wavelength would greatly enhance a coherent laser radar's ability to exploit target signatures. In addition, a tunable laser radar could be used to build other types of useful sensors, such as a sensor to detect almost any type of vapor or aerosol. The critical technological challenge to building a tunable coherent laser radar is the availability of a source capable of generating a tunable single frequency output. The state of the art in OPOs is now advanced enough to consider developing one as a practical tunable source for a coherent laser radar. We have selected the 1.5 to 5 micron region because the atmosphere is quite transparent throughout this region. There is a large existing body of passive sensors and research in this region which we can use to calibrate and compare with our

measurements, and laser radiation in the region is relatively safe for exposure to human eyes which greatly simplifies testing. Phase I will focus on the design of the OPO and experimental work to validate the design. This phase will also include a material selection for the oscillator, selection of a pump wavelength and source, and the design of the actual cavity for the OPO. Maintaining adequate frequency stability of the OPO over the time of flight of a pulse shall also be investigated. Phase II will include building the device, demonstrating its operation, and fully characterizing it. It shall identify system improvements such as ways to increase the device's efficiency and stability and reducing the package size. The issue of using a single set of optics and detector over the entire operating wavelength band shall also be investigated. Phase II may also build a second OPO and investigate injection seeding it from the first OPO to force the two outputs to be coherent. In a heterodyne detection laser radar, the first OPO would be the CW local/master oscillator, and the second OPO would be the source for a pulsed or CW transmitter. Phase III will incorporate a master oscillator/injection seeded slave oscillator combination into a wavelength tunable laser radar. It will investigate all issues associated with a wavelength tunable laser radar such as detector efficiency, optical transmission efficiency, etc. At the end of Phase III the laser radar will be delivered to the Air Force for use in advanced research in target search and identification techniques.

AF92-104 TITLE: Double Pull Electronic Counter-Countermeasure (ECCM)

OBJECTIVE: Investigate, develop, and evaluate techniques/tactics to protect airborne radars from Double Pull Electronic Counter (ECM) Technique.

DESCRIPTION: Velocity gate pull-off (VGPO) and range gate pull-off (RGPO) are well defined and documented ECM techniques. Double Pull is the coordinated use of both of these techniques. With the rapid development of digital technology, specifically Digital RF Memory (DRFM) at a 6-8 bit capability and growing, Double Pull potentially provides realistic false targets with both range and velocity characteristics. New ECCM techniques need to be developed to negate Double Pull with and without chaff. The technique(s) to be developed shall be of such a nature that they are a basic part of the fundamental radar design. Also, the technique(s) must consider the total electronic warfare environment that the radar will encounter and not just an isolated Double Pull threat (i.e., in conjunction with a stand-off jammer, but not necessarily limited to). This effort will require access to classified foreign intelligence information, a facility, and personnel clearance level of SECRET/NOFORN. Under Phase I of the proposed research, the contractor shall investigate and define new ECCM techniques that will counter the Double Pull ECM threat. In Phase II, the techniques will be fully developed and evaluated to show the greatest potential for success in Phase I of the project. At the conclusion of Phase II, the contractor's final report will document the techniques, as well as possible future enhancements. Phase III would be an airborne flight demonstration of a brassboard model for potential future ECCM applications.

AF92-105 TITLE: Improved Real-Time Simulation of Antenna Effects

OBJECTIVE: Develop an improved simulation of antenna effects for Electronic Warfare (EW) signal environment simulation.

DESCRIPTION: Real-time EW laboratory simulators have typically been developed with relatively simple handling of antenna pattern effects. This has occurred for several reasons. First, the computation and storage requirements for sophisticated models were beyond the capability of existing processors. Second, the requirements of the devices being evaluated had only minor reliance upon high fidelity of antenna effect simulation for effective performance. Next, the accuracy of signal modulators was a limiting factor on implementations. Finally, the cost of high-speed digital microwave signal modulators was a prohibitive constraint for most organizations. Recent designs of EW systems have incorporated antenna effects as more central elements to system performance. A notable example is the development of antiradiation missiles which use amplitude and phase antenna pattern effects to generate tracking error signals. Together with the increase in emphasis in antenna effects for system effectiveness are breakthroughs in technology in the areas of signal processing speed and low-cost, high-speed, precision signal modulators. This topic is intended to develop a cost effective antenna modeling capability which can be incorporated into existing and future EW signal environment simulators. A successful design will address all aspects of antenna effects and develop both a real-time computational model and signal modulation device implementation. In Phase I, the contractor will develop a preliminary design for both antenna algorithmic modeling as well as the precision control of the signal modulation devices. A prototype demonstration of the proposed design is highly desirable to minimize risk in proceeding with Phase II development. Phase II will implement 66

the design generated in Phase I and integrate it with existing simulation equipment to provide an enhanced simulation capability. In Phase III the contractor will be able to answer the need for ground tests to evaluate inherent design flaws before production is approved. In addition, the contractor will be able to improve the simulation of antenna effects at the pure digital phase, brassboard and systems phase.

AF92-106 TITLE: High Temperature Superconductor (HTSC) Switching for Electronic Warfare (EW) System Applications

OBJECTIVE: Develop low-loss, small-size, HTSC switching with adequate properties for EW system applications.

DESCRIPTION: High temperature superconductivity is beginning to revolutionize microwave system design by enabling smaller, more reliable systems to be produced with higher operating frequency, wider bandwidth and lower insertion loss than conventional technology. Great success has been achieved in producing compact, low loss HTSC components such as microwave delay lines and filters with excellent performance. Work is now beginning on system and subsystem applications development. A means for extremely low loss, compact switching is needed to advance the technology from the component and subsystem level to the full operational system level. This would be done without degrading the advantages of using HTSC by adding heat and size to the system. This effort will explore low loss HTSC switching concepts which will enable microwave HTSC systems to be developed that fully exploit the performance and size advantages of using HTSC while minimizing the logistic penalties of cryogenic cooling. Under Phase I, a small HTSC thin film switch designed for practical use in an EW system will be fabricated. The switch will be measured for important figures of merit such as switching speed, operation bandwidth, insertion loss/return loss, isolation and power dependence in the open and closed state. Switches useful for system applications in the 2-20 GHz range are of primary interest. Under Phase II, the implementation of the switching concept into a practical high payoff EW application will be pursued. The application may require multiple switches and emphasis will be placed on overall system practicality and payoff as well as the ability to reproduce the desired switching characteristics. A demonstrated subsystem using the developed switching concept will be the goal of Phase II. Phase II will result in a final report documenting results and conclusions along with a hermetically packaged operational subsystem with input and output connectors. The goal of Phase III is envisioned to demonstrate the practicality of the switching concept at the system level.

AF92-107 TITLE: Programmable Emitter Signature Generator

OBJECTIVE: Develop a programmable, radar waveform signature generator for Electronic Warfare (EW) signal environment simulation.

DESCRIPTION: Hybrid EW laboratory signal environment simulators have historically concentrated on the generation of gross radar signal characteristics (center frequency, pulse recurrence interval, pulse width, scan type, etc.) to evaluate aircraft signal intercept and warning systems. This approach was sufficient for the early generations of signal identification and warning systems where the relatively simple gross characteristic template matching approach was sufficient to meet the demands of the operational signal environment. Any differences in discrete warning receiver performance between "clean" laboratory generated signal and actual emitters could be remedied relatively quickly during flight testing. Modern signal environments, however, are significantly denser and more complex. This drives receiver developers to explore faster and more robust methods to sort and identify signals. This is done by using more subtle characteristics of signal waveforms such as pulse shape and unintentional frequency variations that occur with different microwave oscillators and amplifiers. Complexity of the newer EW system designs also serves to drive the need for more realistic laboratory testing. Tracking down design problems in integrated and interdependent systems is much more difficult and is becoming prohibitively expensive to resolve with flight testing only. This topic seeks to develop a cost effective, programmable emitter waveform generator which can integrate with other aspects of the current generation of laboratory signal environment generators, to produce not only the gross but also these more subtle radar signal characteristics. The recent developments in direct digital synthesizer and arbitrary waveform generator technology appear to offer considerable promise or success in this area. A successful design will address signal definition requirements and programming, high-speed digital control interfaces, minimization of unwanted simulator artifacts, and ability to operate at frequencies up to 18 GHz with octave or multi-octave operating bandwidth. Under Phase I, a preliminary design for the signal generator device will be developed. A prototype demonstration of the proposed design or critical aspects is highly desirable to minimize risk in proceeding with Phase II development. Phase II will implement the design generated in

Phase I and integrate it with existing simulation equipment to demonstrate the viability and performance of this enhanced simulation technique. Under Phase III, the contractor will be able to provide enhanced testing capability to both manufacturers and federal test facilities of weapon systems and advanced threat identification systems.

AF92-108 TITLE: Engineering R&D for Permanent Avionics Suites

OBJECTIVE: Develop Permanent Avionics Suites (PASs) for Air Force aircraft.

DESCRIPTION: "PAS" means that the suite's avionics components and subsystems will deliver adequate performance during a ten-year service life with no maintenance actions. "Adequate performance" means no individual or combination of avionics components and subsystems degrades the total aircraft system below its minimum specified performance. "No maintenance actions" means that the component or subsystem shall require no attention--no application of tools, Avionics Ground Equipment, or personnel. In all cases, battle damage is excepted. "Ten-year service life" means nine years of peacetime service with about 400 flight operating hours and 300 ground operating hours each year (fighters), or 750 flight/1500 ground (airlift); and one year of no wartime service with 1200 flight hours and 600 ground hours (fighter), or 1200 flight/800 ground (airlift). The wartime service can be expected to occur at any time during the service life and not be continuous. The PAS is expected to merge with existing and future total aircraft systems with no new penalties over existing avionics suites. Proposals may assume replacement or abolition of Government regulations, procedures, standards, or policies which would thwart the goals of PAS, but they must be explicitly stipulated, when known. The intent of Phase I is to create engineering techniques for development and fielding of equipment which can be trusted to deliver both high instantaneous and high sustained performance without attention. Techniques are desired to develop replacements for existing components and subsystems; for complete new subsystems; for conceptual and computational engineering tools for design, development, and trade-off analyses; for conceptual and computational tools which can be used to calculate and demonstrate the value of PAS in terms of: vehicle mission effectiveness, group mission effectiveness (e.g., Bombs On Target And Return), deployment response time, peacetime and wartime costs, etc. Note that construction of a complete avionics suite is likely a job suitable for a large prime contractor but scores of smaller efforts are required to build the technology base which makes PASs possible. Efforts under this program will be to develop the techniques for adequately specifying and verifying sustained performance and the development of practicable PAS warranty requirements, measures, and remedies. Phase II will be breadboard or brassboard or brassboard hardware, software, tests, or analyses, which result in a significant advance in the development of PASs. Phase III will be incorporation of these techniques in PASs.

AF92-109 TITLE: Improved Reliability Through Compliant Interconnects

OBJECTIVE: Develop compliant interconnect techniques for improved reliability and maintainability.

DESCRIPTION: Future requirements for electronic systems are becoming more complex and performance driven. This has resulted in electronic assemblies being composed of many different incompatible materials in an effort to achieve the electrical, mechanical, thermal, environmental, and system throughput requirements. Innovative techniques are needed at all levels of the electronic assembly which will remove or lessen the stresses on the interconnects caused by the differences in thermal coefficient of expansion (TCE) of the various materials and structures. Methods must be developed which decouple these mismatches in TCE while providing reliable and maintainable electrical, mechanical, and thermal interfaces to the system. Some of the more familiar approaches being pursued today include elastomers, button board technology, and soft die attach. Phase I of this effort will identify, analyze, and trade off alternate techniques, processes and materials which will promote the greatest potential for obtaining reliable electrical, mechanical, and thermal interconnects. During Phase II, the most promising candidates will be further developed, analyzed, characterized, and verified through hardware assembly and testing. Phase III would result in a commercially viable compliant interconnect technology.

AF92-110 TITLE: Very-High-Speed Integrated Circuit Hardware Design Language (VHDL) Behavioral Simulation Acceleration Engine

OBJECTIVE: Design a system that will improve the simulation time of VHDL models 3-4 orders of magnitude.

DESCRIPTION: In order to insure the correctness of DOD's digital system designs, a significant amount of simulation is imperative before manufacturing and field testing costs are incurred. Systems simulated thoroughly will be better optimized, will require fewer redesigns, and consequently they will enter production more rapidly and with lower cost. Although simulation is an accepted methodology for the design of individual integrated circuits, it is not generally applied for the design of boards, processors, subsystems, and entire systems. One primary reason is that simulation models of the behavior of these entities rapidly become too large for today's workstation based simulators to simulate in a time efficient manner. Phase I of this effort is to investigate the constructs of the VHDL-IEEE/ANSI 1076 and identify data structures, paradigms, algorithms, and architectures which collectively offer the potential for 3 to 4 orders of magnitude improvement in simulation time. During Phase II, the most promising candidates will be further developed, modeled, and analyzed. The expected result of this effort is a specification for implementing a custom VHDL behavioral simulation acceleration engine. During Phase III, hardware and software for the accelerator would be implemented and integrated into a working prototype system.

AF92-111 TITLE: Direct Diode Pumped Optical Parametric Oscillator (OPO) for Infrared Sources

OBJECTIVE: Produce tens of watts of tunable output power in the 1-5 micron spectral region.

DESCRIPTION: This device must operate in the continuous wave mode and use all solid state components for compactness and reliability. Currently demonstrated high power diode laser technology should be utilized as a narrow bandwidth pump source. A narrow bandwidth can be achieved by locking the diode source to an external cavity. Compared to a frequency doubling scheme, which is also a nonlinear device, an OPO has the advantages of wide and continuous tunability. Although diode lasers have been used for frequency doubling with 40% efficiency, a diode pumped OPO has never been demonstrated due to the threshold power required. If this technical obstacle can be overcome, OPO operation is also possible. This technology enables the use of infrared sources in flight where power consumption and volume are critically constrained. It also creates a range of new applications in both military and commercial markets. Phase I will demonstrate the feasibility of the approach by addressing the central issue of obtaining a low enough OPO threshold for diode pumping. Phase II will then demonstrate full tuning range, conversion efficiency, beam quality, and spectral purity of a prototype laboratory device. Phase III would package and environmentally test the compact device.

AF92-112 TITLE: Carbon and Tellurium Doping Sources for Molecular Beam Epitaxy (MBE)

OBJECTIVE: Develop carbon and tellurium sources applicable to doping of molecular beam epitaxy grown semiconductor materials.

DESCRIPTION: Heavy p- and n-type doping of III-V compound semiconductor materials is a requirement for several major classes of advanced microelectronic devices. Experience with gas source based epitaxial techniques has demonstrated the utility of carbon as a source of acceptor atoms. Carbon has been found to resist migration during growth of semiconductor materials unlike other candidate dopants such as beryllium. At present, these carbon doping methods are typically based upon organometallic compounds, which introduce the additional complication of large quantities of unwanted gases, and are as such, not directly applicable to solid source MBE. This program seeks a source of carbon, which can be introduced at high concentrations (10^{20} - 10^{21} cm⁻³) in a conventional MBE environment. Tellurium has been identified as a donor atom relevant to a wide range of III-V semiconductors. Due to its vapor pressure vs temperature characteristics of potential source compounds (e.g., GaTe), it shows great promise as an n-type dopant source. In the same fashion as for carbon, this program seeks a solid source MBE relevant source for general III-V compound doping at high doping concentrations. To the maximum extent possible, direct application to existing solid source molecular beam epitaxy systems is desired. Modifications to the vacuum and control apparatus in these systems are not desirable. Phase I is expected to be a theoretical and experimental effort which identifies innovative techniques by which the doping of semiconductors may be accomplished. Control, reproducibility, range of fluxes, source lifetime and purity of dopant beams will be applied as a measure of success. The Phase II effort will include fabrication and demonstration of appropriate dopant sources. One prototype source of each type, capable of additional testing in a government MBE system, will be considered a phase II deliverable. For Phase III the sources would be made commercially available for the growth of lasers, heterojunction bipolar transistors, and high electron mobility transistors in MBE systems.

AF92-113 TITLE: Automated Submicron Thermal Imaging/Defect Analysis System for Microelectronic Integrated Circuits (ICs)

OBJECTIVE: Develop automated high spatial resolution imaging temperature and surface defect measurement system for IC applications.

DESCRIPTION: Automated imaging systems have been used for many years for measuring the temperature of electronic devices; these systems typically have spatial resolution on the order of a few microns. State of the art microelectronic fabrication technology has advanced to the point where devices with submicron dimensions are a reality. Due to the small physical size of the active devices and the high power densities within the device structures, surface analysis and thermal design of the circuits are critically important to insure circuit performance and reliability. In order to insure proper device and circuit design, a direct measurement of device temperature and substrate quality is essential. Today's imaging systems do not provide the necessary spatial resolution to obtain an accurate thermal profile for submicron microelectronic devices. Finite element computer models require actual device structures and material properties to get accurate temperature profiles. Automated techniques for substrate surface analysis are evolving. Surface analysis is usually performed manually with the use of microscopes and/or photomicrographs. The development of automated techniques for detection, classification, determination of orientation, and distribution of surface features such as etch pits and oval defects would improve integrated circuit yield and performance. This program is to address the design, fabrication, testing, and delivery of a submicron thermal imaging and surface analysis system for microelectronic integrated circuits. Phase I of the program will address the theoretical and practical aspects of such a system and the definition of a system design. Phase II of the effort will be design, fabrication, testing, and delivery of the system. The system requires quick scan of a digitally controlled scanning stage with a readout and spatial resolution of 0.05 micron for interrogating up to three inch diameter wafers. Device and circuit temperatures will range from 300o to 500o Kelvin requiring 0.1o measurement resolution. An auto calibration, real-time color image, hardcopy system shall be incorporated (design, operation and maintenance manuals included) and be capable of both CW and pulsed operation. Phase III would provide commercially available equipment for the valuation of microelectronic and microwave materials, devices and integrated circuits.

AF92-114 TITLE: Microwave High-Temperature Devices

OBJECTIVE: Develop microwave devices utilizing the improved electrical and thermal characteristics of advanced materials.

DESCRIPTION: Airborne radar, electronic warfare, and communication systems require solid state microwave transmitters, receivers and signal control components with increased performance and affordability. The use of advanced semiconductor materials and processing techniques, monolithic integrated circuits, and advanced packaging and interconnect technologies are key development areas to pursue in building highly integrated advanced microwave components and subsystems. Performance parameters of greater output power, improved reliability, and higher operating temperatures are very difficult to solve with conventional gallium arsenide monolithic microwave integrated circuits (MMICs). The development of high temperature semiconductor materials and devices will be an enabling technology from which advanced MMICs with the required performance will be demonstrated. Large bandgap semiconductor materials that are presently under development include silicon carbide and diamond. The objective of the program is to develop a practical high temperature transistor for use at microwave frequencies. The transistor thin film active layers and associated contacts must be amenable to conventional batch fabrication procedures and eventually suitable for MMIC implementation. In Phase I, emphasis will be placed on developing the device processing technology necessary to produce microwave devices. There is an especially high interest in developing metalization processes for producing high-temperature-capable ohmic and Schottky contacts to SiC, but proposals are not limited to this narrow scope. Phase II will focus on demonstration and optimization of processes which will enable device operation at temperatures up to 600o Celsius. Phase III would provide affordable and commercially available high temperature microwave devices for advanced DOD systems.

AF92-115 TITLE: Corrosion Detection and Life Analysis for Aircraft Structural Integrity

OBJECTIVE: Develop a corrosion detection technique and fatigue life analysis for aircraft structures which accounts for corrosion effects.

DESCRIPTION: The biggest threat to aircraft structural integrity for the past 20 years has been corrosion. The detection and modeling of corrosion would help the Air Force to maximize the structural safety of its aircraft and keep maintenance costs to a minimum. Corrosion can go undetected in the hidden areas of an aircraft structure for years while it initiates and propagates structural damage. Although programs are in place to reduce corrosion, it will never be eliminated. Currently, there is no sensor that reliably detects the onset of corrosion. The detection and treatment of corrosion before it creates major structural damage would save the Air Force a significant amount of money and maintenance manhours. The structural integrity (i.e., durability and damage tolerance) of aging aircraft is of major concern in both the commercial and military sectors. An accurate fatigue life analysis is necessary to ensure the structural integrity of aging aircraft. Analytical deficiencies currently exist primarily due to the inability to account for the effects of corrosion on the fatigue behavior of aging aircraft. Corrosion affects each fatigue phase in the total structural life of a component (i.e., fatigue crack initiation, propagation, and final fracture). For example, fatigue crack growth behavior is influenced not only by the presence of a corrosive environment at the crack tip, but also by the presence of corrosion in front of the crack tip which causes accelerated growth. Corrosion particularly influences the total fatigue life when multiple site damage is present. It is necessary to obtain a fundamental understanding of the fatigue phenomena in the presence of corrosion to preclude the occurrence of excessive structural problems in aging aircraft. The end product of Phase I will be a report detailing the feasibility of the development of a corrosion detection package consisting of the necessary hardware and software technique and corresponding structural life analysis. The end product of Phase II will be a corrosion detection package consisting of the necessary hardware and software and a structural life analysis that accounts for the effects of corrosion. Phase III of this project would entail the refinement of both the detection technique and the life analysis.

AF92-116 TITLE: Experimental Instrumentation/Damage Monitoring for Hypersonic Vehicle Certification

OBJECTIVE: Develop accurate and reliable methods to measure damage and temperature in coupon and small component test specimens.

DESCRIPTION: Future high performance aerospace vehicles (e.g. National Aerospace Plane) will operate in high performance/temperature environments. The operating temperature of their structural components can easily exceed 2000oF. To certify the safety of these vehicles, structural integrity tests must be performed for specimens at high temperatures. Damage growth properties of materials are greatly affected by temperature. Therefore, there is a need to develop a reliable method to measure temperature and damage for coupon and small component test specimens. Since future vehicle components will consist of metallic polymer-matrix composite, metal-matrix composite, and refractory-matrix composite materials, it is desirable that these methods be applicable to a number of material systems. The most reliable means of damage measurement is to optically monitor the damage as it grows under cyclic loading. This method is difficult to perform under a high temperature environment due to high levels of infrared radiation. The electrical potential method of damage measurement requires visual verification because of the possibility of electromagnetic interference caused by the test heat source. Specimen temperature measurements are generally taken with thermocouples in contact with the surface. However, these temperature probes tend to behave as heat sinks and are not extremely accurate. An alternate method is needed to accurately measure surface temperature and/or calibrate less accurate thermocouples. Phase I will detail the feasibility of developing methods to measure temperature and damage for a variety of material types at temperatures exceeding 2000oF. Phase II should result in the development of innovative methods to accurately measure temperature and damage for coupon and small component test specimens operating at high temperatures. Phase III of this project would entail the refinement and automation of these techniques.

AF92-117 TITLE: Three-Dimensional (3D) Mapping of Hypersonic Flow-Field Properties

OBJECTIVE: Develop techniques to measure gas property distributions throughout an Electron Beam (EB) excited hypersonic flow field.

DESCRIPTION: Advanced methods are required to quickly and quantitatively describe the entire flow-fields in

experimental hypersonic research. This arises from the need to experimentally verify computational fluid dynamic programs as well as advance hypersonic technology, including impact on the National Aerospace Plane. While techniques such as laser velocimetry and hot wire anemometry are being advanced in a number of performance directions, extensive flow-field data cannot be quickly obtained by these because of their time-consuming nature to map complete flow-fields. Electron Beam techniques have been pursued in the past for low density flow-field visualization and gas diagnostics. Currently at Wright Laboratory, EB Planar Flow Visualization, utilizing a sweeping beam, is a routine use tool in Mach 12 and 14 flows using real-time video recording. These video images cannot currently be directly related to quantitative values of flow parameters. However, gas density and temperature measurement techniques have been previously developed to quantify these parameters along a thin (nonsweeping) electron beam. It is the intent of Phase I of this effort to investigate and develop theory and the approach which could plausibly couple the air properties measurements to the sweeping 2D/3D EB Flow Visualization technique. An element of this phase would be to upgrade, by a factor of two or more, the measurement accuracies over those previously attained. Phase II would include hardware and software development, demonstration, and verification at the Flight Dynamics Directorate's 20-inch Hypersonic Wind Tunnel. A Phase III program would lead from extension of the quantitative 3D flow properties capability to like 3D determination of the thermochemical properties of high-speed, low-density flows.

AF92-118 TITLE: Advanced Photonic Sensors for Flight Systems

OBJECTIVE: Determine advanced sensor applications of photonic technologies for aircraft vehicle management, flight management and flight control.

DESCRIPTION: By extending the amount of sensed data and fusing it to situational information, improvements can be made in flight performance, probability of mission success, and aircraft survivability. The emerging technologies in photonics have untold potential for advanced applications in aircraft flight systems. Optical physics may provide advanced sensing capability with components that have smaller size, less weight, and require less power. This effort will investigate photonics technologies and determine new sensing opportunities for vehicle management, flight management, and flight control. Phase I is an investigation of the photonics technologies and determining the state of the art sensing capabilities. For each sensing technology, potential flight applications will be derived. Computer simulation will be used for preliminary proof of concept. The speculated benefits will be described per each application. Phase II will involve the laboratory demonstration of the most promising of the advanced applications. Phase III would provide control data acquisition opportunities for advanced aircraft of all types, as well as manufacturing and other applications. Sensors resulting from this activity should provide cost-effective alternatives for many measurements and enable the performance of others.

AF92-119 TITLE: Common Input/Output (I/O) Interfaces for Vehicle Management Systems

OBJECTIVE: Reduce the proliferation of I/O interfaces in vehicle management systems through adaptable common modules.

DESCRIPTION: Current flight control systems are highly (I/O) intensive. Future Vehicle Management Systems (VMS), encompassing flight and integrated control functions, will have even more demanding I/O requirements. VMS functions may interface to a multitude of sensors and actuators, each having different interface requirements. Historically, this has resulted in the development of unique and specialized I/O modules for each function and system architecture. A recent trend in aircraft avionics is the use of Common Processing Modules to simplify maintenance, reduce spare parts requirements, and lower system life cycle costs. Common modules have not been proven practical for flight control because of the myriad of I/O interfaces currently required for flight critical systems. However, advances in Digital Signal Processing (DSP) technology are enabling the development of flexible and programmable I/O interfaces not previously possible. DSP software can replace complex analog circuit designs and allow a DSP module to replace a variety of specialized I/O modules. This makes possible a common I/O module, which provides all the benefits of common modules and may reduce the proliferation of unique I/O modules. Phase I will examine flight control sensor and actuator interface requirements and will investigate the applicability of DSP technology towards creating common I/O modules. A design of an adaptable common I/O module will result. Phase II will develop a laboratory brass-board to demonstrate the ability to interface with typical flight control sensors and to adapt to changing interface requirements. Phase III would extend the ability to interface various I/O devices, as well as the capability for adapting to changing interface requirements. This capability would significantly simplify the implementation of System management

techniques.

AF92-120 TITLE: Fiber-Optic Techniques for Survivability Enhancement

OBJECTIVE: Identify protection techniques for fiber-optics systems to enhance the survivability of flight critical data busses.

DESCRIPTION: The physical smallness of optical fiber enables several Flight Control System vulnerability reducing techniques. Intrinsically, optical fibers provide a smaller target than most electrical cabling. With the smaller size, fibers can be routed to take advantage of structural shielding. But to increase the protection, it may be feasible to embed the fibers in fuselage and wing skins. Optical fibers have also been demonstrated at a laboratory level for their ability to be embedded into glass and carbon-carbon composites, cast aluminum, and cast titanium. In the future, embedded fiber could be feasible in sheet aluminum, fiber-reinforced metal matrix composites, and aluminum/composite laminates. The embedding techniques need evaluation to determine the positive or negative battle damage effects. Fiber-optics are inherently immune to electromagnetic (EM) threats. Their employment is the optimum solution to EM vulnerability of flight control systems. Ballistic threats cause the major source of vulnerability to fiber-optic systems. With electric cabling, a certain amount of damage can be sustained, causing an impedance mismatch, but data communication can still occur. With optical fiber, the damage usually results in fractures, shutting off data communication. So, in comparison to electric cabling, fiber is more vulnerable to shell fragmentation due to its fragility. But since optical fiber is smaller than electric cabling, protective techniques such as embedding in skins and structural shielding become more feasible. The approach is to investigate the favorable characteristics of fiber-optics that will reduce the flight control system vulnerability and to develop techniques to provide protection to distributed optical data busses. Phase I will examine techniques to enhance the survivability of the fiber-optic data bus. These techniques will include structural shielding, adhesion, lamination, and embedding optical fibers to minimize their susceptibility. This phase will examine the state of the art technologies in fiber embedding/adhesion and evaluate them for applicability. The most promising technologies will be combined into a viable set of protection techniques. This phase will also investigate implementation issues concerning the survivable fiber-optic techniques: Technology Maturity Issues, Structural Issues, Manufacturing Issues, and Maintenance/Repair Issues. Phase II will judge the relative merit of the techniques by using test evaluation. Samples of the promising techniques will be fabricated. To optimize the test and evaluation, a test plan will be prepared for each sample. The ballistic, fragmentation, and fire testing will be done, evaluated and compared to a survivability assessment. Phase III would extend the survivability concepts demonstrated to increase the reliability of electronically directed systems. This should result in more confidence for application of advanced systems to critical applications.

AF92-121 TITLE: Sensor Development/Verification for Aircraft Structural Health Monitoring

OBJECTIVE: Design and develop fatigue crack, corrosion, and composite delamination sensors and associated instrumentation.

DESCRIPTION: Current operational aircraft are getting older, and newer aircraft are using more composite materials. The older metallic aircraft have serious problems with fatigue cracks due to fatigue and corrosion. Current Air Force Damage Tolerance Design Methodology requires that an aircraft be designed with assumed initial flaws. These assumed flaws, coupled with knowledge about the aircraft's flight history, help set conservative inspection intervals. Inspections that are manpower intense, decrease the operational readiness of an aircraft and can result in damage where none existed previously. Newer aircraft using composites are overdesigned to compensate for scatter in material properties and possible undetected delaminations. Consequently, the benefits to be achieved through weight reduction are not as great as first expected. As with metallic components, they also have to be inspected periodically for damage. Metallic and composite structures would benefit from the strategic placement of fatigue crack, corrosion, and delamination sensors. These sensors would not only reduce the frequency of required inspections but also reduce the aircraft downtime required for the inspections. Phase I should result in initial designs and bread-board prototypes. The bread-board prototypes would offer a proof-of-concept. Phase II should result in refined designs and brass-board prototypes which would be tested in a laboratory simulating typical environmental conditions expected to be seen by the user. These tests would characterize sensitivity, accuracy, and robustness. Phase III would result in the commercial availability of the innovative crack, corrosion, and delamination sensors. These sensors would find widespread application to aircraft of all types. It is envisioned that these sensors could be used by logistical support organizations and as part of a Structural Health Monitoring System. They could significantly enhance the reliability and maintainability of existing and future

aircraft.

AF92-122 TITLE: High Angle-of-Attack Agility Enhancement

OBJECTIVE: Improve combat performance of advanced fighters through the application of Innovative Flow Control Devices.

DESCRIPTION: Advanced fighter configurations such as the next generation Multi-Role Fighter, can be generally characterized as having chined forebodies, swept wings with sharp leading edges and other signature dedicated features. The forebody and wing are prime vortex generating shapes which produce highly non-linear aircraft aerodynamic characteristics, at high angles-of-attack, that seriously limit aircraft agility. These non-linear aerodynamic effects can be effectively controlled, with the proper application of unique mechanical and/or pneumatic flow control devices, to produce superior combat performance. Phase I will include an experimental investigation of innovative flow control devices applied to a typical advanced fighter configuration. Phase II will include flow control performance validation, with experiment and simulation, prior to a Phase III flight demonstration.

AF92-123 TITLE: Optical Signature Control Materials and Techniques

OBJECTIVE: Develop new and improved materials and techniques for controlling the optical signatures of aircraft.

DESCRIPTION: The Air Force is interested in conducting research into the science of understanding and controlling the optical signature of aircraft with emphasis on the infrared region. Specifically, research shall involve controlling emissivity/reflectivity in the ultraviolet, visible, and infrared regions of the electromagnetic spectrum. Investigations may include bulk materials properties and/or novel concepts based on combinations of constituent materials in some unique construction. Phase I will address application requirements and goals as well as initial formulation, fabrication and evaluation of specific subjects for proof of concept. Phase II will further develop and optimize the material(s) techniques, and produce larger samples for a full spectrum of evaluations. Phase III will scale-up the concepts for full-scale flight demonstration.

AF92-124 TITLE: Direct Fluorination Technology

OBJECTIVE: Develop direct fluorination by preparing a series of perfluoropolyalkylether fluids with varying molecular structures.

DESCRIPTION: Perfluorinated materials are the only materials with the inherent oxidative stabilities at elevated temperatures to meet the extremely demanding requirements for high temperature nonstructural materials. While fluorinated organic materials have been available for over 30 years, the wide spectrum of molecular structures that could be totally fluorinated was extremely limited until the recent improvements in the state of the art of direct fluorination. Theoretically, any hydrocarbon precursor can be perfluorinated, i.e., all of the original hydrogen atoms replaced with fluorine atoms using this powerful direct fluorination technology. Practically, there are still many obstacles to the application of that technology to such a wide range of materials. The main objective of the Phase I effort will be to demonstrate the feasibility of applying this technology to the preparation of a series of perfluoropolyalkylether fluids with varying molecular structure. The Phase II effort will extend that technology to a wider range of molecular structures for base fluids as well as to polyfunctional materials that are required for the development of perfluorinated elastomers and additives for the perfluoropolyalkylether fluids. In addition, the Phase II effort will address the issues involved with scale-up of this technology to large (over 10 kg) samples of fluids and polyfunctional compounds. During the Phase III effort, the issues to be addressed would primarily be involved with the further scale-up of this technology to commercial scale (over 1000 Kg/day) samples of fluids and polyfunctional compounds.

AF92-125 TITLE: Advanced Thermal Protection Materials

OBJECTIVE: Investigate advanced thermal protection materials and associate technology.

DESCRIPTION: Advanced thermal protection materials are required for future ballistic and maneuvering reentry vehicle systems. Projected maneuvering reentry environmental trends, for example, include extended heating, heat soak-out effects, and large structural loads. Phase I will investigate advanced materials and associate technology including innovative materials concepts, analytical/experimental techniques to assist in materials selection and potential performance assessment, and mechanistic studies on critical material/environmental interactions. Reentry vehicle components and elements include the nosetip, aeroshell/heatshield, antenna window, control surfaces, interface joints, thermal insulation, specialized surface treatments, boundary-layer, and trailing wakes. Phase I studies within this broad technical field must address key technical challenges for significant improvements over the current state of the art. Phase II will continue the R&D of promising materials and technological elements, with emphasis upon understanding the interrelationships between compositional valuables and thermal protection performance. Phase III will develop a materials and processing capability for processing high performance material for flight test (or equivalent ground test) demonstration.

AF92-126 TITLE: High-Performance Light Metal Alloys and Metal Matrix Composites

OBJECTIVE: Develop improved light metal alloys and composites based on aluminum, beryllium, titanium, and magnesium systems.

DESCRIPTION: Unique approaches which result in new aluminum, beryllium, magnesium, and titanium alloys and composites are required to support the technology/system requirements identified in AFSC Forecast II Study. Incorporated are ultrahigh temperature aluminum alloys to replace titanium for applications up to 900oF, and ultrahigh temperature titanium alloys to replace superalloy for applications to 1800oF. Environmentally stable, ultralight magnesium and beryllium alloys are also desired. Included in the response of all alloys to secondary processing, titanium alloy requirements specifically address three areas: (a) temperature stability up to 1800oF; (b) strength up to 210 ksi; and (c) high modulus/density ratio. Improvements in strength, stiffness, and reduction in density may be possible using novel alloying additions. Metal matrix composites 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. Phase I of the program will address application requirements and goals and develop mechanical property data or indicators. Phase II will optimize chemistry and processing and also produce larger amounts of material for a full spectrum of mechanical property evaluation. Phase II will also include preliminary evaluation of trade and design studies to give an early indication of future application potential. Phase III would evaluate procedures to scale-up to production size parts and develop processing parameters for the production of qualified parts.

AF92-127 TITLE: High-Temperature Structural Materials for Advanced Air Force Systems

OBJECTIVE: Develop and characterize advanced high temperature structural materials and model forming processes.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (2500oF to 4000oF, excluding carbon-carbon composites), (b) intermetallic materials and composites (2000oF to 3000oF, excluding titanium aluminides), and (c) model forming processes for advanced structural materials. For ceramic composites, research may include the following: (a) new, unique continuous ceramic reinforcement/ceramic matrix systems and coatings; (b) reinforcement/matrix interactions during processing or use; (c) continuous fiber development; (d) 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 (e) 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 low synthesis temperatures; (b) methods for identifying, synthesizing, characterizing, and modeling intermetallic composites; and (c) methods of fabricating composites to provide chemistry control on a sub-micron scale while maintaining the ability to vary and control the final microstructural scale. For modeling of forming processes research may include modeling of (a) the unit forming process; (b) the material behavior in response to the demands of the unit process; (c) the interface between the work piece and the die or mold; and (d) novel methods for obtaining physical property data and constitutive equations for insertion into the models. Phase I will focus on the critical issues which, when solved, will provide proof of concept. Phase II will 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. Phase III will pursue material development effort aimed at specific aerospace components.

AF92-128 TITLE: Improved Nondestructive Evaluation

OBJECTIVE: Development of 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 techniques. Applications focus on the detection, imaging and characterization of flaws and other integrity-reducing anomalies in flight vehicle and engine materials including metals, and metal and nonmetal matrix composites. Improved techniques are needed for real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed for (a) the detection, imaging and characterization of bulk and surface anomalies both metallic and nonmetallic structures, (b) the evaluation of the integrity of bondlines in structures containing adhesive and metal-metal bonds, (c) the determination of the condition of matrix and reinforcing substructures in advanced composite structures, (d) establishing the quality of high-temperature material coatings, (e) the inspection and evaluation of electronic device materials and components, and (f) the quantitative characterization of materials properties. 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 clear potential for ultimate use in realistic manufacturing or in service environments. Phase I of this program will address the initial formulation, fabrication, and evaluation of specific NDE techniques for demonstration of proof of concept. Phase II will perform enhanced development for optimization of the techniques investigated in Phase I. Phase III will, as appropriate, perform the remaining development required to bring the technique or equipment of a marketable state.

AF92-129 TITLE: Advanced Semiconducting Materials

OBJECTIVE: Develop advanced semiconducting materials and improved processes for the growth of these materials.

DESCRIPTION: Advanced Air Force systems will require new and novel semiconducting materials to meet challenging power, frequency, speed and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Materials systems of interest include (a) innovative Group IV and III-V heterostructures and superlattices; and (b) semiconductors such as silicon carbide and the nitrides for high temperature applications. Many of these materials will be in the form of extremely thin-layered structures of different materials. These artificially structured materials require the development of improved techniques for epitaxial growth. Innovative improvements in growth techniques such as molecular beam epitaxy, metal-organic chemical vapor deposition, and laser ablation are sought as well as new techniques. Process modeling of the growth techniques is of interest. The offeror is reminded that this is a materials task, and projects that are primarily device development or device processing will be considered nonresponsive (not relevant to topic). Phase I will address process development and initial testing to show proof of concept. Studies and/or design without actual testing are not appropriate for Phase I. Phase II will develop advanced semiconducting materials for relevant processes to demonstrate potential. In Phase III, advanced semiconducting materials will be optimized for specific applications.

AF92-130 TITLE: Nonlinear Optical Materials

OBJECTIVE: Demonstrate approaches for obtaining nonlinear optical materials with superior properties compared to those presently available.

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 new laser sources (optical parametric oscillators and harmonic generators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts must address material issues for either inorganic and organic materials in either bulk or thin film forms.

Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only for the purpose of evaluating and demonstrating the properties of the material(s). Phase I of this program would demonstrate the proposed growth or processing techniques. Phase II will develop advanced nonlinear materials and relevant processes to demonstrate potential. In Phase III, advanced nonlinear optical materials will be optimized for specific applications.

AF92-131 TITLE: High-Temperature Superconducting Materials

OBJECTIVE: Develop processors for growing high-temperature, superconducting, thin films for electronic and optoelectronic applications.

DESCRIPTION: High temperature superconducting (HTS) materials offer a variety of application opportunities. For example, detection of infrared (IR) radiation can potentially be improved by increasing sensitivity, operating temperature, and signal processing speed over present technology. The properties of HTS materials must be established and controlled, and detection techniques (i.e., bolometers and Josephson junctions) must be evaluated in order to fully assess their value as sensors. 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. The topic addresses development of thin film processing techniques and characterization of optoelectronic properties. Device development will not be supported. Phase I will address initial formulation, fabrication and evaluation of specific subjects for proof of concept, as well as application requirements and goals. Phase II will develop high temperature superconducting materials and relevant processes to demonstrate potential. In Phase III, high temperature superconducting materials will be optimized for specific application.

AF92-132 TITLE: Biotechnology for Nanostructures, Electronic, Optical and Waste Management Applications

OBJECTIVE: Apply biotechnology to obtain novel processes or materials to solve Air Force problems.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of biotechnology to aerospace requirements. Such programs should address the fabrication of materials with compositions and/or microstructural morphologies of such complexity that they are only obtainable via natural processes. The study of this area could conceivably lead to the development of lower energy processing and materials with very specific electronic or electro-optical properties and also contain very few microstructural anomalies. Since biological materials often perform several functions with ease, an investigation of the tradeoffs involved in natural material systems could lead to a design philosophy for multifunctional materials with, for example, both electro-optical and structural properties. Lastly, bioremediation is an area receiving attention for the removal of materials such as coatings and for the disposal of either current or previously discarded toxic materials. Phase I programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, fabrication, and evaluation required for proof of concept. In Phase II, the process or design concepts from Phase I would be developed through optimization and scale-up efforts in order to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product after a Phase III program.

AF92-133 TITLE: Surface Preparation of Metals for Adhesive Bonding

OBJECTIVE: Develop nonchemical base surface preparations for metal.

DESCRIPTION: Phase I would produce nonchemical processes for forming good bonding morphology on the surfaces of copper, aluminum (2024 and 7075) and titanium (6 Al 4V). A process is needed to improve bond durability, increase service temperature range and provide cost reductions as well as reductions in the use of hazardous materials and volatile organic compounds. Existing surface preparations are based on chemically grown oxides. These oxides are hydrated and thus have limited temperature stability and are grown on the metal surface. In addition, the chemical processes are based on strong acids and bases and toxic/hazardous materials including chromates. Phase I work will demonstrate the feasibility of the use of physical process for producing the desired surface morphology for adhesive bonding. Phase II will

involve optimization of the processes developed in terms of speed and uniformity of surface preparation in Phase I. Phase III will involve commercialization of the treatments developed to replace existing chemical base processing.

AF92-134 TITLE: Snap Cure Epoxy Adhesive and Resin Formulations

OBJECTIVE: Develop high strength rapid cure resin and adhesive formulations.

DESCRIPTION: Existing adhesive and resin products are not designated for rapid temperature rise rates, and when so heated do not provide high strength products. Chemical formulations designed for rapid cure (1 to 5 min) via induction heating, etc., are needed for structural repair application of composite and metallic components and are Phase I anticipated goals. Formulations not designed for rapid temperature rise and cure tend to foam and bubble causing unacceptable porosity in the part. In addition, rapid cure of these systems causes chemistry changes which contribute to low strength polymers. Phase II work will optimize the products developed under Phase I for rapid core capabilities and development of high levels of mechanical properties and commercialize them under a Phase III effort. The Phase III effort will include field testing of the products, modifications to conform to customer needs, and establishing formulations to be put into production.

AF92-135 TITLE: Precise Flux Control for Lattice Matched Superlattice Materials

OBJECTIVE: Develop a methodology for maintaining tight flux control during frequent load changes on flux source.

DESCRIPTION: Lattice matched superlattice materials grown using Molecular Beam Epitaxy (MBE) are becoming an area of increased interest due to the unique properties they possess. A major obstacle in achieving consistent material properties is the flux transient caused at shutter opening. This transient becomes very significant in superlattice materials where the layers are much thinner. Tight flux control is much more important when attempting to match lattice constants. An effective method for reducing the area of these transients by at least a factor of 50 is desired. This method must take into account the variation in the temperature characteristics of the effusion cell caused by the cycling of the cells during superlattice growth. The Phase I effort is anticipated to feature just one improvement or may incorporate several improvements. The Phase II goal is to produce a marketable MBE control system which achieves the above objective in addition to a user friendly recipe growth capability. The Phase III goal is to enable commercial support for in-house MBE control system, as well as distribution and support for other government, industrial and academic users.

AF92-136 TITLE: Integrated Product Development (IPD) for Electronics

OBJECTIVE: Develop IPD modeling capability to capture design and manufacturing attributes for electronic multichip module components.

DESCRIPTION: IPD is the integrated design of the product, manufacturing, and support processes together with emphasis on efficiency, improved quality, and reduced cost. The Air Force has a particular interest in improving the product life-cycle of multichip modules that require new packaging techniques and innovative interconnect structures. Three areas of particular interest include (a) modeling existing techniques that are used to trade off system parameters (i.e., performance, cost, reliability, etc.), technical parameters (i.e., electrical, mechanical, thermal, chemical properties), materials, and processes; (b) defining an information architecture that includes both product and process information that can be presented in a functional, logical, or physical view upon demand; and (c) identifying/developing applicable design and decision support tools to facilitate integration. Phase I will address application requirements and goals for proof of concept. This includes identifying attributes to describe the function, sizing, component behavior and fabrication processes needed in a multichip module electronic design. Phase II will develop and demonstrate the methodology applied to a targeted electronic product design. This would include a capability to model both product and process information for analysis. Phase II will establish the information storage and retrieval mechanisms for modeling the behavior of complex multichip modules and appropriate interconnect structures needed for the design. Phase III will develop a candidate IPD software tool that can facilitate the integration of product and process information to perform multichip module designs. This activity will provide storage and retrieval mechanisms for modeling the behavior of

electronic products using new packaging strategies.

AF92-137 TITLE: Space Power, Energy Conversion, and Thermal Management

OBJECTIVE: Develop survivable and lightweight space power technology for spacecraft applications in the 5 to 100 kilowatt regime.

DESCRIPTION: Develop photovoltaic energy conversion source devices, components, materials and subsystems for advanced space power system applications. Proposals should relate to the following technologies: (a) high efficiency, highly radiation resistant photovoltaic cells; (b) survivable photovoltaic cell stack (greater than 600oC); and (c) ultralightweight cells and lightweight/low cost planar and concentrating arrays for application to space missions ranging from a low threat environment to a high-threat environment including tactical missions and electric propulsion for Orbital Transfer Vehicle. Phase I effort will be preliminary investigations to demonstrate feasibility of the proposed concepts. Phase II effort goals will be to fully demonstrate the capabilities of the proposed technology as it applies to survivable space-power systems. Phase III efforts are expected to include optimization of performance and final verification of concept capabilities as well as clarification of any unresolved production and manufacturing issues.

AF92-138 TITLE: Aircraft Power, Power Electronics, and Thermal Management

OBJECTIVE: Develop power electronic devices and systems for aircraft applications.

DESCRIPTION: Develop one or more of the following advanced power and power electronics technologies for future aircraft: (a) high temperature (greater than 500oC) components, fluids, and seals for hydraulic systems; (b) cold weather (-55oC) energy storage technology (batteries, hydraulic accumulators, capacitors); (c) high temperature (200o-1000oC) electrical power and distribution components; and (d) novel thermal management techniques for cooling integral generators, power electronics, and electrohydraulic/electromechanical actuators. Phase I goals include analytical derivations and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III goals include demonstrating flight qualified flight readiness hardware.

AF92-139 TITLE: High Power Technology for Aerospace Applications

OBJECTIVE: Develop high power component technology for aerospace applications.

DESCRIPTION: Development of one or more of the following advanced high power component technologies is needed for future aerospace high power applications: (a) advanced lightweight power sources with power densities less than 0.02 kilograms/kilowatt; (b) superconductivity as applied to pulsed power componentry; and (c) high power superconductive devices and systems, especially those using high temperature superconductors. Phase I goals include analyses and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III will involve a full prototypical demonstration.

AF92-140 TITLE: Combustion Ignition for Gas Turbine Engines

OBJECTIVE: Develop advanced ignition devices and systems for reliable ignition of aircraft gas turbine engines.

DESCRIPTION: Future gas turbine engine combustors will be physically smaller, operate at wider fuel/air ratios and at lower residence times. In order to maintain or increase ignition system performance under these stringent conditions, advanced ignition systems must be developed to improve the reliable light and relight of combustor and augmentor flows during initial start up and at high altitude operating conditions of an engine. These advanced ignition system components must be more durable to reduce maintenance costs while tolerating increased temperatures and pressures in combustor and augmentor environments. These systems should show potential for weight and cost reductions as well as possible

combinations with other subcomponents such as flame sensors. The goal of Phase I will be a feasibility demonstration of the ignition concept. Phase II goals will include a full-scale demonstration of the ignition techniques in a modern gas turbine engine. Phase III efforts will include optimization and refinement of the ignition technique, as well as clarification of any unresolved production or manufacturing issues.

AF92-141 TITLE: Smart Actuators for Aircraft Turbine Engines

OBJECTIVE: Conduct preliminary design and analysis of a "smart" actuator for aircraft gas turbine engine applications.

DESCRIPTION: In order to meet future gas turbine engine weight goals, control systems will be more distributed, employing fiber-optic data busses interfacing to self-contained "smart" actuators and sensors. Currently, sensor and actuator compensation is accomplished in the engine digital electronic control unit. While this approach contributes to very high cable and harness weights and consumes a large portion of the engine control's processing time, it is the only practical method due to the temperature limitations of today's silicon-based microelectronics. Advances in fiber-optic technology and in high temperature, silicon-carbide (SiC) semiconductor technology, make feasible the design of "smart" sensors and actuators. A "smart" actuator is an actuator that is copackaged with an electronics module that provides control signal compensation and actuator control loop closure directly at the source. The "smart" actuator should be a totally self-contained device providing all signal compensation, including self diagnosis and built-in test. The goal of Phase I is to investigate current technology "smart" actuator developments and to conduct a preliminary design of a "smart" actuator for advanced engine applications. The preliminary design should be based on advanced fiber-optic and SiC technologies. The preliminary design will include a description of all compensation functions. A detailed design and fabrication of a prototype actuator shall be conducted on Phase II. Phase III will include qualification testing on a demonstrator engine.

AF92-142 TITLE: Turbine-Engine Test Instrumentation

OBJECTIVE: Develop new sensors/systems for accurately determining strain and temperature under actual engine operating conditions.

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state of the art of structural instrumentations has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor. For these reasons, new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding the temperatures and strains typical of turbine engines for extended periods while detecting strain to within plus or minus 5 percent and temperature to within plus or minus 1 percent. Additionally, proposed techniques should have minimal influence on blade structural parameters and gas flow path characteristics. The goal of Phase I will be a basic feasibility demonstration of the advanced sensing concept. Phase II goals will include a full-scale demonstration on the technique in an environment which duplicates the anticipated conditions in a modern gas turbine engine. Phase III efforts are expected to include optimization and refinement of the sensing technique, as well as clarification of any unresolved production or manufacturing issues.

AF92-143 TITLE: High Temperature Thermally Stable Aviation Turbine Fuel Development

OBJECTIVE: Measure fuel degradation and test additives to improve the thermal stability of JP-8 fuel.

DESCRIPTION: Aircraft subsystems generate waste heat that must be removed to ensure adequate component reliability and life. Fuel is utilized as a main heat sink on most aircraft. New high heat sink fuels are needed to absorb the large heat loads projected for future aircraft. Studies indicate that thermal stability improving additives can be added to increase the operating temperature of JP-8 fuel from 325oF to 425oF. Phase I of this program will focus on

identifying and testing additives to improve the thermal stability of JP-8. As part of the testing, new test methods/devices are needed to quantitate fuel degradation. It is highly desirable that these devices be able to operate at temperatures as high as 900oF and pressure of 500 psig or higher in either a static or flow environment. Phase I can include experiments to test the feasibility/capability of the test method/device. Phase II of this effort will include testing of fuel/additive combinations in aircraft components or devices which simulate the environment of aircraft components. In addition, new test methods/devices for which the feasibility was demonstrated in Phase I can be fabricated and used to test thermal stability additives. Phase III of this effort would include packaging for the commercialization and marketing of the test methods/devices and/or fuel additives to industry and government agencies.

AF92-144 TITLE: Methodology for Turbine Engine Lubrication Sensitivity Analysis

OBJECTIVE: Develop methodology to assess impact of lubrication systems on turbine engine performance.

DESCRIPTION: For turbine engine design purposes, methods have been developed to assess the impact, e.g., sensitivities of compressor flows, efficiencies, on projected engine performance. Such methods typically employ iterative computer algorithms to calculate the sensitivities. The cycle decks are typically restricted to basic performance parameters with, perhaps, some capability to determine the effect of parametric changes on projected missions. Cycle decks are not available to assess impact of performance of new lubricants and lubricant system designs using software codes for personal computer implementation. Development of these critical methodologies and software are required to perform sensitivity analyses so that Integrated High Performance Turbine Engine Technology design goals might be efficiently met. Phase I activities will include assessment of the concept, gathering of pertinent data on current and planned lubrication systems' performance projected for advanced turbine engine designs, assessment of projected mission profiles and selection of algorithms, software, and hardware required to implement the system for sensitivity studies. Phase II activities will include development of the methodology and software sufficient to perform such sensitivity studies using a personal computer. Demonstration and delivery of the software will be required. Phase III will develop software designed for use by turbine engine engineers, aircraft designers, and lubricant and lubrication system component vendors to effectively perform lubrication system sensitivity analysis.

AF92-145 TITLE: Auxiliary Bearings for Magnetically Supported Rotors

OBJECTIVE: Develop auxiliary bearings for magnetic bearing systems.

DESCRIPTION: Studies of active magnetic bearing systems have shown the potential payoffs and high risks involved in the development and application of this technology for advanced aircraft gas turbine engines. Active magnetic bearings represent an innovative approach to aircraft engine rotor support with the potential of providing significant benefits not possible with conventional rolling element bearings. The successful application of magnetic bearings would result in engines with no oiling systems, high rotor speeds, reduced blade tip and seal clearances, reduced weight, and enhanced rotor dynamic control. However, technology for advanced, fail-safe auxiliary bearings has been identified as a critical factor in successfully achieving an operational aircraft engine magnetic bearing system. In an aircraft engine configuration wherein the primary support for the mainshaft rotor is provided by an active magnetic bearing system, the auxiliary bearings would serve as a fail-safe support mechanism. The unlevitated rotor will be statically supported by the auxiliary bearings. Additionally, in the event of a power failure in the magnetic bearing control circuit or during excessive bearing loading conditions caused by the loss of turbine or compressor blades or due to a severe aircraft maneuver, the selected auxiliary bearings must be capable of withstanding these high loads so as to prevent contact between the magnetic bearing rotor and stator. The auxiliary bearings, under these conditions, must have sufficient life to enable the pilot to fly his aircraft safely to the nearest airbase. Phase I goals will include the design and analysis of innovative auxiliary bearing concepts with potential of meeting the speed, temperature, and loading requirements, as related to the conditions described above. Phase II activities will include the detailed design, fabrication, and testing of selected, promising, auxiliary bearing configurations. Phase III effort will involve working with large and small engine contractors to introduce active magnetic bearings into their engines.

AF92-146 TITLE: Very-Low-Cost Airbreathing Propulsion for Standoff Munitions

OBJECTIVE: Develop a very low cost airbreathing propulsion system for tactical standoff munitions.

DESCRIPTION: Develop minimum cost airbreathing propulsion concept(s) for powering standoff air-to-ground munitions at high subsonic speeds. Concepts other than rockets or turbojets are of interest in this program. Simplicity and low cost are sought. The propulsion system encompasses the propulsion unit, the fuel, its delivery system, and all means for starting the propulsion system and controlling it. The Phase I effort will involve examination of new propulsion systems, projection of performance, limited preliminary design, projection of feasibility and definition of critical experiments required to prove the concept(s). Phase II will involve conducting critical experiments leading to fabrication and demonstration of an integrated propulsion system. Construction of a prototype and further necessary testing would be carried out in Phase III.

AF92-147 TITLE: High Mach Combined Cycle Engine Technologies

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6 flight speeds.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turboramjets and air-turborockets to be very attractive propulsion concepts at Mach 0 to 6 flight speeds. Both concepts combine the flexibility and efficiency of turbomachinery at flight speeds of Mach 0 to 4 with the simplicity, low weight and high specific impulse of the ramjet in the Mach 3 to 6 flight range. Currently, plans are underway to develop technologies for both a turboramjet and an air turborocket under the High Mach Turbine Engine Technologies (HiMATE) program. Under this program, technologies which would be applicable to either cycle are of primary interest. Examples of these technologies include air intake systems, exit nozzles, solutions to reduce the length and weight of the inlet and nozzle components, ramburner structures, ramburner fuel injection/flammeholding schemes, endothermic fuel reactor/engine integration, heat exchangers using either fuel or a nonexpendable fluid to cool air, ramburner cooling techniques and air driven power generation devices. Proof-of-concept testing is preferred, but analytical investigations will also be considered. The goals of Phase I will be to identify a novel concept, quantify its payoff and conduct a small scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate feasibility and to plan experiments for larger-scale development in Phase II. The goals of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

AF92-148 TITLE: Automatic Brightness Control (ABC) for Cockpit Electronic Display Instruments

OBJECTIVE: Develop methodology, sensors, and related electronics for controlling displays' brightness from sunlight through nightvision conditions.

DESCRIPTION: New and modernized older military aircraft cockpits are being equipped with various electronic display technology instruments, i.e., multicolor and monochromatic, cathode ray tubes, dot-matrix and segmented devices. The typical aircraft, so equipped, will now have a smaller number of individual instruments in the cockpit than required in the era of the old, dedicated analog, needle and dial instruments. However, controlling the luminance (brightness levels) of these new multifunction instruments, under all operational conditions and flight maneuvering possibilities, becomes significantly more complex. This is because the legibility threshold of these displays under the very broad range of cockpit ambient light conditions (full sunlight, cloud cover, dusk, flares, lightning and nightvision) must now be dealt with on an individual display basis. Not only must the fidelity of portrayed alphanumerics, graphics and video be preserved, but also the intended color and grey shades must be maintained under the changing ambient. Doing the brightness adjustment task manually, especially for each of the primary flight display instruments, subjects pilots to a highly undesirable workload. The Phase I effort will include the development of a technique/methodology, a definition of the sensors and the electronics required to accomplish the desired results automatically (with a manual override), and a basic demonstration of the concept. This effort should consider various aspects:

- (1) The control of display instrument brightness over the range of 0.01 to 10,000 ft lamberts, with a sufficient number of gradations so as to not cause brightness changes that are noticeable and distinguishable to the pilot throughout this range.
- (2) The capability to handle up to 5-6 primary flight display instruments concurrently.
- (3) The capability to relate the individual light sensor locations to the locations of the primary flight display

instruments in the cockpit.

- (4) Timing constraints, as related to day and night operations, and reaction times needed for the system to respond to ambient light changes --- considering the adaptation characteristics of the human eye.
- (5) Capability of the system to sense speed and direction of moving shadows across the cockpit instrument panel and, using these outputs, to influence the ABC.
- (6) Built-In Test (BIT)
- (7) The same design should be practical and economical to install in a variety of military aircraft types, to promote standardization.
- (8) Design should lend itself to standardization of component parts.
- (9) Making use of existing on-board aircraft computer for some of the functions, where practical.

The Phase II effort will design and fabricate the necessary unique sensor components, and three breadboard ABC systems will be assembled for test and experimentation in static and dynamic simulators. These systems are to be based on the Phase I-developed concept. Following the evaluations, three additional flight-worthy prototypes will be fabricated for military flight testing; these tests will also involve aircraft types similar to those utilized for commercial purposes. During phase II, the prototypes resulting from the Phase II effort would be re-designed into a producible ABC system. Sufficient quantities of the production design would then be fabricated to enable MIL-SPEC qualification testing.

AF92-149 TITLE: Verification and Validation of Associate Systems

OBJECTIVE: Identify verification and validation techniques for associate systems software.

DESCRIPTION: Currently, there are research programs within each military service and NASA to exploit the significant potential of associate systems. Associate systems perform functions previously thought to require human judgment, knowledge, or intelligence, using heuristic, search-based techniques. Conventional software verification and validation techniques do not apply to associate systems because the system is both a piece of software and a model of human knowledge and reasoning, and, like all models, will never be "perfect." Even if the software is completely valid and reliable, the embodied model may be in error. In addition to the problems generated by the model characteristics, associate systems employ both numeric and symbolic information which make traditional numeric verification and validation techniques infeasible. Unless compelling evidence can be adduced that such associate software can be trusted to perform its function without error, it will not be used, or may not perform up to expectations. In either case, the decisions generated by the associate system may be inappropriate or wrong, and, if relied upon, may result in considerable damage to the user of the system. Therefore, the verification and validation of associate systems is a critical task. Phase I work will identify specific verification and validation issues concerning the current implementation of the Pilot's Associate software. The Pilot's Associate is a knowledge-based, decision-aiding system being developed to support tomorrow's single-seat fighter. The unique aspects of the Pilot's Associate software (data structures, reasoning processes, dynamic behavior, etc.) will be used to determine the real issues surrounding verification and validation of associate systems. Based on these issues, appropriate verification and validation requirements for associate systems will be identified. After requirements determination, the effort will concentrate on research into the integration of existing applicable verification and validation techniques and the design of new techniques to address requirements not covered by the existing techniques. Upon completion of the Phase I effort, the verification and validation techniques that have been considered will be rated in terms of technical merit and feasibility, and the best ideas will be chosen for pursuit in Phase II. Phase II of this effort will investigate the most promising Phase I techniques using the Pilot's Associate software as a test case. The Phase II goal will be to develop an integrated, computer-based technique to meet the verification and validation requirements of associate system software. Products of the Phase II effort will include the integrated, computer-based technique for verification and validation of associate systems software, a detailed final technique as applied to the Pilot's Associate software. Phase III effort is directed toward the development of a comprehensive computer based tool set for verification and validation of software for associate systems.

AF92-150 TITLE: Low Cost Manned Simulation of Air Combat

OBJECTIVE: Provide the tools to perform Air-to-Air and Air-to-Ground manned simulation of future combat systems.

DESCRIPTION: As part of the Department of Defense critical technologies, simulation of advanced technological

capabilities is crucial to the wise investment of research and development dollars. The level of fidelity required for parametric analysis of technologies at Wright Laboratory is low when compared to simulations used for training systems and flight controls development. Present low-cost, low-fidelity, manned, simulation facilities permit only beyond-visual-range combat symbologies and displays. The limiting factors in these simulations are the displays format and processing requirements. Virtual reality is a display format which shows a great deal of promise in overcoming these limiting factors. A person may don a head-mounted display device and be placed in a virtual world created with computer generated images. These images are updated by the subjects' head movements and other dependencies such as time and position of objects in the virtual environment. The contractor will outline a software architecture and define display requirements for a virtual simulation of Air-to-Air and Air-to-Ground scenarios integrated with our existing low-cost, manned, simulation facility (Phase I). The core simulation will be a version of the Advanced Air-to-Air System Performance Evaluation Model (AASPEM). The virtual simulation will utilize state of the art image processors and head mounted display/tracking technologies for "out-the-cockpit views". Phase II will accomplish full scale development of a single virtual pilot station complete with head-mounted display, head tracker, control stick and throttle. This first pilot station would only be a prelude to the vast potential of this virtual environment. Phase III efforts could create a small low-cost tool which would offer an alternative to multi-million dollar dome simulator facilities. This approach should be inexpensive enough to allow introduction into the entertainment market or a multitude of industrial applications.

AF92-151 TITLE: Cost Methodology for Premilestone I Planning

OBJECTIVE: Devise/Develop effective cost methodology for use in Premilestone I Planning.

DESCRIPTION: This category of Premilestone I Planning methodology is intended to cover the following three specific areas of interest in FY92:

- (1) Advanced avionics and integrated avionics architecture.
- (2) High-performance turbine engines and other innovative propulsion systems.
- (3) High-temperature materials properties and dollar per pound for manufacture.

Phase I should address Premilestone I cost estimating for emerging technology to be fielded into new weapon systems/subsystems. This will provide needed approaches to estimate the cost impacts of specific technologies into total weapon systems/subsystems cost modeling. During Phase II the contractor will develop a working computerized cost model compatible with IBM PC applications and build an appropriate data base. For Phase III the contractor will develop additional definition of the appropriate data base, i.e., airframe, avionics, propulsion etc., with larger working database of aircraft systems.

AF92-152 TITLE: Applications of Advanced Processing and Computing Techniques to Emerging Systems

OBJECTIVE: Apply advanced processing and computing techniques and architectures to emerging aeronautical systems and to their development and analysis.

DESCRIPTION: Advanced processing and computing techniques and architectures offer enhanced mission effectiveness and high payoff under certain circumstances:

- (1) Applied to emerging aeronautical systems/subsystems. Two areas of specific interest are identifying mobile targets and pilot aiding.
- (2) Applied to the development and analysis process for these emerging systems/subsystems. Areas interest are hardware and software solutions to the data management, organization and presentation requirements of Integrated Product Development (IPD) planning.

Innovative software and hardware technologies, such as object-oriented programming, adaptive networks, and knowledge representation, are solicited. High importance is placed in Phase I upon the proposed approach, the potential application, testing methodology, and validation of the capability and maintenance of developed software/hardware systems. Phase II and III efforts are to provide software/hardware products such as integrated multimedia platforms, software and/or hardware systems addressing aircraft system functionality/development (e.g., mission subsystems, design tools), and advanced simulations.

AF92-153 TITLE: Mission Area Planning

OBJECTIVE: Formulate and evaluate operational concepts.

DESCRIPTION: In the field of Mission Area Planning the Air Force has a number of requirements:

- (1) Formulate operational concepts to perform tasks more effectively and to achieve operational and support objectives.
- (2) Evaluate concepts on the basis of effectiveness and cost.
- (3) Provide support for interpreting and evaluating Operating Command deficiencies.
- (4) Refine operational requirements and define responsive development options.
- (5) Provide information/decision support for acquisition decisions, traceability, and quality management.

This involves the full spectrum of Air Force aeronautical missions (e.g., tactical, airlift, mobility, strategic, training) and operational concepts for integrated DoD and/or Allied forces components. Specific areas of interest are as follows: (Specify subtopic by letter)

a. Develop methodology, techniques, and tools for the conceptualization and definition of 1) evolutionary training systems; 2) collective/group training systems; 3) systems for relating strategies to tasks, composite forces, and military modeling, and 4) systems for relating doctrine, strategy, tactice, training, or organization to task accomplishment.

b. In the area of bomber defense, develop innovative ways to defeat airborne and ground launched threats to bomber aircraft. Methods should include investigating lethal and/or non-lethal concepts (e.g., novel approaches to reducing radar cross section of B-52s).

c. Develop methods and models for procedures to develop and validate operational capability in the strategies-to-tasks process. Areas of interest include planning, management, deficiency analysis, requirements push/analysis, documentation and information support systems, decision support systems, function analysis, cost and risk analysis, technology insertion, and organization. Consideration should be given to the evolution of concepts and systems and their development in large, complex enterprises. Ideally, the tools developed should be generic in nature.

d. In the future, total system integration may take on new meaning. It may grow to encompass a large or even total force structure. Consideration may have to be given to the possibility that an all-stealth force may not be desirable for cost or performance reasons. In the future, the notion of a system may imply more than one aircraft. Each such system may have as its components many diverse aircraft, even though in outward appearance many may look alike. Expectations are that this perspective on the notion of a system may achieve new levels of operational effectiveness.

In Phase I the contractor will develop a definition and conceptual solution to the problem and perform an analytical assessment of the proposed solution. Phase II will entail an in-depth analysis of the solution and/or development of the methodology, techniques and computer-aided tools to allow implementation. In Phase III fully implement the proposed solution.

AF92-154 TITLE: Decision Support System for Early Acquisition Supportability

OBJECTIVE: Devise/develop a methodology for logistics life cycle cost (LCC) modeling for use in Premilestone I Planning.

DESCRIPTION: Seventy percent of decisions defining total life cycle cost (LCC) have been made by the end of Premilestone I system concept studies. Therefore, a decision support system capable of identifying acquisition supportability options and their associated costs is needed. An analytical methodology and tool capable of assessing and providing premilestone I logistics LCC estimates is required to aid key weapon system program decisions such as defining the operational scenario, establishing quantitative performance requirements, specifying deployment locations, and selecting the system maintenance concept. The analytical methodology should define integration of emerging technologies into total system/subsystem logistics support planning and LCC cost models. Examples of emerging technologies to be addressed in development of the analysis methodology are USAF Logistics Research, Development

and Acquisition Strategic Plans Programs, PRAM and RAMTIP Programs, and AFLC Technology Application Program Management (TAPM) programs. The logistics supportability analysis methodology should also be capable of assessing LCC impacts of the emerging technologies individually or in combination for a specific system application. Additionally, assessment of the integration of the emerging technology into the AFLC Weapon System Master Planning and Modification Requirements Review Board processes should also be identified and the LCC impacts determined. In the area of logistics supportability analysis methodology, the decision support system should also be able to determine the "cascade" effect of changing system requirements as they effect DOD 5000.1 defined integrated logistics support elements of weapon system supportability. For example, as the range requirement for the system is changed, what effect does that change have on maintenance activities, manpower and training requirements, safety, facilities, support equipment, etc. During Phase I the contractor will study feasibility of developing a flexible supportability decision support methodology and provide a detailed development plan with supporting technical analysis, identification of data sources, and analytically based recommendations. In Phase II, the contractor will develop the decision support system, test it, produce appropriate documentation, and deliver a usable IBM-AT based system to the government. For Phase III provide feedback on system deficiencies and improvements for system use, incorporate government-identified improvements, and deliver a fully developed decision support system with all system documentation.

AF92-155 TITLE: Automatic Probe Seeking Aerial Refueling Drogue

OBJECTIVE: Study the possible design approaches to provide an aerial refueling drogue which automatically seeks the receiver probes.

DESCRIPTION: Current drogues in aerial refueling probe-drogue pod systems cannot control their flight characteristics while in trail. The drogues fly in a position depending on the drag and weight of the drogue/hose/coupling and the flight airspeed/altitude. These drogues become unstable in air turbulence and are also affected by the receiver aircraft bow wave (flow field). Currently, the receiver pilot must make vertical, lateral flight control corrections and make speed (forward/aft) corrections with his throttle to engage the drogue/coupling. Drogue movements/perturbations can result in a missed hookup, which is time consuming, and can prevent the receiver aircraft from making a hookup, which can result in aborted missions. In some cases, the perturbations can cause damage to the receiver aircraft; e.g. canopy/windshield flight controls, instrumentation, pilot tube; with a loss of aircraft a distinct possibility. A drogue which eliminates the lateral and vertical receiver aircraft flight movements and automatically seeks the probe tip position in the last 20 feet of receiver aircraft closure can eliminate aircraft damage, significantly reduce pilot workload, and reduce time consuming drogue misses. During Phase I, design and analyze potential automatic probe seeking aerial refueling drogue techniques. Phase II of the project will provide a prototype design and flightworthy prototype system of the tanker coupling/drogue system and the receiver's probe. Phase III would involve a flight test and service test on the prototype system.

AF92-156 TITLE: Superior Fiber Inserts for Nuts

OBJECTIVE: The development of a fiber insert for nuts that will allow multiple uses.

DESCRIPTION: Nuts with fiber inserts are currently being used in military aircraft. These nuts are not considered reusable, i.e., when the nut is demated it must be thrown away! This procedure often leads to aircraft not being mission ready because spare parts (nuts) are not available. Phase I would consist of the selection of fiber insert material(s) which have a memory, i.e., returns to its initial position after demating so it can be used again. These inserts would then be fabricated, installed in a nut, and laboratory tested to demonstrate their recovery capability. In Phase II these nuts would be installed on an aircraft and the concept validated. After concept validation, the intent of Phase III would be the use of these reusable nuts on production aircraft systems/subsystems.

AF92-157 TITLE: Armament Research

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air-delivered non-nuclear munitions and armaments. These include bombs, submunitions, warheads, projectiles, fuzes (including safe

and arm devices for air-to-air missiles), dispensers, seekers, explosives (including energy sources and conversions), 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; high-voltage storage-and-switching techniques; millimeter wave-seekers for mid-course and terminal guidance; heavy-metal, self-forging, fragment warheads; heavy-metal shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid-generation techniques, and warhead hydrocode-assessment techniques.

AF92-158 TITLE: Compact, Low-Acceleration, Single-Shot, Light-Gas Launcher

OBJECTIVE: Investigate a compact light-gas launcher which minimizes the launch accelerations of experimental packages.

DESCRIPTION: A two-stage light gas gun is presently used in the Aeroballistic Research Facility (ARF), Eglin Air Force Base, Florida, to launch experimental and research aerodynamic configurations into the instrumented portion of the ARF. Because these models are relatively fragile, it is important to minimize the acceleration loads they experience during the launch cycle. Also, since the facility has limited length, (about 30 feet) the launcher must be compact. In conventional two stage light gas gun design, compactness and low launch accelerations are usually mutually exclusive. However, it is believed that during the past few years, some unique designs and concepts have been proposed which combine these two very desirable features. Some of these concepts also include other desirable features such as a cartridge case which contains stacked propellants, piston, and light gas. Such features would add to the ease of operation and possibly make weaponization of such launchers more attractive in the future. Phase I of the SBIR task will be to propose unique designs for a single-shot light gas gun for use as a laboratory launcher. Along with the design, an analysis of the launch cycle will be conducted which will encompass launch weight, muzzle velocity, launch accelerations, pressures, etc. The most promising design will be selected for Phase II. Phase II of this effort will be to construct the single-shot launcher designed in Phase I. The launcher will be installed and tested in the ARF at Eglin AFB as a research tool. The launch cycle prediction routines should be documented.

AF92-159 TITLE: Test Mode Anechoic Chamber Characterization

OBJECTIVE: Exploit the latest microwave technology to characterize the performance of anechoic chambers containing large irregular-shaped objects.

DESCRIPTION: The Air Force is placing greater emphasis on digital modeling and the use of ground simulation facilities prior to, and in lieu of, costly flight testing. Installed test facilities containing aircraft and missile-sized anechoic chambers are the last step in the ground testing. Evaluation of the anechoic chambers is performed after the initial construction and repeated periodically during its lifetime. Once a large (relative to chamber size) object is placed in the chamber, the evaluation, or characterization, of the chamber must once again be performed to determine if free-space conditions are being represented. This is frequently the most time-consuming and tedious part of the test activities. The goal of this task is to develop techniques and methodologies for accomplishing these characterizations with greater accuracy. A secondary goal is the automation of these characterization tests in order to minimize the test setup time. The technical challenge is to exploit recent advances in Radio Frequency (RF) measurement technologies and techniques to allow greater resolution of anechoic chamber performance by characterizing and isolating "hot spots" as opposed to a total chamber characterization. Phase I of this SBIR program should include a survey of potential technologies and techniques and propose a preliminary methodology for anechoic chamber performance evaluation in the presence of large irregular-shaped objects. Phase II of this SBIR program is to demonstrate in an anechoic chamber that the proposed methodology does provide greater resolution and isolation of "hot spots" that contribute to overall chamber performance degradation. Phase III of the SBIR is to produce an automated system that has application to any anechoic chamber containing large irregular test items. The automated system should, in addition to providing detailed resolutions, be of such a design and implementation that it reduces the overall characterization time by a significant amount.

AF92-160 TITLE: RF Simulation Range Extent Device

OBJECTIVE: Exploit Radio Frequency (RF) technology to develop a radar target and ground clutter range extent simulator.

DESCRIPTION: Analog devices are being used in RF simulators to provide for signal delays to simulate range extent for ground clutter and radar targets. These devices provide discrete delays, or fixed tap spacings, close to the range gate size of the radar and are usually made from specific lengths of coaxial cable. The main problem with using coaxial cable is the stability of the delay through the device over a temperature range. A critical limitation of the device is the fixed length, or time delay spacing, of each tap, as well as having a fixed number of taps. The goal of this program is to develop the components or device that can be integrated into an existing RF Simulator and that will provide range extent that is stable over temperature. The device must also have the capability to allow easy programming of the tap spacings and/or the number of taps used. This will enable an RF testor to readily respond to changing test requirements without having to build new discrete tapped delay lines. Phase I of this SBIR program should include surveying of various methods of achieving the programmable/variable range extent, accomplishing preliminary designs to exploit the concept, and reporting the advantages and disadvantages of each proposed concept. Finally, the Phase I task will culminate with a recommendation of the candidate approach to be demonstrated in Phase II. Phase II of the SBIR task is expected to demonstrate in the laboratory the ability of the selected concept to provide the programmable/variable range extent over a changing temperature profile. This demonstration will be provided by a brassboard of the range extent device. Phase III is expected to provide a production version of the prototype programmable/variable range extent device demonstrated under Phase II of the SBIR program.

AF92-161 TITLE: Composite Hydraulic Components

OBJECTIVE: Reduce weight of aircraft armament subsystems by investigating hydraulic components manufactured from composite materials.

DESCRIPTION: In recent years, work has been accomplished to develop hydraulic-powered carriage and release equipment. The programs have led to the development and use of 8000 pounds per square inch (psi) hydraulic components in bomb rack and missile launcher systems. This concept has many benefits and looks promising for future carriage and release hardware. However, as with all aircraft subsystems, weight is critical. Weight reduction must be explored as the hydraulics are further developed. The goal of this task is to investigate the use of composite materials for manufacturing hydraulic components, such as valves and accumulators. The components must be capable of 8000 psi hydraulic operation, compatible with standard aircraft hydraulic fluid, and designed to withstand proof pressure testing at 16000 psi. Phase I of this SBIR task is to identify components and select composite materials to satisfy the pressure and operational requirements. Conceptual designs of the selected components will be the end items in this task. Phase II of this SBIR task is expected to demonstrate the feasibility of the Phase I designs. The conceptual designs should be detailed, fabricated, and laboratory tested during Phase II. Production of components for system application is envisioned for Phase III.

AF92-162 TITLE: Ultrahigh Frequency Subminiature Video Transmitter For Projectiles

OBJECTIVE: Develop an X or K band wideband FM subminiature 10 MHz analog "video" transmitter.

DESCRIPTION: The development and testing of next generation smart submunitions and precision guided projectiles demands the ability to transmit very high bandwidth "video" format data of the focal plane detector or instrumentation cameras output to a ground telemetry station for capture and subsequent analysis. Current video transmitters are too large for these applications and have been developed with discrete or hybridized Radio Frequency (RF) components. Current technology also has the characteristic of low power efficiency requiring excessive power. For video transmission at currently authorized S and C bands (2200-2400 and 4500-4600 MHz), narrow channel allocations, due to interference with adjacent allocations, preclude the use of high deviation ratios necessary to obtain desired FM signal gains needed for high resolution data acquisition throughout the projectiles trajectories. The goals of the program are to apply advanced RF Monolithic Microwave Integrated Circuit Technology to develop subminiature analog video transmitters with data subcarriers that can withstand the high G environment of rocket-delivered submunitions and cannon-launched, precision, guided weapons (2000 G side forces and 18,000 G setback force). Phase I will include analysis and design of an Ultrahigh-Frequency, monolithic, component transmitter and data link; demonstration of the performance of the critical

device components; and documentation of the effect of modulation waveform characteristics on link performance. The advantages, disadvantages and performance of the different concepts will be reported and presented along with actual bench demonstrations of 10 Megahertz video signal input (aliased and unaliased). The Phase I will culminate with the recommendation of a candidate approach to be pursued in Phase II. Phase II of the project is expected to develop a data link system with at least 4 breadboards and 10 brassboards for component testing at actual environments, link testing over typical ranges, and flight demonstrations in simulated precision guided munitions. Phase III of the project is expected to produce a prototype, ultrahigh-frequency, data-link system with modular components that can be produced to meet the stringent packaging and environmental requirements for development and testing of production submunitions and cannon-launched projectiles.

AF92-163 TITLE: Laser Radar Scene Projector

OBJECTIVE: Design and develop a Laser Radar scene projector.

DESCRIPTION: The design, development, and testing of Laser Radar (LADAR) seekers requires a Laser Radar projector. LADAR seekers are currently undergoing various phases of development and will require laboratory and field testing and evaluation. A LADAR scene projector is a key component in providing the Air Force with the ability to evaluate seeker performance in laboratory tests and hardware-in-the-loop (HIL) simulations. An HIL simulation consists of a test unit mounted on a flight motion simulator with a LADAR scene simulator providing high fidelity target scene. The LADAR scene simulator consists of a scene generation system and a LADAR projector. The LADAR projector converts the output of the scene generator into a radiometrically correct (true to life) representation of the scene. Under this SBIR the contractor will design, develop and build a high fidelity LADAR projector. The projector must preserve all the phenomenology present in a LADAR scene. Two types of LADAR scenes are possible. In the unresolved target scene, the target is smaller than the LADAR beam. In the resolved target scene the beam is smaller than the target. Essentially, a LADAR image is a high resolution angular position (azimuth & elevation) array of range, doppler or amplitude returns. Since LADAR uses a coherent source of illumination, the seeker may use direct energy or heterodyne detection techniques. The reflection of coherent light from a surface incorporates an intensity distribution, frequency modulation due to target motion and local vibrations, target surface coherence length effects (speckle), and lint (specular reflection). The scenes must be generated at least as fast as the seeker frame rate can be synchronized to the seeker. Phase I includes a determination of system technical specifications from the projector performance requirements. The technical specifications will be used to formulate candidate designs. The designs will be evaluated to determine optimum performance considering cost, performance, reliability and maintainability. Phase II consists of the fabrication and demonstration of system component technologies, followed by the integration, installation and validation of a fully operating projector.

AF92-164 TITLE: Knowledge Automatic Target Recognition Discrimination (KATRED)

OBJECTIVE: Apply knowledge based and neural network techniques to the five automatic target recognition discrimination levels.

DESCRIPTION: Numerous applications of image processing (IP), knowledge based procedures (KBP), and neural networks (NN) have been used to solve the automatic target recognition (ATR) problem without success. This SBIR is to investigate the complexities of applying KBP and NN to five levels of ATR discrimination. Discrimination levels are defined as the location in the decision hierarchy for detection, classification, recognition, identification and characterization with detection being the least complex. Detection is defined as the discrimination level at which targets are distinguished from nontargets. Classification is defined as the level at which a target class is declared, e.g. aircraft or vehicle. Recognition is defined as the level at which target subclasses are declared, e.g. fighter, bomber, truck or tank. Identification is the level at which the target type is declared, e.g., F-16 or M1). Characterization is the level at which the detailed physical characteristics of the targets are determined, e.g. F-16C with missiles or M1A1. Phase I will apply KBP and NN techniques to classical image processing and develop paradigms and algorithms for each discrimination level or images in the visible range. Knowledge specifications and decision procedures will be determined for each level. The targets of interest in Phase I are buildings, vehicles, and people. The resolution requirements for R and LADAR images should be expressed in terms of pixels on target, pixel area, and grey scale. Phase I will construct the discrimination methodology for Phase II. Phase II will extend the effort to developing hardware and software by investigating the

effectiveness of paradigms and algorithms with near IR, medium wavelength (MWL), and long wavelength (LWL) infrared images, and millimeter wavelength images. Data fusion should be addressed separately. Images with multiple targets will be used. Targets of interest in Phase II are extended to aircraft, aircraft shelters, command and control facilities, armored vehicles, and soldiers. Ada language will be used for both phases. Government image data will not be available.

AF92-165 TITLE: Optimization of 1,3,3-Trinitroazetidine (TNAZ) Synthesis

OBJECTIVE: Optimize the production process for synthesis of TNAZ.

DESCRIPTION: TNAZ is a high density, high energy, low melting, less sensitive explosive of great promise for use in the formulation of high energy composites for Air Force warheads. The present production process for TNAZ requires five separate synthetic steps. First epichlorohydrin and t-butylamine are combined to produce the intermediary alkyl-azetidinol. The azetidinol then is combined with methanesulfonyl chloride to yield the corresponding mesylate. The mesylate group is then displaced by sodium nitrate producing the mononitro salt in the third step and further nitrated to the dinitrosalt in the fourth step. In the fifth step a final nitramine is added using nitric acid. Overall yield of the process varies from 10 to 25 percent. Improvements in yields, optimization and control of reaction conditions, reduction of waste production and substitution of costly reagents are essential to develop a commercially feasible synthesis process. The Phase I effort should examine and define suitable alternatives to the present reaction pathways to increase yields especially the troublesome second step formation of the mesylate. Laboratory scale (1 to 10 pound batch sizes) work would identify optimum reaction conditions, stoichiometry, reagents, solvents, and provide plans for waste elimination or recycling. In addition, techniques and instrumentation will be developed to enable accurate monitoring and control of all reaction processes. The goal of the effort is to achieve an overall yield of at least 60 percent, while reducing waste by-products by half. The follow-on Phase II effort should include conducting and demonstrating engineering scale-up and production of 100 pounds of TNAZ utilizing the optimized process as identified in Phase I. Special emphasis should be placed on insuring all aspects of safety to assure thermal hazards are minimized. All processes and reaction conditions should be optimized in the scale-up process.

AF92-166 TITLE: Laser Diode Initiation of Primary Explosives

OBJECTIVE: Develop a low cost laser initiation system for use with "out-of-line" explosive trains.

DESCRIPTION: Significant development work is underway to develop laser initiation systems for various types of explosives and propellants. This work, however, is concentrating on systems employing insensitive ignition mixes within the limitations of current laser diode technology. This has resulted in the use of relatively high-power expensive devices. In the majority of AF fuzing systems, an explosive train interrupter is used which employs very low energy hot wire initiation. In these systems, the sensitivity of the ignition mix (lead azide, etc.) is not an overriding issue because detonation before arming is nonhazardous from a system standpoint. There may be significant advantages to be obtained by laser initiation of out-of-line explosive trains. Not the least of these include elimination of mechanical switches to electrically protect the detonator. To be of use in these types of systems, the diodes must be low cost as typified by laser diodes used in commercial compact disk (CD) applications. The primary goal of this task is to develop a low-cost laser initiation system compatible with out-of-line explosive trains. The primary technical challenge is to develop an ignition mix capable of detonating when exposed to low-level (as typified by a CD diode) laser pulse. Phase I of this SBIR will involve demonstrating the capability to ignite an ignition mix with the energy from a low-cost diode. Phase II of this SBIR will involve fabrication and laboratory demonstration of a laser initiated out-of-line explosive train and quantifying its potential performance parameters.

AF92-167 TITLE: Algorithm Development For Hard Target Encounter

OBJECTIVE: Develop a concept for a generic algorithm to perform fuze-function decision making for smart-fuzed hardened-target munitions.

DESCRIPTION: Hard-target fuze algorithms in the past have been developed with the assumption that acceleration level discrimination and integration over time are the only meaningful inputs available for fuze decision logic to determine target layer impact and distance traveled. Recent recorded accelerometer data suggest other useful information may be

extracted from the accelerometer output signal. For example, additional information might be present in the form of frequency shifts at target material interfaces (i.e., concrete to soil). Another possibility relates to momentary signals/events, such as impacting a steel section while experiencing high-level deceleration in concrete. The primary goal of this program is to develop an algorithm of discriminating, widely-varying, target types (POL, hangarages, bunkers, runways, etc.) capable of determining position within the target for burst point control. The primary technical challenge is to determine what information can reasonably be expected from accelerometer data and how that information can be reduced for use in a fuze algorithm. Phase I of this SBIR task will determine techniques for handling the accelerometer signal to extract all the useful information (frequency shifts, small amplitude shifts, travel distance, etc.). At present, only large amplitude shifts have been shown to serve as useful inputs to the fuze algorithm. The Phase I effort will conclude with an approach for utilizing accelerometer data to the fullest possible extent. Phase II of the SBIR task will be a laboratory demonstration of the techniques proposed in Phase I and will include a study of target encounter information expected from the accelerometer output signal. Phase II will conclude with an acceleration signal-processing algorithm to discriminate target types and determine position versus time in a known target.

AF92-168 TITLE: Explosive Initiator Modification and Modeling

OBJECTIVE: Investigate the use of dopants or other species implanted into initiator explosive/bridge materials to enhance output.

DESCRIPTION: Initiator explosive and bridge materials have undergone considerable development in an overall attempt to optimize slapper detonator performance and safety. However, the shock initiation mechanisms remain unclear from a kinetic viewpoint because the pressure-induced reaction itself is poorly understood. Furthermore, the energy-conversion efficiency for an exploding foil bridge is strongly dependent upon resulting flyer velocity, the measurement of which involves a rather complex procedure. If reactive species could be implanted into energetic materials in an orderly manner, subsequent measurements of explosive output might give new insight into the initiation mechanisms. On the other hand, modification of the exploding foil itself in an attempt to increase the electrical-to-mechanical energy conversion efficiency may prove to be even more fruitful. Phase I of this program would include an evaluation of methods for accomplishing explosive initiator optimization validated by several preliminary tests. Phase II would explore a conceptual model in detail, focusing on the most promising dopants/species with the highest potential for enhanced performance.

AF92-169 TITLE: Inflatable Aero-Surface Technology

OBJECTIVE: Develop new techniques in inflatable aero surfaces for weapon fins and wings.

DESCRIPTION: A continuing problem in carrying weapons in conformal or internal carriage aircraft is the interference of fixed wings and/or fins with aircraft structure. Many complex, mechanical, fin-and-wing, folding techniques have been tried to efficiently carry missiles on aircraft pylons and in bays. A new technique to solve this problem is to inflate missile wings after launch. The basic goal of the program is to identify techniques and materials suitable to allow aero surfaces to be conformally packaged along a missile's skin and then inflated by gas generators to perform normal lifting and/or controlling functions. The technical challenge is to find suitable metal or composite materials which can be inflated to form aerodynamic airfoil shapes and which can withstand the dynamic environment inherent in an aircraft-launched missile or dispenser vehicle. Phase I of this SBIR effort should concentrate on analyzing and defining inflatable wing/fin concepts, surveying potential materials, and generating preliminary designs of preferred concepts. Phase II would include final design of selected fin and wing concepts, conducting static deployment tests, wind tunnel tests, structural/vibration tests, and performance of production cost estimates.

AF92-170 TITLE: Laser Doppler Velocimeter (LDV)

OBJECTIVE: Develop a self-contained optical sensor for measuring the wind velocity vector gradient over a 2.5 kilometer range.

DESCRIPTION: Current aircraft platform fire-control systems (such as helicopter gunships) use the wind velocity vector

at the firing platform to predict wind effects on projectile trajectory. This approach assumes homogeneous wind between the platform and the target. Wind, however, is rarely homogeneous due to nonuniform topography prediction could be significantly improved if wind velocity vectors could be determined at fixed intervals (i.e. range gating) along the flight path of a projectile. The technical challenge is to develop a small device to determine wind velocity vectors over 2.5 kilometers in real time. LDV technology may also provide an innovative technique for measuring relative velocities between the platform and target for fire control and air-to-air fuzing. The Phase I approach will develop a laser doppler velocimeter design with supporting analysis showing feasibility and expected performance using available technology. Phase II will include fabrication and testing of the Phase I design to demonstrate proof-of-concept. Phase III will integrate the Phase II LDV system with a fire-control system.

AF92-171 TITLE: Advanced Missile Safe and Arm (S&A) Concepts

OBJECTIVE: Develop concepts for optimizing the performance, cost, safety and reliability of air-launched missile safe and arm mechanisms.

DESCRIPTION: Current air-launched missile S&A mechanisms employ electro-mechanical devices to accomplish the completion of the explosive train. Current widespread developments are underway to eliminate all moving parts by using programmable electronics and "slapper" or exploding foil initiators (EFI), which do not require explosive train interruption. The complications (i.e., environmental sensors and high voltage) necessitated by these new developments dictate that we reevaluate the "in-line" versus "out-of-line" trade-offs for inertially armed devices. The new "in-line" technology is currently being evaluated against existing "out-of-line" devices employing technology which is at least 40 years old. To assure that the ordnance community is not on the wrong development track, we must evolve new "out-of-line" concepts that are not constrained by the older technology. Many advances in small electrical prime movers (motors, etc.) have recently occurred to keep pace with the demand necessitated by robotics, optics and consumer electronics. In addition, sensitive initiator advances including the SCB (Semiconductor Bridge) and laser detonators may offer potential for improving the electrical-sensitivity/explosive-sensitivity trade-off. The primary goal of this program is to evolve concepts that would increase the performance and reliability of air-launched missile S&A devices while reducing cost, weight and volume. The primary technical challenge is determining what combination of technologies (i.e., safing and arming, initiation, electrical prime movers, electronics) can optimize the conflicting requirements of missile S&As. Phase I of this SBIR will include analytical designs with a combination of technologies that appear most promising to achieve the overall goal. Phase II of this SBIR would provide laboratory demonstrations of one or more of the selected designs. As a result of this Phase II, S&A alternatives will be available for missile systems applications.

AF92-172 TITLE: High Current OHMIC Contracts for Gallium Arsenide

OBJECTIVE: Explore new types of low resistance ohmic contracts applicable to gallium arsenide (GaAs).

DESCRIPTION: There is presently no reusable, testable, solid-state, high-voltage switch suitable for military fuzing applications. GaAs can provide the switching speed, reliability, and breakdown voltage essential for high-performance detonation of exploding foil initiators that will be used in advanced fuzes. However, high current ohmic contracts for adequate electrical connection to the GaAs remains a problem. Scale-up of either high-resistance ohmic or Schottky contacts does not appear feasible; development of more uniform, low-resistance ohmic contacts is more likely to be a solution to the problem of carrying ten-kiloampere current pulses repeatably within a compact, low-inductance configuration. The Phase I effort should be a study of all applicable types of ohmic contacts and deposition techniques appropriate for GaAs. This should include a determination of the relative potential for scaling them up to handle many kiloamperes of current. Phase II should be a demonstration of the optimal types of ohmic contacts using laser-activated, semiconductor-quality, GaAs wafer sections. A controlled test method must be established for determining the level of current density which can be routinely handled in a pulsed (submicrosecond) mode using individual contact areas of up to 5 square millimeters.

AF92-173 TITLE: Semiconductor Bridge (SCB) Detonator

OBJECTIVE: Develop SCB detonator concepts applicable to non-nuclear fuzing and safe and arm systems.

DESCRIPTION: The SCB Detonator, developed by Sandia National Laboratories has shown significant improvements in narrowing the "all-fire/no fire" band and in decreasing function action time. However, the device has not found its way into conventional weapons because of (1) the difficulty of attaching the semiconductor chip to a conventional header and (2) system development vs reluctance to employ new component technology. One approach to eliminating (1) above may evolve from Tape Automated Bonding (TAB) the SCB die to a stripline and assembling the device to an explosively loaded cup of DXW-1 [Mercury (II) Bi5 - (5 Nitrotetrazole)] in the current manner of exploding Foil Initiator (EFI) assembly. This may be possible because DXW-1, unlike Lead Azide, is compatible with copper, and it is non-hydroscopic, therefore, not requiring hermetic sealing. (2) above can only be eliminated by demonstration of the distinct advantages of the SCB for typical, conventional, weapon-systems application. These demonstrations may include fabrication and testing of configurations (to include DXW-1) for igniting class 1.6 explosive directly with a minimum head height initiator; minimizing firing energy for a 1 AMP, 1-watt no-fire detonator; piezo-electric and inductive generator firing of the SCB; minimizing the explosive output necessary for igniting MIL-STD-1316 approved explosives; and quantifying shock survivability. The primary goal of this program is to develop and demonstrate a new class of initiators which will increase the electrical safety, response time and simplicity of "out-of-line" initiator systems for conventional armaments. Phase I of this SBIR will demonstrate a simple header configuration compatible with DXW-1 ignition and evolve concepts for weapon system applications. Phase II of this SBIR will demonstrate selected concepts by development, fabrication and function testing of completed detonators. The result of this Phase II will be a family of economical detonators which could be qualified to offer significant performance advantage over existing systems.

AF92-174 TITLE: Aliphatic Polymer Fiber Optic Pressure Sensor

OBJECTIVE: Develop an ultra-rugged aliphatic polymer pressure sensor based upon the principle of refractive index pressure sensitivity.

DESCRIPTION: Military structures that incorporate thick layers of reinforced concrete cannot be destroyed simply by general purpose bombardment with weapons that explode upon impact. These hardened targets are designed and built to withstand prolonged impact bombing; therefore, penetration munitions with special fuzing for warhead burst point control are required to defeat such targets. Advanced fuzing will take advantage of weapon deceleration and internal pressure as inputs, contingent upon the development of very rugged sensors that can be interfaced with a fuze microprocessor. The sensor must exhibit no resonant frequency limitation that would impair its function below 10 kG acceleration. Pressure sensors have traditionally been diaphragmatic or unidirectional in nature, not designed to measure hydrostatic pressure distinct from acceleration in a rigorous, high-G environment. It would be a significant achievement to make use of an isotropic method of pressure sensing which is more compatible with the penetrator weapon environment. Phase I of this SBIR task will involve an evaluation of the optical transmission of silicone rubber, polyethylene, or other aliphatic polymer fibers with a high degree of axial straight-chain orientation. Transmission measurements should be performed both at standard atmospheric pressure and under either high-static pressure or high-pressure shock. If conceptually feasible, Phase II would involve adaptation of the sensing technique to measurement of high pressure shock profiles such as those experienced by a penetrator weapon during hard target encounter.

AF92-175 TITLE: Store Trajectory Analysis Technology

OBJECTIVE: Take advantage of new developments in telemetry hardware for bomb flight dynamics characterization.

DESCRIPTION: In the past there has been much effort devoted to characterizing weapon separation from aircraft. The requirement for an accurate trajectory measurement (six-degree-of-freedom model) has its foundation in two areas: establishing safety of separation and refinement of aeroballistic models to provide more accurate weapon delivery. Recent developments in small, low-cost, telemetry/RF devices has opened the door for much lower cost weapon evaluation instrumentation. It is envisioned that both aircraft and captive weapons could be instrumented with multiple antennas and subminiature transmit-and-receive modules. Multilateration and regression techniques could then be used to process a chirped CW, or other wave-form to obtain a six-degree-of-freedom trajectory for the weapon. The processing will effectively determine the distance from each antenna on the aircraft to each antenna on the weapon. The goal of this effort is to determine hardware, software, and test environment requirements for realizing one inch and one degree resolutions on weapon position in space. The technical challenges are to develop requirements for the transmit,

receive, and antenna components, to develop processing algorithms that make optimal use of multiple CW signals, and to keep the instrumentation low-cost. Phase I of this SBIR task is to conduct a study of system architecture to meet the resolution requirements and accomplish a preliminary design of both hardware and software. The design will exploit the advances in subminiature telemetry devices and surface mount technologies. Phase II of this SBIR task will fabricate breadboards to determine in the laboratory if the accuracy requirements can be reached. In addition, production cost estimates will be evaluated. Phase III is expected to yield the production design. Multiple systems will then be built and implemented for several weapon evaluation programs.

AF92-176 TITLE: Innovative Dual Mode (IR/RF) Sensor

OBJECTIVE: Develop low-weight, volume, and drag approaches for IR/RF sensor for medium range air-to-air missiles.

DESCRIPTION: Current approaches for configuring dual mode sensors in the Infrared (IR) and Radio Frequency (RF) bands have several system performance problems. Tip-mounted IR sensors in front of an RF Antenna result in undesirable impacts to antenna patterns and very high drag penalties for the overall missile. Side mounted or pop-up IR sensors minimize impact to the RF sensor performance, but still add considerable drag and also place other restrictions on the missile control system. The technical challenge for this effort is the development of innovative approaches for implementing a dual mode IR/RF sensor with application to seven-inch diameter class medium-range air-to-air missiles. Successful approaches would maintain missile radar and kinematic performance while not imposing significant constraints on endgame trajectories. Approaches should be affordable and ready for transition to a system application in the 1995 timeframe. Phase I of this SBIR task is to develop concepts for implementing the IR/RF sensor which are compatible with medium range air-to-air missiles in terms of realistic physical and performance requirements. Identify key technical issues for each concept. Perform requirements analysis. Phase II will be implementation in breadboard form of the critical technologies associated with the selected concept. Key performance factors will be demonstrated. Phase III applies results of previous phases to develop a detailed design and brassboard system. Sensor performance verified through captive flight testing.

AF92-177 TITLE: Thermal Imaging System

OBJECTIVE: Develop a reliable method of measuring temperature distributions on hypersonic structural components to 2000°C.

DESCRIPTION: Future, high-performance, aerospace vehicles will operate in high-temperature environments. In order to ensure the structural integrity of these vehicles, various subassemblies are tested in high-temperature facilities. To assure that these components are tested to the specified environmental conditions, a reliable and accurate method of measuring the temperature distributions on the component needs to be developed. The heat source for these test components is typically the Vortek II focused light source. The Phase I effort should develop and demonstrate a concept for a thermal imaging system. In Phase II, the system will be refined, demonstrated, and calibrated in a high-temperature facility.

AF92-178 TITLE: Methods for Reducing Plasma Effects on the NASP

OBJECTIVE: Reduced plasma effects on the NASP communications system.

DESCRIPTION: Due to both thermal and impact ionization, a plasma of significant electron density is generated in hypersonic flight. The high density of electrons interferes with, or even blocks, electronic communications. Part of the plasma comes from ionization of the ambient air, and part comes from erosion and ablation of the vehicle surface. For example, sodium silicate is commonly used to protect carbon-carbon composites from oxidation. Because sodium has a very low ionization potential, it contributes heavily to the plasma density. Alternate coating materials, perhaps one which would deliver a highly electronegative molecule, are a possible means of electron suppression. In Phase I, the contractor will evaluate methods for plasma reduction and select one for demonstration in Phase II. Methods may involve alternate materials or may be independent of material properties. The contractor must be familiar with methods of hypersonic vehicle construction and have a clear understanding of the effects of plasma on electronic communications.

AF92-179 TITLE: High Temperature Strain Sensors for NASP Material Tests

OBJECTIVE: Develop strain sensor technology for use at temperatures in the 3000°F range.

DESCRIPTION: Testing and data generation programs for metals and non-metals designated for use on NASP will be conducted at temperatures up to and above 3000°F in air. Accurate strain measurements will be required to calculate materials properties as well as to design efficient hot structures. Phase I work will demonstrate either or both of contact and non-contact strain sensors in both static and dynamic testing from room temperature to at least 3000°F. Phase II work will optimize and extend the Phase I technology.

AF92-180 TITLE: Materials for High-Temperature Antenna Applications

OBJECTIVE: Antenna materials for use at temperatures up to 2500° F.

DESCRIPTION: Antennas for hypersonic vehicles such as the NASP are exposed to severe environmental conditions for extended periods of time and must provide high structural and electrical performance at high temperatures. For example, an electronically steered antenna may be composed of an array of open-ended waveguides. If the antenna must also be thermally insulating, the dielectric constant of the material may fall below the value necessary to provide the cutoff frequency of the waveguide. The ideal material would be porous and have a very high dielectric constant. It would also be fibrous to survive fabrication, handling, and assembly as well as its operating environment. In Phase I, the contractor will select one or more promising materials and design a test antenna. Material selection must be supported by test data covering the operating range. In Phase II, the test antenna will be built and demonstrated over a representative range of operating conditions.

AF92-181 TITLE: Ozone Enhancement

OBJECTIVE: Means to enhance atmospheric ozone levels during flight.

DESCRIPTION: The possibility exists that the X-30 may be able to reverse the damage to the atmosphere rather than cause it. Some researchers have claimed that with a hydrogen/oxygen reaction, one may be able with additives, to stimulate ozone formation rather than harm ozone as with hydrocarbon exhaust products. The objective of this SBIR will be the identification of any material (chemical, catalyst, etc....) which would encourage the formation of ozone in the Earth's atmosphere during flight tests. The initial SBIR should include a preliminary investigation of combustion on the X-30 with the aim of selecting a chemical process that would generate ozone in the anticipated X-30 flight envelope from takeoff thru orbit. The selected process will be demonstrated in the laboratory at a simulated X-30 flight condition. The second phase of the SBIR should include a laboratory demonstration of the process under the atmospheric conditions that will be encountered by the X-30 in its entire flight envelope. The demonstration shall quantify the increase in ozone generated by the combustion process using the chemical process or catalyst and compare it to the baseline, unmodified combustion process. The demonstration can be conducted in conjunction with X-30 engine testing.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Office of Administration and Small Business. 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/OASB/SBIR
Attention: Dr. Bud Durand
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448**

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 129 technical topics, numbered DARPA 92-001 through DARPA 92-129, to which small businesses may respond in the first fiscal year (FY) 1992 solicitation (92.1). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 160 technical topics which were numbered DARPA 91-084 through DARPA 91-243. A list of the topics currently eligible for proposal submission 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 and highly relevant to the DARPA mission. 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, or it may fund no proposals in a topic area. 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 1992 Phase I SBIR

Check List

1) Proposal Format

- a. Cover Sheet - Appendix 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 RED 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. _____

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DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

FY 1992 Small Business Innovation Research Topics

DARPA 92-001	Computational "Wind Tunnel" for Close-In Combat Vehicle Dynamics
DARPA 92-002	Control Methodologies for Tailless Atmospheric Flight Vehicles
DARPA 92-003	Spacecraft Development Process Improvement
DARPA 92-004	Remote Sensing for Climate Research and Tactical Surveillance
DARPA 92-005	MILSATCOM Network Simulation
DARPA 92-006	Spacecraft Reliability Study
DARPA 92-007	Small Satellite Cost Estimating
DARPA 92-008	Fiber Optic Gyroscope (FOG) Manufacturability
DARPA 92-009	Advanced Displays for Post Stall (PST) Maneuvering Fighters
DARPA 92-010	High Repetition, High Power "Blue" Optical Sources
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DARPA 92-013	On-Board Spacecraft Data Architecture
DARPA 92-014	Advanced MILSATCOM Terminal Concepts
DARPA 92-015	Lightweight, High Resolution Stereographic Head-worn Display System for Computer Generated Imagery
DARPA 92-016	Low Cost Multi-spectral Signal Processing to Simultaneously Process Spatially and Temporaneously Disjoint Wideband Signals
DARPA 92-017	Low Cost, Self-Contained, 6 Degree of Freedom Orthometric Localization Orientation System (OLOS)
DARPA 92-018	Miniature Integrated Optical Circuit Technology Enhancement
DARPA 92-019	Modulation and Coding Design to Provide Two Orders of Magnitude Improvement in Meteor Burst Communication Throughput, Wait Time, and Low Probability of Intercept (LPI)
DARPA 92-020	Low Cost, Self-Contained GPS-Based Aircraft Location Transponder
DARPA 92-021	Low Cost, Self-contained Ground-Impact Trajectory Detection System
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DARPA 92-024	Unsteady Aerodynamic Measurement Techniques for Dynamic, Post Stall (PST) Maneuvering Flight Applications

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DARPA 92-027	Ceramic Shields for Satellite Protection Against Hypervelocity Impact
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DARPA 92-032	Electron Beam Processing
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DARPA 92-045	Smart Materials and Structures
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DARPA 92-048	Compact High Power Ultra-Wide-Band (UWB) Radio Frequency (RF) Sources
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DARPA 92-053	High Efficiency Polarizers

DARPA 92-054	Indium Phosphide (InP) Material Growth
DARPA 92-055	Indium Phosphide (InP) Microwave & Millimeter Wave (MMW) Devices and Circuits
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DARPA 92-067	Sensors or Methods for Airborne Detection and Discrimination of Buried Land Mines
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DARPA 92-069	Circuit Architectures that Employ Real Time, Reconfigurable Interconnections
DARPA 92-070	Circuits that Employ Resonant Tunnel Diodes/Transistors
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DARPA 92-074	Neural Network Signal Processing Techniques for Communication Links
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DARPA 92-078	Dictation System for Tactical Environments
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DARPA 92-080	Military Applications of Speech Recognition
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DARPA 92-082	Robust Speech Parameterization for Channel Independence and Noise/Interference

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DARPA 92-094	Development of a Compact, Minimum Noise, Auxiliary Power Unit (APU) for Lightweight Vehicles
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DARPA 92-096	Feature-Based Design Methods for Predictive Design Paradigms
DARPA 92-097	High Power Laser Pumping of Solid State Lasers
DARPA 92-098	High Speed Electrodes for High Density Optical Guided Wave Devices
DARPA 92-099	High Speed Image Capture for Fiber Optics Payout Applications
DARPA 92-100	Identification Friend or Foe (IFF) System for Ground Vehicles
DARPA 92-101	Infrared Signal Combining Techniques for Multi-Color Projector Applications
DARPA 92-102	Innovative Detection and Tracking Techniques for Missile Seekers Engaging Low Flying and Hovering Aircraft in Clutter
DARPA 92-103	Innovative Utilization of Interferometric Technology to Demonstrate Precision Transfer Alignment
DARPA 92-104	Integration of Expert System for Process Planning and Feature-Based Designs
DARPA 92-105	Millimeter Wave (MMW) Combat Identification Devices
DARPA 92-106	Millimeter Wave (MMW) Device Models and Computer-Aided Design Techniques for Smart Weapons
DARPA 92-107	Millimeter Wave (MMW) Sensor Design for Hypersonic Missile Applications
DARPA 92-108	Millimeter Wave (MMW) Infrared (IR) Synthetic Scene Generation Using Fractals
DARPA 92-109	Multiple Beamwidth Millimeter Wave (MMW) Antenna for Direct Fire Missile Guidance

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DARPA 92-110	Optical Fiber Development for Military Applications
DARPA 92-111	Optimal Decision Fusion in Passive Multisensor Target Acquisition
DARPA 92-112	Parallel Infrared (IR) Magneto Optical Mapper for Semiconductor Material
DARPA 92-113	Perspective Scene Generator/Simulator for Advanced Correlator Analysis
DARPA 92-114	Polarization Sensitive Infrared (IR) Detectors for Target Discrimination
DARPA 92-115	Real-Time Printing of Fine Line Patterns on Printed Wiring Boards
DARPA 92-116	Tank-Mounted Millimeter Phased Array Radar for Self-Defense
DARPA 92-117	Wavelet-Transform Representation of High-Range Resolution Radar (HRR) Signatures
DARPA 92-118	Advanced Timing Concepts for Satellite Networks
DARPA 92-119	Positive Combat Identification
DARPA 92-120	Seismic Waveform Representation
DARPA 92-121	Genetic Algorithm (GA) Machine Learning of Seismic Waveform Characteristics
DARPA 92-122	Rules from Neural-Nets for Seismic Source-Region Specific Knowledge
DARPA 92-123	Automatic Contrail Detection & Avoidance/Elimination
DARPA 92-124	Electric Propulsion System
DARPA 92-125	Optical Interconnect Technology
DARPA 92-126	Full-Scale Submarine Control Surface Lift, Drag, and Torque Measuring Devices
DARPA 92-127	Low Lift, Low Drag, Very Low Aspect Ratio (Order 1) Control Appendages
DARPA 92-128	Blunt Body Separation Control and Vorticity Management and Concept Development
DARPA 92-129	Simultaneous, Multi-point, Off-body Flow Measurement Techniques for Unsteady, Very High Reynolds Number Flows

DARPA 92-001 TITLE: Computational "Wind Tunnel" for Close-In-Combat Vehicle Dynamics

CATEGORY: Exploratory Development

OBJECTIVE: Develop design for, and establish feasibility of, a high speed computational methodology to investigate the aerodynamic environment of a flight vehicle undergoing rapid close-in combat maneuvering.

DESCRIPTION: Computational simulations of aerodynamic flow characteristics associated with three-dimensional air vehicle shapes undergoing rapid, multi-axis maneuvering motions including post stall flight would be an invaluable design aid for future high performance flight vehicles - including manned and unmanned aircraft and missiles. Aircraft such as the X-31 are expected to pioneer dynamic maneuvering in the post stall regime. Future vehicles, including sophisticated tailless configurations employing enhanced thrust vectoring for control, may possess even greater maneuverability. Advanced computational methods could well surpass physical testing techniques due to the inherent difficulties in generating multiple degree-of-freedom motions in a flow facility and extracting useful aerodynamic data. A computational capability which integrates flow environment, vehicle structural behavior and propulsion effects would provide a new level of design insight and enhance optimization.

Phase I: Develop and study computational approaches which address complex vehicles undergoing multiple degree-of-freedom dynamic motions (time-dependent boundary conditions) replicating advanced air combat maneuvers. These methods should examine external aerodynamic effects alone and in combination with structural behavioral and/or propulsion effects. Methods which couple vehicle flight mechanics with nonlinear unsteady aerodynamic behavior are also desired.

Phase II: Based on a promising concept, develop and implement a software design for investigating these flows. Demonstrate feasibility employing one or more relatively simple but illustrative test cases.

DARPA 92-002 TITLE: Control Methodologies For Tailless Atmospheric Flight Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: Develop flight control techniques which minimize the requirement for traditional aerodynamic surfaces on highly maneuverable atmospheric flight vehicles.

DESCRIPTION: Aircraft such as the X-31 Enhanced Fighter Maneuverability (EFM) demonstrator are expected to pioneer dynamic maneuvering in the post stall regime. These vehicles are equipped with enhanced thrust vectoring capability to provide necessary control authority at high angles-of-attack. Future atmospheric flight vehicles can be expected to exploit more fully these unique control capabilities eliminating the need for more traditional aerodynamic surfaces. Effective flight control algorithms and implementation schemes are needed to provide a basis for future designs and their evolution. These schemes should consider such factors as statistically unstable configurations and unsteady aerodynamic effects including rate-dependent hysteresis of the aerodynamic coefficient curves.

Phase I: Investigate candidate flight control methodologies. Develop promising algorithms including top level designs.

Phase II: Develop the most promising candidate design, including detailed design and software implementation. Test the design using computational simulation on a hypothetical flight vehicle and assess its performance and potential.

DARPA 92-003 TITLE: Spacecraft Development Process Improvement

CATEGORY: Advanced Development

OBJECTIVE: Develop new techniques and approaches to streamline spacecraft design, manufacture, integration, and test.

DESCRIPTION: The spacecraft development process can be characterized as complex and extremely man-intensive. Often times, the process is different from program to program, but not as a result of conscious attempts at improvement. Consequently, an overall review of current spacecraft design, manufacture, integration, and test is required to identify areas of improvement and inspire new concurrent engineering techniques and standardize approaches to streamline the development process. With the proliferation of computer-aided design, engineering, and manufacturing techniques, an improved, flexible approach to spacecraft development can be created. This project will review existing spacecraft development methods, propose improvements, and create a comprehensive development plan, including the incorporation of computer-aided

engineering tools.

Phase I: Review current spacecraft development processes to identify areas of improvement. Propose a baseline development concept that streamlines all aspects of spacecraft design, manufacture, integration, and test. Quantify time and cost savings. Identify existing and new concurrent engineering and system engineering tools needed to improve efficiency.

Phase II: Create a process handbook for spacecraft design, manufacture, integration, and test. Develop a comprehensive plan for building, integrating and demonstrating the computer-aided engineering tools.

DARPA 92-004 TITLE: Remote Sensing for Climate Research and Tactical Surveillance

CATEGORY: Advanced Development

OBJECTIVE: Develop the requirements and payload concept for a small satellite optimized both to collect climatic and tactical surveillance information.

DESCRIPTION: Sensing climatic change from satellites has much in common with the increasing need for wide area, tactical surveillance. Currently, the designs of these systems diverge when the sensor is optimized to one or the other task. The goal of this project is to develop a payload sensor suite for small satellites that can identify climatic information and simultaneously perform tactical surveillance. The utility of climatic and tactical information that would be collected needs to be formulated as well as the on-board processing and data compression algorithms and hardware required. Economic benefits of a combined sensor should be assessed.

Phase I: Define climatic data to be collected and explain its importance. Define the surveillance data to be collected and requirements that will satisfy both mission applications. Design the payload sensor at the functional level. Consider the technologies and approaches for on-board data processing and compression. Generate cost and schedule to build a demonstration payload. Identify as potential problems, special constraints the sensor imposes on the rest of the system (payload, launch or ground station). Suggest approaches resolving each problem. Assess economic benefits of the sensor as compared with separate sensors.

Phase II: Develop an end-to-end simulation to demonstrate the sensor capability according to the design, cost and schedule of Phase I. The simulation will validate the sensor requirements and the design approach.

DARPA 92-005 TITLE: MILSATCOM Network Simulation

CATEGORY: Advanced Development

OBJECTIVE: Develop an acquisition simulation tool for integrated Military Satellite Communication (MILSATCOM) development to enable trade-offs based on satellite performance, cost, and O&M issues examining operational implications in a "combined architecture."

DESCRIPTION: Currently, there is no way to easily quantify the cost effectiveness and utility of improvements made to the MILSATCOM architecture by adding a new satellite or modifying existing satellites. There is also no method for performing trade studies to identify optimum satellite performance requirements versus overall architecture performance. The goal of this project is to develop a MILSATCOM simulator (menu driven) which allows the user to easily assess the utility versus life-cycle cost of a new satellite in the architecture. The simulator, at a minimum, should take all MILSATCOM satellites, ground terminals, and satellite control segments into account.

Phase I: Identify parameters required in the simulator and prioritize parameters in order of importance. Identify existing software that can be integrated into the simulator. Develop top-level, menu-driven simulation architecture that accommodates most important parameters.

Phase II: Incorporate detailed parameters into a comprehensive MILSATCOM simulator.

DARPA 92-006 TITLE: Spacecraft Reliability Study

CATEGORY: Advanced Development

OBJECTIVE: Develop alternate methods for specifying and predicting spacecraft reliability in lieu of current Military Standards (MIL-STD).

DESCRIPTION: Spacecraft reliability specifications and predictions conforming to MIL-STD practices and procedures can be overly conservative, given the quality of current electronic piece-parts. Consequently, this potential for over-specification may result in costly design implementations and preclude the use of commercially

available piece-parts and components. MIL-STD practices also slow the insertion of new technology into spacecraft. This project will review existing MIL-STD reliability specification, prediction and part usage methods, propose improvements, and create a new spacecraft reliability prediction handbook.

Phase I: Assess current military reliability specification and analysis procedures and develop new procedures based on current manufacturing standards and best commercial practices.

Phase II: Develop a spacecraft reliability handbook with new procedures for specifying and analyzing the use of off-the-shelf components.

DARPA 92-007 TITLE: Small Satellite Cost Estimating

CATEGORY: Advanced Development

OBJECTIVE: Provide an interactive, menu-driven computer model facilitating the integrated design and cost assessment of small satellites from system-level requirements.

DESCRIPTION: Current satellite and launch vehicle cost models are oriented to the full size satellites and their corresponding launch vehicles and are decoupled from the design process. An integrated design and cost model for the small satellite and booster class of vehicles is needed to reflect the development considerations and technology usage that are particular to this community. Commercially available packages and languages will be used whenever possible. The user interface will consist of large, easy-to-read menus. Menu selections will allow for user customization of satellites and launch vehicles down to the component level. Users will be able to specify items such as weight range, altitude and plane of orbit, type and complexity of mission, type of power subsystem, commercial availability of piece parts, launch time of year, etc.

Phase I: Identify the parameters necessary for technical design and top-level costing of small satellites and the prioritizing of those parameters into the appropriate order of importance. Develop a top-level integrated design and cost estimating model. Identify and acquire relevant historical data and compile this data into a formal structured database. Also include a simple, but functional menu-driven user interface with submenu branching, to one additional level.

Phase II: Further refine the integrated design and cost estimating model. Incorporate a more complicated series of branching submenus. Provide default choices of systems, subsystems and components for users who wish to design a more general product, and provide the capability of specifying to the piece part level for users who wish a more customized product. Validate the model and cost estimating relationships against actual data from small satellite programs.

DARPA 92-008 TITLE: Fiber Optic Gyroscope (FOG) Manufacturability

CATEGORY: Advanced Development

OBJECTIVE: Provide exploratory development model fixtures, devices, and techniques designed to reduce the current cost estimates of fabricating interferometric fiber optic gyroscopes (IFOGs) from < \$1000 per axis to less than \$100 per axis level.

DESCRIPTION: The feasibility of producing navigation-grade (i.e., bias stability <0.01 deg/hr), all solid state IFOGs has been demonstrated in the laboratory and is rapidly moving towards the flyable brassboard stage. This technical breakthrough has been achieved by the use of miniature integrated optical circuitry, and all solid state optical sources. In order to achieve the low-cost potential of this technology by the mid 90s, it is necessary to develop robotic/quasi-robotic, high-rate-of-production machinery and methods capable of being installed and tested in a factory environment within the next 3-5 years. Example manufacturing areas requiring significant technical advancement are: 1) precision alignment of MIOC-to-polarization maintaining (PM) fiber interconnections, and PM fiber-to-fiber splices; 2) precision alignment of optical source-to-PM fiber pigtail; and, 3) automatic environmental testing of completed IFOG subassemblies.

Phase I: Select and design a robotic/quasi-robotic assembly process capable of significantly lowering the manufacturing cost of IFOGs. Justify the selection and quantify cost savings.

Phase II: Fabricate and demonstrate a laboratory version of the Phase I design.

DARPA 92-009 TITLE: Advanced Displays for Post-Stall (PST) Maneuvering Fighters

CATEGORY: Exploratory Development

OBJECTIVE: Develop cockpit aids, including advanced displays, which enhance pilot performance during

dynamic, PST maneuvering flight.

DESCRIPTION: Aircraft such as the X-31 Enhanced Fighter Maneuverability (EFM) are expected to pioneer dynamic maneuvering flight in the extremely high angle-of-attack, PST regime. This flight environment is expected to be highly disorienting to pilots and will probably induce a significant loss of visual situational awareness due to rapid, large amplitude changes in vehicle orientation. Cockpit aids, including visual displays, may well provide significant performance enhancement to pilots employing these close-in-combat tactics, as well as serve as effective training aids.

Phase I: Study alternative displays and other cockpit-mounted devices capable of enhancing pilot performance during dynamic PST maneuvers. Establish related evaluation criteria to assess performance of these devices. Systematically evaluate the concepts.

Phase II: Design, fabricate, and test a promising representative device. Demonstrate capability in a ground simulation or, if possible, a flight demonstration.

DARPA 92-010 TITLE: High Repetition, High Power "Blue" Optical Sources

CATEGORY: Advanced Development

OBJECTIVE: Provide an exploratory development model optical source designed to provide variable color, high power "Blue" light at a high repetition frequency.

DESCRIPTION: The Department of Defense (DoD) has been developing new and novel means for space-based/airborne two-way communications to a submerged submarine. Recent analyses of laser-based communications systems suggest that a frequency-agile, high power, high repetition rate optical source could be useful in achieving this goal. This source should be color-tuneable between nominally 440-480 NM at KHz rates.

Phase I: Design a high power optical source capable of being tuned between 440-480 NM at KHz rates. All solid-state devices are preferred.

Phase II: Fabricate and demonstrate a laboratory version of the Phase I design.

DARPA 92-011 TITLE: Commercial Components for Satellites

CATEGORY: Advanced Development

OBJECTIVE: Identify specific opportunities and assess feasibility of using commercial technology and components in space applications.

DESCRIPTION: Currently, spacecraft components are expensive and trailing behind the state-of-the-art of similar commercial technology. Components are custom designed so that they can tolerate the spacecraft environment. Some commercial components, however, can withstand the space environment as they are currently commercially manufactured, or could survive with small modifications in packaging or electronic parts selection. The goal of this effort is to identify specific opportunities for using commercial components in satellite applications and demonstrate their ability to perform in the space environment.

Phase I: Identify and analyze candidate commercial components based on their ability to survive and operate in the spacecraft and launch environment with minimal modification. Recommend required minimal modifications when necessary.

Phase II: Perform minimal modifications to selected commercial components as identified in Phase I, and using DoD Handbook 343 for guidance, environmentally test the selected candidate components.

DARPA 92-012 TITLE: Interactive Flight Vehicle/Ground Simulator Network for Close-in-Combat Evaluation

CATEGORY: Advanced Development

OBJECTIVE: Develop and implement methodology to link high performance airborne vehicle(s) with manned or unmanned ground-based air vehicle simulators to replicate close-in-combat conditions and evaluate tactics.

DESCRIPTION: Aircraft such as the X-31 Enhanced Fighter Maneuverability (EFM) demonstrator are designed for a high degree of agility to enhance effectiveness in close-in aerial combat. Anticipated maneuver tactics of these types of vehicles involves rapid motions and excursions to large angles of attack, as well as extremely close proximity of combatants, thus creating a potentially hazardous flight environment. The ability to electronically

link a high performance airborne vehicle with a manned or unmanned ground-based air vehicle simulator to replicate an air battle would provide an invaluable aid for pilot training, close-in combat, tactics evaluations, and cockpit display development. Combat scenarios could be created, played out and reenacted under relatively benign conditions. The development of a network and real-time methodology capable of linking single or multiple ground simulators (including domed facilities) with an inflight vehicle is desired. Implementation should consider such factors as simulated vehicle performance models and their limitations, vehicle tracking and orientation, pilot awareness - both airborne and simulator-bound, simulated weapons modeling, and availability of advanced hardware/software technologies.

Phase I: Develop and refine several network concepts and approaches to implementation.

Phase II: Develop a preliminary (top level) design for a selected concept, including an evaluation of development risk factors. Demonstration of key technology elements may be required in this phase.

DARPA 92-013 TITLE: On-Board Spacecraft Data Architecture

CATEGORY: Advanced Development

OBJECTIVE: Develop on-board spacecraft data architectures (using advanced data buses, backplanes, processors, and data storage devices) featuring simple, well-defined interfaces based on commercial and/or military standards.

DESCRIPTION: Traditional spacecraft data architectures are unique to each spacecraft. Interfaces are not standardized and data buses are seldom employed. Current architectures do not allow for rapid insertion of advanced technologies. Design, test, and integration of these architectures is lengthy and expensive. This project will result in the development of on-board spacecraft data architectures that are scaleable to small, medium, and large spacecraft. Designs should address spacecraft environmental issues (i.e., total dose, Single Event Upset [SEU]) while minimizing weight, power, and volume and improving performance where needed. Architectures should feature simple, well-defined interfaces based on commercial/military standards, as well as commercial components (buses, processors, memory, etc.) to significantly reduce overall spacecraft design, integration, and test cost, and enable rapid advanced technology insertion.

Phase I: Evaluate commercial literature to identify candidate technologies which can be incorporated into spacecraft architectures. Define candidate architectures based on spacecraft environment, power, weight, volume, cost, and performance.

Phase II: Breadboard and test the selected Phase I candidate architecture using Department of Defense (DoD)-HDBK-343 for guidance.

DARPA 92-014 TITLE: Advanced MILSATCOM Terminal Concepts

CATEGORY: Advanced Development

OBJECTIVE: Investigate innovative concepts for common, modular Military Satellite Communication (MILSATCOM) terminals emphasizing the use of commercial components.

DESCRIPTION: Current MILSATCOM terminals are expensive to manufacture, operate, and maintain. The focus of this project is to develop modular terminal subsystem building blocks that are frequency-independent and can be used in any terminal (mobile through fixed site). These modules should be designed with commercial components where feasible, to reduce terminal cost. Common interfaces within terminals, to take advantage of these modular building blocks, should also be addressed.

Phase I: Develop system-level modularity concepts for MILSATCOM terminals and characterize the life-cycle cost advantage of building terminals in a modular fashion. Define standard interfaces within the terminals. Identify the technology which needs to be developed.

Phase II: Conduct detailed performance and cost trade-offs and further refine the system and subsystem design. Analyze the manufacturability, maintainability, and interoperability of the subsystem terminal modular building blocks.

DARPA 92-015 TITLE: Lightweight, High Resolution, Stereographic Head-worn Display System for Computer Generated Imagery

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative lightweight, self-contained capability to display real-time stereographic,

computer generated imagery.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating advanced technologies and concepts for providing a compact, lightweight, high resolution display device for operators to wear as interface to computer generated synthetic environments. A typical system would be a small and self-contained stereo-vision system, the size of ski-goggles, capable of operation with minimal (preferably zero) connection to external power and data sources. It might utilize rechargeable batteries with an electro-optical (EO) or radio-frequency data link. The display would be full color, maximum resolution possible, capable of being driven with minimal hardware and software interfacing to commercial-off-the-shelf computer graphics generators.

Phase I: Provide detailed analysis of the functional design of the proposed hardware technologies to be incorporated in an innovative lightweight, self-contained capability to display via head-worn system real-time color stereographic imagery. Describe the necessary integration for the operational incorporation of the system into a computer generated synthetic environment system. Phase II: Develop a feasibility demonstration model of the system concept and demonstrate its performance.

DARPA 92-016 TITLE: Low Cost Multi-spectral Signal Processing to Simultaneously Process Spatially and Temporaneously Disjoint Wideband Signals

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative low cost multi-spectral signal processing using multi-channel electro-optical (EO) bragg cells to simultaneously process spatially and temporaneously separate wideband signals.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating advanced technologies and concepts for providing tactically useful techniques for processing wideband data-hidden signals, spread both spatially and temporaneously. Such signals might result from multi-emitter, single-receiver battlefield surveillance systems. One potential candidate might include using multi-channel EO bragg cells. 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 utilized.

Phase I: Provide detailed analysis of the functional design of the proposed technologies to be incorporated in an innovative tactical signal processing system. Include a prediction of the operational utility of the processing technique (e.g., effective detection range for types of illuminated targets, number of emitters able to be acquired and processed meaningfully, a-priori knowledge of emitters required).

Phase II: Develop a feasibility demonstration model of the system concept and demonstrate its performance.

DARPA 92-017 TITLE: Low Cost, Self-Contained, 6 Degree of Freedom Orthometric Localization Orientation System (OLOS)

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative low cost, lightweight, self-contained head and/or hand/finger position sensors and processing capable of resolving 1 arc minute in pitch, roll and yaw, and 1 millimeter in vertical, lateral and longitudinal position.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating advanced technologies for measuring real-time displacement and orientation of a human operator's head, eye, hand, and fingers while operating in a computer generated synthetic environment. DARPA is interested in innovative sensor and processing technologies to detect and classify small and large-scale movements in real-time. Possible approaches could include use of magnetic, radio frequency or electro-optical emitters, and detectors coupled with innovative signal processing techniques. 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 utilized.

Phase I: Provide detailed analysis of the proposed OLOS detection and tracking sensor technique based on physical principles, as well as an analytical assessment of any available experimental data. Include a plan for how OLOS data would be output to be used by its synthetic environment.

Phase II: Develop a feasibility demonstration model of the system concept, and demonstrate its

performance.

DARPA 92-018 TITLE: Miniature Integrated Optical Circuit Technology Enhancement

CATEGORY: Advanced Development

OBJECTIVE: Develop new methods and subassemblies for fabricating miniature optical circuit components having performance characteristics at least a factor of 10 better than is currently available.

DESCRIPTION: The Department of Defense (DoD) has been developing new and novel military devices for various applications, which require the use of miniature integrated optical circuitry (MIOC). Currently the theoretical performance of a complete MIOC device can be achieved because of current fabrication techniques used to make the individual devices (e.g., wave division multiplexers, modulators, polarizers) are immature or non-optimal. This project is expected to result in new device fabrication technology, capable of impacting the development of fiber optic gyroscopes or signal processing units the DoD is envisioning for future military implementation.

Phase I: Develop a new procedure(s) or design a new device(s) capable of improving MIOC component fabrication to a level such that a factor of 10 component performance enhancement is achieved. Justify component selection and quantify the amount of performance gain potentially achievable.

Phase II: Fabricate and demonstrate a laboratory version of the Phase I design(s).

DARPA 92-019 TITLE: Modulation and Coding Design to Provide Two Orders of Magnitude Improvement in Meteor Burst Communication Throughput, Wait Time, and Low Probability of Intercept (LPI)

CATEGORY: Exploratory Development

OBJECTIVE: Design, develop, and demonstrate modulation, coding, and link protocols with two orders of magnitude improvement in throughput, waiting time and LPI compared with MIL-STD-188-35 performance while maintaining compatibility with current frequency allocations.

DESCRIPTION: Concepts are sought for modulation, coding, and link protocols that will optimize communication performance for the meteor channel for three broad application areas: high throughput to support voice and data; low wait time for 200 character messages; and for users that require LPI communication. Novel communication designs should take advantage of new antenna/RF technology that provides 70 dbw link Effective Radiated Power (ERP) and acquisition windows of 90 degrees. The schemes that maximize throughput or minimize wait times are to be constrained by current frequency allocations to 20 or 40 khz. LPI techniques must be mutually compatible with current users of the VHF band. Concepts will be reduced to practice, implemented in a machine to run in real-time, interfaced with RF equipment, and demonstrated on-the-air in conjunction with MB adaptive antennas, over a variety of ranges.

Phase I: Design a proof-of-concept system and provide detailed descriptions, design and performance analyses of the modulation/coding/link protocol schemes that provide the desired performance improvements for a two-way 70 dbw ERP link.

Phase II: Implement the schemes in software and hardware and support the integration, testing and evaluation of the proof-of-concept system.

DARPA 92-020 TITLE: Low Cost Self-contained GPS-based Aircraft Location Transponder

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative lightweight, self-contained capability to transmit ownship location via a "C-Band like" transponder.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating advanced technologies and concepts for providing operationally meaningful detailed position management information for dynamic, multi-vehicle flight environments. A typical system would be small and lightweight, capable of operation with minimal (preferably zero) connection to external power and/or data sources. It might adapt in some configurations to utilize rechargeable batteries in conjunction with solar cells. It would have capability to receive Global Positioning System data and compute and transpond (transmit upon interrogation) ownship state vector data, including altitude, airspeed and heading, as well as longitude and latitude. It might also compute and transpond ownship orientation of roll, pitch and yaw, based upon solid-state or optical accelerometers and

gyros. It should have data output ports and an optional, separate recorder (solid-state, magnetic or electro-optical) which can be connected for long-term storage of the ownship position data, when desired. The recording media would preferably be solid state to eliminate problems associated with mechanical systems operating in uncontrolled environments. Any integrated data processing software should be contained in plug-in solid-state modules to permit replacement or upgrade of the software. Proposals must include a discussion of how the technology would be operationally utilized, and how the transponder data from multiple vehicles in a dense, dynamic airborne environment would be acquired and processed for aircraft flight management.

Phase I: Provide detailed analysis of the functional design of the proposed hardware technologies and requisite software to be incorporated in an innovative lightweight, self-contained capability to transpond and record ownship location information.

Phase II: Develop a feasibility demonstration model of the system concept and demonstrate its performance.

DARPA 92-021 TITLE: Low Cost Self-contained Ground-impact Trajectory Detection System

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative airborne sensor systems for the detection and prediction of undesirable ground impact trajectories using "AI" predictive ground avoidance trajectory evaluation and warning.

DESCRIPTION: The Defense Advanced Research Projects Agency is investigating advanced technologies for detecting and predicting from onboard airborne platforms, both manned and unmanned vehicles, undesirable trajectories resulting in ground impact. Airborne sensing of the undesirable trajectory trend would provide warning to air vehicle operators for modifying the trajectory prior to ground impact. The Ground Impact Trajectory Assessment and Warning (GITAW) system should provide more than ground collision avoidance through the incorporation of intelligent inference of trajectory behavior based upon a-priori knowledge of the air vehicles' flight profiles, characteristics and purpose. Real-time trajectory trend data from self-contained GITAW inertial reference would be tracked against a-priori knowledge of acceptable flight profiles. Examples (for clarity only) might be that the system would recognize weapon delivery dive bomb trajectories as benign, while 1-gravity descending turns as incipient to "death spirals." System concepts should provide for self-contained inertial reference, possibly using combinations of Global Positioning System receiver system and optical/solid state gyros and accelerometers. Possible approaches could include use of innovative signal processing and kalman filter techniques. The systems must provide self-contained software and hardware for intelligent trajectory assessment processing. Any integrated data processing software should be contained in plug-in solid-state modules to permit replacement or upgrade of the software. The system must have output ports and input/output control appropriate to the system concept output data, but consistent with commercial practices for data transfer among avionics systems onboard current generation military air vehicles (e.g., 1553B data bus). Systems must be able to be adapted to a variety of platforms through the software loading of air vehicle parameters (flight characteristics and "acceptable" flight profiles). Although system accuracy, performance and lack of false alarms is of primary concern, low cost, low power, low maintenance and lightweight system concepts provide greatest potential for integration across military and commercial vehicles. Strong emphasis will be placed on truly innovative concepts that offer the potential for radical leaps in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally incorporated into air vehicles and utilized.

Phase I: Provide detailed analysis of the proposed detection, prediction, and processing technique to be used to determine that the air vehicle is undergoing an incipient ground impact trajectory, based on physical principles as well as an analytical assessment of any available experimental data on typical flight profiles. Provide detailed analysis of the functional design of the proposed hardware technologies and requisite software to be incorporated in the GITAW system. Describe system test considerations and effort required for incorporation for flight test. Include a plan for how GITAW data could be output to be used by its airborne platform.

Phase II: Develop a feasibility demonstration model of the system concept and demonstrate its performance.

DARPA 92-022 TITLE: Small, Low Cost, Remote-controlled, Turbojet Powered Avionics Testbed

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate innovative small, low cost, remote-controlled, turbojet powered avionics testbed for concept evaluation of small avionics systems.

DESCRIPTION: DARPA is investigating advanced technologies for testing new small avionics systems for airborne platforms, both manned and unmanned vehicles. Airborne testing of avionics concepts provides incremental system evaluation without reliance on more expensive end-product platforms. The Inexpensive Turbojet Avionics Platform (ITAP) would provide light behavior knowledge of the component technologies of future missile and air vehicle avionics, without the strenuous requirements of man-rating components for flight test on manned vehicles. Candidate avionics for test on ITAP include small self-contained guidance packages, sensor systems, miniature high-performance computer systems, battery technologies, transmitters, receivers and antennas. Remote control of ITAP should be independent of the avionics under test, with the ITAP air vehicle merely providing the platform for obtaining flight conditions. No avionics will be integrated within ITAP. ITAP should be ground launched, recoverable and recycled for further launches with minimal labor, time and resources, at industrial and remote locations. System concepts should provide for the air vehicle, remote-control system and launch, recovery and recycle techniques. The full-up air vehicle should be two-man-portable without special handling equipment. The air vehicle should be able to fly and be controlled at airspeeds up to 250 knots, with mission durations up to 30 minutes, at altitudes up to 5000 feet above ground level. The air vehicle must provide for up to 25 pounds and 750 cubic inches of avionics test components. Typical ITAP fuselage diameters should encompass no less than 5 inch diameter avionics packages. Electrical power supplied by the turbojet is desirable, but not required. The remote-control system should provide for line-of-sight control beyond the range of average visual acuity. Possible ITAP approaches could include use of innovative scaled aircraft models powered by commercially available miniature turbojet engines. Composite or other non-metallic material construction of the air vehicle is desired. Although performance and controllability are of primary concern, low-cost and low maintenance solutions provide greatest potential for long-term use as avionics test beds. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in avionics testing capability, even if there is technological risk. Proposals must include a discussion of how the technology would be effectively utilized.

Phase I: Provide detailed analysis and design of the proposed ITAP air vehicle system, including launch, recovery and recycle technique, and turbojet and remote control systems to be utilized. Describe system test considerations and effort required for incorporation of avionics components for flight test.

Phase II: Develop a feasibility demonstration model of the system concept and demonstrate its flight, recovery and recycle performance, while incorporating an operating, generic avionics system component for evaluation.

DARPA 92-023 TITLE: Transform Mission Planning into Classical Mechanics Domain

CATEGORY: Advanced Development

OBJECTIVE: Transform and redefine the threat avoidance mission planning problem from an operational research paradigm into an analytical domain resolvable through the precepts of classical Hamiltonian and Lagrangian mechanics.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating advanced mathematical concepts and computational techniques for providing tactically useful on-board aircraft mission planning systems for real-time threat avoidance. DARPA is interested in innovative mathematical and computational schema for moving the planning problem away from dynamic programming techniques to a functional redefinition of the problem as an N-Space multi-variable non-linear, probabilistic state-space that can be numerically solved with next generation high throughput computers. Techniques of interest might include categorizing the threat and cost functions as bounded N-Space curves and surfaces, with extrapolation of energy relationships and gradient techniques for path finding. Analogies to physical systems such as steel balls finding their way down inclined, mountainous surfaces might be appropriate.

Phase I: Provide detailed analysis of the mathematical techniques to be used and transformation and redefinition to be performed. Include a prediction of the operational utility of the mathematical construct and computational technique to implement it.

Phase II: Develop a feasibility demonstration model of the mathematical and computational system concept and demonstrate its performance.

DARPA 92-024 TITLE: Unsteady Aerodynamic Measurement Techniques for Dynamic, Post-Stall (PST) Maneuvering Flight Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel, effective methods for characterizing aerodynamic behavior and performance of highly maneuverable flight vehicles undergoing large amplitude, unsteady motions.

DESCRIPTION: The next generation of high performance atmospheric flight vehicles is expected to incorporate dynamic, PST maneuvering capabilities for enhanced close-in-combat effectiveness. Unsteady aerodynamic measurement techniques capable of extracting relevant flowfield, surface and vehicle performance parameters are necessary to support laboratory and flight test investigations. Such techniques may also provide the basis for a new generation of instruments to support operational flight, supplementing or replacing existing sensors and instrumentation.

Phase I: Study novel approaches to laboratory and inflight measurement techniques to assess unsteady aerodynamic effects arising from large amplitude vehicle motions. Provide a detailed specification for a selected, representative system including rationale for selections, as well as a design and fabrication feasibility assessment.

Phase II: Design, fabricate and test a prototype sensor to evaluate concept viability and establish performance limitations.

DARPA 92-025 TITLE: Application of High Temperature Superconductors to Compact High Frequency Antenna Arrays

CATEGORY: Basic Research

OBJECTIVE: Evaluate methods of fabricating compact, low profile high frequency (3 to 30 MHz) antennas capable of vehicular operation. The method should be based upon the application of high temperature superconductors.

DESCRIPTION: There is a need for compact, low profile antennas in the regime from 3 to 30 MHz which could be mounted conveniently on aircraft and/or ground vehicles. Vehicles equipped with such a compact antenna would be capable of jamming and employing other electronic countermeasures while on the move and, consequently, would have a substantially increased survivability. However, the Q (quality factor) for conventional compact HF antenna designs is too high, resulting in narrow bandwidths. For the mobile application being considered, a bandwidth of 1.5 to 30 MHz would be highly desired. Antenna systems fabricated with high temperature superconductors can yield an electrically small element that has a high radiation efficiency, but also has a substantially reduced bandwidth.

Phase I: Address the utilization of high temperature superconductors in HF antennas by considering means of broadbanding without sacrificing radiation efficiency. The Phase I proposal should provide the basic scheme for electromagnetic propagation, and the work itself should complete a design study to construct such an antenna, considering mechanical requirements and cooling.

Phase II: Construct an antenna based on the design study of Phase I.

DARPA 92-026 TITLE: Applications of Fullerene Chemistry

CATEGORY: Exploratory Development

OBJECTIVE: Explore the possibility of developing useful technological applications involving the use of Fullerenes such as C-60.

DESCRIPTION: Fullerenes form a series of new allotropes of carbon that have a variety of fascinating properties. Proposals are sought to identify and demonstrate the feasibility of using Fullerenes in novel applications. Other issues, such as the investigation of fundamental properties and structure, synthesis and purification, chemical reactions, electrochemistry, conductivity, and the superconductivity of these materials, as they relate to the intended application, should also be addressed in the proposal.

Phase I: Demonstrate the feasibility and utility of using Fullerenes in the intended application.

Phase II: Test the performance of these novel materials in the intended application.

DARPA 92-027 TITLE: Ceramic Shields for Satellite Protection against Hypervelocity Impact

CATEGORY: Basic Research

OBJECTIVE: Explore the use of ceramics in stand-off shields for protecting satellites against hypervelocity impacts by orbital debris and/or kinetic energy pellets.

DESCRIPTION: Subsequent to deployment, a number of important and costly space systems will be subject to impacts from projectiles traveling at relative velocities as high as 15-20 km/sec. In peacetime, the primary source of such hypervelocity projectiles is man-made orbital debris. In wartime, hostile offensive action may result in the addition to this debris environment of projectiles such as the pellets and fragments from the breakup of other satellites. To protect these space systems, effective debris impact shields must be designed and implemented. Since the impact velocities exceed considerably the capabilities of current ground launcher technology, the design and analysis of such shields must rely heavily on the extension of laboratory impact data from "moderate" to "high" impact velocities by computer simulations of impact events. In an effort to optimize shield performance, DARPA is exploring the use of certain classes of materials which offer the potential for major improvements in shield capability. Of particular interest are ceramics. Examples include lightweight ceramic armor (e.g., boron carbide) and ceramics with microstructure (e.g., embedded carbon microspheres or fibers). Accordingly, it is the intent of this research topic to identify and demonstrate the advantageous use of ceramics in advanced shield designs.

Phase I: Identify a promising application of ceramics which would enhance significantly the performance of stand-off shields against hypervelocity impact by projectiles with masses up to 1-2 gm and relative velocities in the 5-20 km/sec regime. Provide a preliminary design, and demonstrate the enhanced capability via theoretical analysis and/or computer simulations. While the concept may be explored theoretically/numerically in this study, the use of laboratory experiments for demonstrating feasibility at some level, or investigating critical technical issues, is not excluded.

Phase II: Demonstrate the capabilities of one or more candidate shield designs with the aid of large-scale computer simulations of impact events and appropriate laboratory experiments.

DARPA 92-028 TITLE: Ceramic Fiber Development

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost manufacturing methods for ceramic fibers with properties suitable for use in advanced metal and ceramic matrix composites.

DESCRIPTION: Ceramic fiber/metal matrix and ceramic fiber/ceramic matrix composites have been identified by the Department of Defense as important to the development of advanced military systems. Widespread use of components made from these composites will depend upon the availability of low cost/high performance fibers. For thermostructural applications of interest to the Defense Advanced Research Projects Agency (DARPA), fibers must maintain high strength and creep resistance at temperatures up to 1500°C. Innovative methods capable of producing weavable fibers (usually having fiber diameters of about 20 microns and below) are of particular interest.

Phase I: Provide a bench scale demonstration of process, capable of producing fibers with the desired high temperature creep and strength properties.

Phase II: Provide a pilot plant scale-up of process to produce material for characterization, evaluation, and to determine ultimate manufacturing costs.

DARPA 92-029 TITLE: Nonlinear Dynamics Applied to Signal Processing and Innovative Coding Schemes

CATEGORY: Exploratory Research

OBJECTIVE: Investigate the application of techniques from nonlinear dynamics to noise reduction in signal processing and to development of secure coding schemes for communications.

DESCRIPTION: Nonlinear dynamics offers a novel approach to signal processing which may lead to significant capability in noise reduction with computational efficiency. Chaotic dynamics may also offer means for establishing efficient methods for secure communications systems when coupled with other techniques. The goal of this topic is to investigate these applications in a realistic environment of interest to Department of Defense (DoD).

Phase I: Develop an approach to noise reduction in signal processing using nonlinear dynamics targeted at a specific problem of interest to DoD; or investigate techniques for secure communications which use nonlinear dynamics as part of the scheme.

Phase II: Implement methods investigated in Phase I and demonstrate on target application.

DARPA 92-030 TITLE: Compressive Surface Strengthening of Pressure Densified Structural Ceramics

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate methods to increase the bend strength of pressure densified structural ceramics utilizing surface compressive stresses.

DESCRIPTION: Pressure densification of structural ceramics can result in materials with extremely small volume flaws such that bend strength fracture origins are related to surface defects. Significant enhancement of bend strength is expected for this class of ceramics if compressive stresses sufficient to prevent growth of surface flaws is applied. This approach combined with post machining heat treatments to heal surface flaws should result in significant enhancement of useful strength. The proposal should identify the method for generating surface compressive stresses, the effect of temperature and pressure on the surface compressive stress, the stress profile resulting from the compressive strengthening method chosen for evaluation, and an estimate of the magnitude of the strength increase to be expected. Surface strengthening mechanisms which continue to operate at high temperature and can be used with components having complex geometries are of greatest interest.

Phase I: Produce samples with surface compressive stresses which can be evaluated in four point bending, using a standard military specification bend bar test. Commercially available material may be used if compatible with the proposed surface compressive stress strengthening mechanism proposed. Samples with optimized strengthening will be evaluated for surface flaw sensitivity using controlled flaw techniques.

Phase II: Components of interest to DoD with significant surface stresses in use will be identified, fabricated and evaluated to demonstrate the capability and utility of the surface compressive strengthening method chosen.

DARPA 92-031 TITLE: Concurrent Engineering Technology

CATEGORY: Exploratory Development

OBJECTIVE: Explore new ideas for technology that will enable concurrent engineering of Defense products and systems for the purpose of greatly reducing cost and increasing quality.

DESCRIPTION: The term "Concurrent (or Simultaneous) Engineering (CE)" connotes the integrated, concurrent design of products and their related processes, including manufacturing and support. There are numerous programs within the DoD and industry concerned with the development and promotion of methodologies, tools, organizational structure, and cultures for CE. By contrast, this SBIR offering is more restricted in scope in that its primary objective is to identify and develop new technologies which enable concurrent engineering by DoD producers. Enabling technologies may include those for enhanced information sharing/comparing, automated management of requirements and constraints, integration of dissimilar automated design tools, and multimedia communication.

Phase I: Conceptual formulation and study of validity and utility.

Phase II: Demonstration of feasibility and key features.

DARPA 92-032 TITLE: Electron Beam Processing

CATEGORY: Exploratory Development

OBJECTIVE: Explore the potential of high energy electron beam for material processing.

DESCRIPTION: High energy electron beam (a few MeV) offers the potential for processing materials in full density or near full density air. Processing that may benefit from this technique are: metal-matrix composite bonding, polymer cross-linking, joining ceramics, surface strengthening, and others. A comprehensive study is needed to compare the advantages of high energy electron beam processing with conventional and unconventional methods like lasers, microwave, plasma and low energy electron beam material processing. A proof-of-principle experiment may follow pending on the outcome of this study.

Phase I: Produce a comprehensive study comparing the advantages of high energy electron beam processing with other methods.

Phase II: Produce a proof-of-principle experiment to demonstrate the advantage of this technique.

DARPA 92-033 TITLE: Flexible Manufacturing Process Development for Ceramics and/or Ceramic Fiber Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop a flexible manufacturing process for advanced ceramics and/or ceramic fiber composites components.

DESCRIPTION: Advanced ceramics and composites are enabling or enhancing technology for DoD systems. Many of the applications where the benefits of these materials can be realized are relatively small volume applications. High tooling costs associated with near-net-shape forming methods for these small volume applications, result in significant cost disadvantages for these materials. Proposals are sought identifying novel manufacturing methods for advance ceramics and/or ceramic fiberceramic matrix composites. Proposed manufacturing processes should: (1) be generally applicable to a large variety of compositions; (2) be capable of producing components with small flaw sizes (less than 10 microns) and high weibul modulus; and (3) exhibit low manufacturing costs at small production volumes (less than ~100 parts).

Phase I: Bench scale demonstration of novel flexible manufacturing process for state-of-the-art ceramic and/ceramic fiber-ceramic matrix composite components.

Phase II: Design and construction of prototype manufacturing equipment and demonstration of its utility in producing a component of interest to DoD.

DARPA 92-034 TITLE: Innovative Laser Crystal Growth Methods

CATEGORY: Exploratory Research

Objective: Growth of large Nd:Host laser crystals with reduced surface damage.

DESCRIPTION: Advances in the diode pumping of Nd:Host lasers opens up the possibility of high average power operation. At present the Nd:Host crystals are limited in size and material damage, as well as amplified spontaneous emission (ASE) and parasitics are limiting factors for high average power operation. The goal of this program is to develop innovative laser crystal growth methods. Growth of large damage resistant Nd:Host laser crystals for extraction of maximum energy density, while suppressing ASE and parasitics, permits the scaling of solid state lasers to high average powers.

Phase I: Develop concepts and proof-of-principle experiments to grow large damage resistant Nd:Host laser crystals.

Phase II: Demonstrate growth of large damage resistant Nd:Host laser crystals.

DARPA 92-035 TITLE: Laser Underwater Imaging

CATEGORY: Exploratory Research

OBJECTIVE: Remotely measure and map the optical characteristics of sea water in localized areas, within the field of regard for laser underwater imaging applications.

DESCRIPTION: Laser underwater imaging of objects below the sea water, including open oceans, coastal waters and harbors, is complicated by the optical characteristics absorption and scattering of light. The absorption and scattering of light in sea water is dominated by the various dissolved substances and organic/inorganic matter. The types and concentrations of these particles and dissolved substances vary in time and space, giving rise to non-uniform absorption and scattering characteristics. The goal of this program is to remotely measure and map the optical characteristics of sea water in localized areas, within the field of regard for laser underwater imaging applications.

Phase I: Develop concepts and techniques to remotely measure optical scattering and absorption of sea water.

Phase II: Laboratory demonstration of concepts and techniques developed in Phase I to measure optical scattering and absorption of sea water for laser underwater imaging applications.

DARPA 92-036 TITLE: Materials for Molecular Devices

CATEGORY: Exploratory Development

OBJECTIVE: Produce and incorporate novel materials in the construction of an operational molecular scale device.

DESCRIPTION: Devices constructed by the assembly of individual molecular components upward, rather than from the bulk material downward, (e.g., the current lithographic approach) offer great promise for size and power reduction, along with increased operational speed of the device. Novel synthetic methodologies are sought for the preparation of materials and actual construction of elements such as molecular wires, switches, nanosensors, and storage devices. Other issues, such as the dynamics of molecular scale structures, stability of the molecules, and how devices of molecular dimension are accessed and driven, should also be addressed in the proposal.

Phase I: Identify and synthesize materials and fabricate a molecular scale device.

Phase II: Test the performance of the molecular scale device and demonstrate cost-effective application.

DARPA 92-037 TITLE: Novel Concepts to Negate Missile Guidance Electronics

CATEGORY: Exploratory Research

OBJECTIVE: Develop and demonstrate novel concepts to negate missile guidance electronics.

DESCRIPTION: The goal of this program is to develop and demonstrate novel concepts to negate missile guidance electronics and prevent the missile from reaching the target. The concepts shall be applicable to electro-optical/infrared (E-O/IR) and millimeterwave (MMW) guided missiles at ranges of several kilometers. This new technology must be compatible with deployment on numerous military platforms including fixed and rotary wing aircraft, tanks and other ground vehicles. Expendable jammers, which are being developed in separate programs, will not be considered in this program.

Phase I: Provide an engineering design of portable brassboard system.

Phase II: Fabricate portable brassboard system and test it in laboratory.

DARPA 92-038 TITLE: Novel Methods for Control of Industrial Processes

CATEGORY: Exploratory Development

OBJECTIVE: Develop control theoretical methods and software amenable to complicated manufacturing environments of interest to DoD.

DESCRIPTION: Recent advances in control enable use of design methods amenable to optimization techniques which incorporate engineering constraints (such as step response, settling time, frequency domain constraints) directly into the objective. Such techniques should lead to software for a general class of multi-input multi-output systems. Furthermore, such techniques should be demonstrated on specific manufacturing or industrial processes of interest to DoD.

Phase I: Develop novel methods for controller design which incorporate practical engineering constraints directly into computer-aided controller design. Select a manufacturing process of interest to DoD to serve as a target application of these methods.

Phase II: Develop software design tools and demonstrate efficacy on selected manufacturing process.

DARPA 92-039 TITLE: Novel Li-Anodes for Solid State Batteries

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate novel Li-alloy anodes or Li-intercalation anodes for the production of high energy/power density, all solid state batteries.

DESCRIPTION: The DARPA Electrochemical Power Sources program is investigating the production of a rechargeable, high energy/power density, all solid state battery, based on the lithium/polymer electrolyte/insertion cathode concept. Novel Li-alloy anodes or Li-intercalation anodes are sought which might lead to an increase in the safety and cycle life of these novel batteries. Chemical compatibility, processibility, and electrochemical stability with the electrolyte are all important considerations. Approaches that integrate a fundamental understanding of ion mobility in solid electrolytes with the design, fabrication, and evaluation of these materials will receive serious consideration.

Phase I: Develop and test promising candidate Li-alloy anodes and/or Li-intercalation anodes.

Phase II: Incorporate the candidates from the Phase I program into an experimental battery and test its performance.

DARPA 92-040 TITLE: Novel, High Efficiency Deposition Processes for Multilayer Laminate Structures

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate novel, cost-effective deposition processes for manufacture of multilayer laminate structures.

DESCRIPTION: A significant limitation to widespread application of advanced fiber reinforced composite materials is the high cost of manufacture. Multilayer laminate structures may offer an effective solution to this problem by incorporating the manufacture of composite reinforcement with matrix consolidation in a single apparatus. To achieve cost-effective manufacture of multilayer laminate composites, materials deposition processes with high material conversion efficiencies, high deposition rates, broad range of deposition temperatures, and large area capabilities are required. These process characteristics may potentially be developed by adaptation of current commercial thin film or metallurgical coating processes or by development of entirely new processes.

Phase I: Identify processes, develop manufacturing cost models, identify scale-up and automation issues, and demonstrate process feasibility by deposition of a variety of alloy and ceramic materials over a broad temperature range with consistent lamina thickness, composition, and microstructure.

Phase II: Refine and optimize mechanical properties of multilayer laminate structures through control of metal and ceramic compositions, microstructures, interface bonding, thickness, etc. Produce and test specimens and update manufacturing cost model.

DARPA 92-041 TITLE: Optical Memory Storage Materials and Device Concepts

CATEGORY: Exploratory Research

OBJECTIVE: Develop and demonstrate materials and device concepts for optical data storage and retrieval.

DESCRIPTION: The ability to store and retrieve large numbers of data in memory systems is useful for new types of ultra-fast computers. In optical memory systems data can be stored in three dimensions and retrieved very fast. Optical memory systems enable many processors to work in parallel. The capability to store and retrieve an entire image very fast can allow video display of the image more easily. The goal of this program is to develop materials for optical storage and data retrieval methods without cross-talk between channels.

Phase I: Identify and characterize materials for three-dimensional optical data storage.

Phase II: Laboratory demonstration of: 1) optical data storage in materials identified in Phase I, and 2) data retrieval methods without cross-talk between channels.

DARPA 92-042 TITLE: Quantum Devices for Optical Communication and Switching

CATEGORY: Exploratory Development

OBJECTIVE: Develop new ideas in fiber-optic communications in both local network and long haul applications.

DESCRIPTION: Long haul fiber optical communication is presently limited by loss and dispersion. Recent advances of erbium-doped fiber amplifier and solitons offer great promise in overcoming these obstacles and provide hope for an all-optical communication system. One of the remaining concerns is the signal-to-noise degradation at detection and amplification. Another concern is the switching speed which may be 100 G bits/second. Innovative ideas for improved signal-to-noise amplifiers and ultra fast switching for all-optical communication are sought in this solicitation.

Phase I: Produce analysis and design studies of amplifier and/or switching for optical communication.

Phase II: Produce a proof-of-principle experiment to demonstrate the key features.

DARPA 92-043 TITLE: Rare-earth Doped Fiber Amplifiers

CATEGORY: Exploratory Research

OBJECTIVE: Develop rare-earth doped fiber amplifiers for transmitters and receivers.

DESCRIPTION: Advances in diode pumping of rare-earth doped laser materials opens up the possibility of

numerous military, scientific and medical applications. The objective of this program is to explore rare-earth doped fiber amplifiers similar to erbium doped fiber amplifiers, for use as power amplifier for transmitters and preamplifier for receivers. This program will address the spectroscopic studies, as well as signal amplification characteristics in rare-earth doped fiber amplifiers.

Phase I: A comprehensive review, analysis and spectroscopic study of diode pumped rare-earth doped fibers.

Phase II: Based on results of Phase I study, perform a proof-of principle experiment to demonstrate the feasibility of rare-earth doped fiber amplifiers.

DARPA 92-044 TITLE: Sensors for Intelligent Processing of Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop in-situ sensing techniques for measuring key process parameters which can be used for feedback control of thin film and metallurgical coating processes.

DESCRIPTION: Metallurgical and ceramic coatings manufactured by chemical vapor deposition or physical vapor deposition processes are frequently characterized by a wide variability in thickness, composition, or microstructure. These attributes are often critical to the functional performance of these coatings, and reduction in variation can result in significant improvement in coating life or functionality.

Phase I: Identify and demonstrate feasibility of cost-effective sensing concepts for in-situ measurement of coating thickness, composition, or microstructure.

Phase II: Incorporate successful sensing technology into a coating manufacturing process to achieve feedback process control.

DARPA 92-045 TITLE: Smart Materials and Structures

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a new class of materials which have the capability to both sense and respond to environmental stimuli and which have the capability of active control of their response.

DESCRIPTION: Smart materials offer many enhancements and new capabilities to DoD systems, particularly in performance, durability and reliability. Smart materials can provide designers and engineers with significant new capability to control geometric shape, structure movement, damping and vibration absorption, and other attributes as designed properties of the material. The proposed program should provide for the development of new materials with active constituents. These materials can be designed to react to external stimuli on either a micro-mechanical or macro-mechanical level. The development of functional adaptive materials along with advances in theory, sensors, actuators, control algorithms and signal processing as applied to smart materials is of interest.

Phase I: This effort is concerned with basic theory and proof of concept in the areas of sensors, actuators, composite design, matrix and reinforcement selection, information management and architecture, and control systems as applied to an integrated smart material or as individual topics which have potential applicability to smart materials.

Phase II: Smart materials and structures characterization, calibration and validation.

DARPA 92-046 TITLE: Structural Ceramics Enabling Demonstration

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate the utility of advanced state-of-the-art structural ceramics in militarily significant and technically demanding systems.

DESCRIPTION: Ceramics offer advantages in strength, elastic modulus, wear and corrosion resistance, reduced weight, durability in extreme environments, and in elevated temperature use. Thus the application of ceramics in certain military systems offers potential improvements in the performance of these systems. The proposal should identify cost-effective ways to significantly increase the capabilities of DoD systems through the infusion of advanced state-of-the-art structural ceramics into fielded weapon systems or platforms. The demonstration should use commercially available materials in any application with military utility. A design methodology appropriate to ceramics must be employed.

Phase I: Evaluate the performance enhancement potential and/or cost savings to systems in which the

demonstration component would be used. Design the component to be used in the demonstration for optimum performance and reliability.

Phase II: Produce the components designed in Phase I and conduct evaluation tests to evaluate component reliability and system performance.

DARPA 92-047 TITLE: Lasers in Supercritical Fluid Processing

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the utility of combining laser irradiation with supercritical fluid processing to provide novel capabilities for materials processing or extraction.

DESCRIPTION: The separation and processing of materials using supercritical fluids are two developed technologies. It is well known that the properties of the supercritical fluid media are both heat and pressure sensitive. Proposals are sought to investigate the utility of laser irradiating the supercritical fluid media to locally and/or globally vary the temperature and/or pressure to enhance supercritical fluid processing. The interaction of the laser radiation with the supercritical fluid media and its detailed effects, along with potential viable applications should be addressed in the proposal.

Phase I: Identify and demonstrate the feasibility of using laser radiation in supercritical fluids to enhance processing.

Phase II: Test the performance of this enhanced processing technique on a specific viable application.

DARPA 92-048 TITLE: Compact High Power Ultra-Wide-Band (UWB) Radio Frequency (RF) Sources

CATEGORY: Exploratory Development

OBJECTIVE: Explore new ideas in UWB RF generation for military applications.

DESCRIPTION: UWB RF sources may offer potential new DoD applications. Numerous ideas have been examined for generating the RF; for example, photo-conductive switches, spark gaps, and electron beam switches. But at present, none of these can satisfy simultaneously the requirements of power (a few gigawatts), pulse repetition rate (up to a few kHz), life time and size. Innovative ideas are needed, other than the three classes of switches mentioned above, to arrive at a device that can satisfy all these requirements.

Phase I: Provide detailed design studies of the system.

Phase II: Perform a proof-of-principle experiment.

DARPA 92-049 TITLE: Wavelets and Failure Prediction

CATEGORY: Exploratory Development

OBJECTIVE: Investigate utility of wavelet techniques in detecting and predicting failure in complex mechanical systems.

DESCRIPTION: Wavelets provide a novel class of methods in signal processing for detecting and analyzing transient signals and for extraction of features from broadband signals. Certain physical systems may exhibit behavior which acts as a precursor to failure. Appropriate sensors may provide data which, when analyzed using wavelet methods, could yield precursors to predict failure. This information could be used as part of an automated maintenance information system. Methods for predicting failure would be especially useful for high maintenance items in DoD systems.

Phase I: Develop methods for analyzing and predicting failure based on signal processing methods using wavelet techniques. Work should be targeted to a specific system of interest to DoD which is likely to exhibit precursor behavior.

Phase II: Having developed the techniques, develop and apply software to real data to demonstrate efficacy of the methods.

DARPA 92-050 TITLE: Conformal Electronics Packaging

CATEGORY: Basic Research/Exploratory Development

OBJECTIVE: Develop processes and device concepts for conformal electronic packages.

DESCRIPTION: Concepts for processes and devices are sought for conformal electronic packages. Conventional electronic packaging is concerned with shrinking the volume of electronics. Conformal electronics packaging is concerned with making electronic packages that allow electronics to be put in odd-shaped systems. The eventual goal is to be able to intermingle computation, sensors and actuators, and mechanical structure.

Phase I: Develop conformal electronic package concepts. Perform preliminary analysis or experimentation of processes and device concepts.

Phase II: Fabricate conformal electronic package test structures and measure electrical/mechanical performance.

DARPA 92-051 TITLE: Chip-on-Glass Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel techniques of placing chips-on-glass for the purpose of improving large area, liquid crystal display electronic driver capability.

DESCRIPTION: Increasing liquid crystal panel sizes and resolutions requires driver electronics to be placed closer to the display pixels to minimize power requirements and increase speed. Novel approaches to placing driver circuitry on glass that exhibit low cost and high reliability are sought.

Phase I: Investigate alternative chip-on-glass packaging approaches that optimize features such as pitch, bonding, interconnection, coefficients of thermal expansion, dielectric constants, cost and reliability. Provide a detailed description of the proposed improved concepts and make recommendations for a production-worthy chip-on-glass technology.

Phase II: Build and test a chip-on-glass breadboard to demonstrate the production capability of the recommended technology.

DARPA 92-052 TITLE: Contrast Enhancement for Electroluminescent Displays

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel techniques for increasing the contrast between on and off pixels in Thin Film Electroluminescent (TFEL) Displays.

DESCRIPTION: Concepts are sought for improving the contrast between on and off pixels in TFEL displays. Techniques to reduce light output from off pixels due to reflection of ambient light and/or to increase light output from on pixels should be investigated.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for incorporating these concepts into current TFEL manufacturing techniques.

Phase II: Manufacture a small TFEL improved contrast panel, and deliver to the Defense Advanced Research Projects Agency (DARPA) for evaluation.

DARPA 92-053 TITLE: High Efficiency Polarizers

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate methods to increase efficiency/brightness of Active Matrix Liquid Crystal Displays (AMLCDs).

DESCRIPTION: AMLCDs require polarizers to produce the image. These polarizers are a significant source of light loss in the optical path. High efficiency would increase the brightness of AMLCDs.

Phase I: Identify candidate materials and configurations for high efficiency polarizers.

Phase II: Fabricate and characterize prototype polarizers.

DARPA 92-054 TITLE: Indium Phosphide (InP) Material Growth

CATEGORY: Advanced Development

OBJECTIVE: Advance the development and fabrication of InP substrates and epitaxial material for microwave and millimeter wave (MMW) devices, and monolithic format circuits that will provide performance

characteristics not presently available and, thus, satisfy system requirements that are not presently being adequately met.

DESCRIPTION: Gallium arsenide is the most common material that is suitable for use in developing microwave and MMW devices and monolithic format integrated circuits. However, further performance improvements have been achieved using InP as a substrate material, particularly at MMW frequencies. Nevertheless, InP material growth is at an embryonic stage of development and established sources of large diameter InP wafers are not yet available. This project is directed toward the improvement of the microwave and MMW performance characteristics of InP substrate material and substrate/epitaxial combinations. It is expected that this project will also lead to the establishment of sources of supply for large diameter (three [3] inches or greater) InP wafers with characteristics suitable for high performance and low cost microwave and MMW device and circuit development.

Phase I: Develop a plan for cost-effective techniques for producing InP substrate material and/or InP substrate/epitaxial material combinations that will result in a supply of material with performance characteristics suitable for producing microwave and MMW devices and circuits.

Phase II: Perform appropriate work to begin or extend the development of sources of InP substrate material or substrate/epitaxial combinations with the characteristics described above.

DARPA 92-055 TITLE: Indium Phosphide (InP) Microwave & Millimeter Wave (MMW) Devices & Circuits

CATEGORY: Advanced Development

OBJECTIVE: Advance the development and fabrication of InP microwave and MMW devices and monolithic format circuits that will provide performance characteristics not presently available and, thus, satisfy system requirements that are not presently being adequately met.

DESCRIPTION: Gallium arsenide metal-semiconductor field effect transistors (GaAs MESFETs) are being successfully used in a wide range of microwave applications and many MMW applications. However, these devices and the circuits built using them have performance limitations in terms of noise figure, power output and efficiency, particularly at frequencies above 50 GHz. This project is directed toward the present state of the art. Particular emphasis should be placed on developing devices and circuits to meet military system requirements that cannot adequately be met with existing structures.

Phase I: Select one or more InP devices and/or monolithic format circuits that offer the possibility of performance improvements at microwave and MMW frequencies beyond the present state of the art. Develop a plan for the fabrication of the device and/or circuit structures. Consider approaches that will result in the desired structures being produced at the lowest possible cost.

Phase II: Develop final design and fabricate prototype samples of the InP device and circuit structures selected for demonstration. Measure and report upon the microwave or MMW devices and circuits' frequency performance characteristics.

DARPA 92-056 TITLE: Large Area, High Precision Assembly Technology for Displays

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel techniques for the mounting and connection of matrix-addressed, large area, flat panel displays.

DESCRIPTION: Concepts are sought for improving the reliability and the ease of electrical interconnection of large area, high resolution displays to off-glass circuitry. The displays range in size from 10" to 40" diagonal, with resolutions of up to 100 lines per inch.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for incorporating them into Defense Advanced Research Projects Agency (DARPA) provided displays.

Phase II: Utilize these techniques to mount a DARPA provided display, and provide data on the positional accuracy and the reliability of the display.

DARPA 92-057 TITLE: Lightweight, Compact Optics for Head Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel techniques for presenting an image, focused at infinity, to an operator

utilizing a head mounted display, and test these techniques utilizing displays provided by the Defense Advanced Research Projects Agency (DARPA) High Definition Systems program.

DESCRIPTION: DARPA has developed high resolution liquid crystal displays (LCDs) and deformable mirror-devices (DMDs) which are uniquely suited to generation of images in head mounted displays (HMDs). Concepts are sought for lightweight, compact optics which will present these images to the operators, allowing for comparison with and overlay to the real world. Both monochrome and color displays are of interest.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for building and testing these devices utilizing DARPA provided displays.

Phase II: Build these HMDs, utilizing displays provided by DARPA, and demonstrate their performance in presenting text, computer generated graphics, and video data.

DARPA 92-058 TITLE: Micro-Actuator

CATEGORY: Basic Research/Exploratory Development

OBJECTIVE: Develop materials, processes, and device designs for micro-electromechanical (MEM) valves.

DESCRIPTION: Concepts, materials, processes, and devices are sought for micro-electromechanical (MEM) valves. In principle, MEM offers numerous advantages for constructing small valves to be used in a variety of systems. MEM devices can be used alone, or distributed systems can be constructed in combination with, for instance, pressure microsensors and conventional microelectronics.

Phase I: Develop MEM valve concepts. Perform preliminary analysis or experimentation of materials and processes. Explore device concepts.

Phase II: Fabricate MEM valve test structures and measure electrical/mechanical performance.

DARPA 92-059 TITLE: Material and Process Optimization for Color AC Plasma Flat Panel Displays

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate and demonstrate materials and processes to improve the performance of color AC plasma flat panel displays.

DESCRIPTION: Color AC plasma flat panel displays require new and different materials and processes from monochrome displays. Some initial key materials and processes for color displays, such as phosphors, insulators, gas mixtures, and deposition techniques, have been identified. These materials, however, need to be optimized to improve display performance.

Phase I: Identify candidate materials and processes for color AC plasma flat panel displays, develop a rationale for how they improve display performance or manufacture.

Phase II: Incorporate materials or process in display panel.

DARPA 92-060 TITLE: Organic Light Emitting Devices

CATEGORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate emissive displays using organic Light Emitting Devices.

DESCRIPTION: Organic light emitting devices are new materials with a potential for being fabricated into emissive displays. Such devices must have attributes of brightness, efficiency, proper chromaticity, and manufacturability into configurations suitable for display applications.

Phase I: Identify candidate materials for organic light emitting devices for display applications.

Phase II: Fabricate and characterize prototype devices.

DARPA 92-061 TITLE: 3-D Electronic Interconnect Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop 3-D techniques for high density packaging of silicon and gallium arsenide high speed logic circuits.

DESCRIPTION: Processes are sought for 3-D packaging of silicon and gallium arsenide logic circuits. The full benefit of increased speed of operation of digital integrated circuits will not be realized at the system level unless signal interconnect delays are minimized. With increasing size of 2-D multichip modules (MCMs) and consequent lengthening of signal lines, 3-D approaches will provide major benefits in density, as well as reducing propagation delays for clockrates of several hundred MHz and higher. Well controlled impedance lines are required to preserve signal integrity. In addition, since power dissipation increases rapidly with clock frequency, innovative approaches are needed to handle high thermal densities.

Phase I: Explore materials and processes for dense 3-D electronic packaging of > 100 MHz logic circuits.

Phase II: Demonstrate a promising approach to dense 3-D electronic packaging of > 100 MHz logic circuits through fabrication and measurement of test structures.

DARPA 92-062 TITLE: Radio Frequency (RF) Driven Fluorescent Lamps

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate the use of RF driven fluorescent sources in a flat configuration to improve the light output per watt of power input, longevity and ruggedness of flat panel liquid crystal digital (LCD) displays.

DESCRIPTION: Flat panel LCD displays need a bright flat backlight. RF driven fluorescent sources in a flat configuration offer the possibility of performance improvement in terms of light output per watt of power input, long life, and enhanced ruggedness due to the lack of electrodes.

Phase I: Identify phosphor materials and gas mixtures appropriate for color LCD flat panels, develop a mechanical design for a backlight, and propose projected lamp performance specifications.

Phase II: Build and characterize prototype lamp.

DARPA 92-063 TITLE: Uniaxial (highly aligned) Materials for Liquid Crystal Display (LCD) Alignment Layers

CATEGORY: Exploratory Development

OBJECTIVE: Investigate and demonstrate materials and/or processes that will eliminate the need for buffing the polymer layer.

DESCRIPTION: Active matrix liquid crystal displays (AMLCD) require a buffed alignment layer to orient the liquid crystal molecules. The buffing process is little understood and a possible source of damage to the display panel during manufacture. Materials and processes are sought that eliminate the need for buffing the polymer layer.

Phase I: Identify candidate materials and methods for producing highly aligned layers.

Phase II: Incorporate the materials or processes in a AMLCD panel.

DARPA 92-064 TITLE: High Reliability Connectors

CATEGORY: Exploratory Development

OBJECTIVE: Develop reliable miniature connectors compatible with high performance electronic multichip modules (MCMs).

DESCRIPTION: Materials and process technologies are sought to fabricate connectors for digital subsystems with MCMs used in military applications such as work stations, avionics, and smart munitions. Desirable attributes of the connector technology include high reliability, high Input/Output (I/O) density, good electrical performance up to at least 300 MHz, and preferably several GHz, ease of insertion/removal, ability to withstand multiple reuse, and potential for low cost manufacture.

Phase I: Investigate candidate materials and process technologies, perform preliminary experiments, and develop a plan for fabrication of connectors suitable for high performance MCMs.

Phase II: Select the most promising approach(es), design and fabricate connectors, and perform chemical, electrical, mechanical, and thermal tests.

DARPA 92-065 TITLE: Electronically-controllable Thin Appliques for Dynamic Alteration of Visual or

Thermal Exterior Surface Signatures

CATEGORY: Exploratory Development

OBJECTIVE: Reduce or change visible signature through use of low cost appliques.

DESCRIPTION: Appliques for combined or independent control of Infrared (IR) and visible signatures are desired. Weights of 40kg/m² or less are desired. Reflectance ranges from 0.2 to 0.9 should be achievable, and the ability to add light or heat is desirable. System costs should be less than \$10,000 per square meter.

Phase I: Perform a detailed analysis of obtaining appliques for combined or independent control of IR and visible signatures.

Phase II: Produce a workable system to do the above at a system cost of less than \$10,000.

DARPA 92-066 TITLE: Methods for Detection of Guerrilla Forces in a Jungle Environment

CATEGORY: Exploratory Development

OBJECTIVE: Detect enemy foot soldiers through dense foliage.

DESCRIPTION: Methods for detecting enemy foot soldiers through dense foliage are desired. Systems should be capable of at least 100 meter detection range, and environmental effects or animals should be avoided. Provision of range and bearing are desirable, but not required.

Phase I: Perform a detailed analysis of a system for detecting enemy foot soldiers through dense foliage with the above criteria.

Phase II: Develop and demonstrate a working system to attain the objective.

DARPA 92-067 TITLE: Sensors or Methods for Airborne Detection and Discrimination of Buried Land Mines

CATEGORY: Exploratory Development

OBJECTIVE: Rapid detection of minefields to support swift moving offensive operations.

DESCRIPTION: Sensors are desired for detection of buried and surface minefields from altitudes of 100 feet and higher. Discrimination of mines from other clutter objects is a must. Sweep rates of at least 30 knots and 100 meter scan widths should be attainable. At least 50 percent of all mines should be detected to assure detection of the minefield.

Phase I: Perform analysis of proposed approach to attain sweep rates of at least 30 knots and 100 meter scan widths with at least 50 percent detection rate of mines.

Phase II: In collaboration with end users, build a working prototype.

DARPA 92-068 TITLE: Circuit Architectures that Employ only Nearest Neighbor and Next Nearest Neighbor Connections

CATEGORY: Exploratory Development

OBJECTIVE: Explore the utility of circuit configurations that are limited in their drive capability to only nearest neighbor and next nearest neighbor connections for general purpose computing.

DESCRIPTION: While there are numerous specialty applications that require only short interconnects between components, it is not clear what limitations a restriction to only nearest neighbor and next nearest neighbor interconnects would have on general purpose computers. As device dimensions progressively shrink to ever smaller dimensions, the need to drive long interconnects limits the usefulness of continued device scaling. It is the intent of this effort to seek innovative solutions to general purpose computing architectures that would suffer the least penalty from the limited drive capability of ultra small devices and to identify the penalties associated with such architectures.

Phase I: Design a general purpose computing architecture that requires only nearest neighbor and next nearest neighbor connections. Analyze its performance and identify limitations.

Phase II: Demonstrate the performance of architectures that appear promising by fabricating and testing critical portions of the design on large gate arrays.

DARPA 92-069 TITLE: Architectures that Employ Real Time, Reconfigurable Interconnections

CATEGORY: Exploratory Development

OBJECTIVE: Explore architectures that will take advantage of the ability to reconfigure interconnects in real-time.

DESCRIPTION: With holography providing the ability to reconfigure free space optical interconnects in real-time, it becomes important to explore what new capability in signal and data processing can result from this new degree of freedom. This solicitation seeks architectural ideas that promise to provide substantial performance advantage in speed, power and/or component count by utilizing real-time, reconfigurable interconnections.

Phase I: Identify and design architectural building blocks that take advantage of real-time, reconfigurable interconnections.

Phase II: Demonstrate the advantages of the identified architectural building blocks by building a simulation and/or hardware implementation.

DARPA 92-070 TITLE: Circuits that Employ Resonant Tunnel Diodes/Transistors

CATEGORY: Exploratory Development

OBJECTIVE: Explore circuit concepts that take advantage of the unique characteristics of resonant tunnel diodes and/or transistors to improve with or without other integrated circuit (IC) components to attain improved performance.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) has been instrumental in developing the fabrication technology needed to build resonant tunnel diodes and transistors. State of the art devices have shown highly promising characteristics both at room temperature and cryogenic temperatures. A few circuit applications have already been demonstrated. It is the intent of this solicitation to broaden the areas of application for these devices. Only room temperature operation is of interest at this time. Ideas are sought that promise to demonstrate that resonant tunnel diodes and transistors, with or without other components, can significantly decrease the device count and consequently reduce the chip area, reduce circuit power consumption, or enhance the speed of either important analog or digital custom circuits. Ideas that apply to possible utilization of these devices in gate or cell arrays that project to a significant advantage are also of interest.

Phase I: Identify a circuit concept, develop a chip layout and substantiate claimed performance advantages by theoretical calculations, simulations or other commonly accepted means.

Phase II: Fabricate and test the designed circuit.

DARPA 92-071 TITLE: Growth of Bulk II-VI Crystals for Visible Light Emitters

CATEGORY: Exploratory Development

OBJECTIVE: Develop improved techniques for growing II-VI bulk crystals for use in visible light emitting structures.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating visible light emitting structures for use in optical displays, high density recording, and military communications. Better quality substrates are needed for research and development of II-VI semiconductor visible light emitters. Two substrates of great interest are heavily doped p-type zinc telluride (ZnTe) and heavily doped n-type zinc selenide (ZnSe). Advances in the growth of these materials are sought which will yield two-inch or larger diameter boules of dislocation-free semiconductor. Proposed approaches should be capable of growing high quality single crystal material.

Phase I: Identify important process parameters to produce high quality, heavily doped, single crystal, bulk II-VI materials.

Phase II: Implement process for improved growth. Demonstrate improved technique by growing two-inch diameter boules of heavily doped p-type ZnTe and heavily doped n-type ZnSe.

DARPA 92-072 TITLE: High Efficiency Blue Light Emitting Diodes (LEDs)

CATEGORY: Advanced Development

OBJECTIVE: Improve light conversion efficiency of blue LEDs.

DESCRIPTION: Blue emitters are of use in optical recording, display, and communications. At present, only available LEDs in the blue are of low efficiency, approximately .1%. This solicitation is to investigate means of improving light conversion efficiency of the LEDs while maintaining long life time, low power consumption, and small size. A realistic goal would be 1% wall-plug efficiency.

Phase I: Investigate and demonstrate doping and contact technology to achieve higher light emitting efficiency.

Phase II: Fabricate and package high efficiency blue LEDs.

DARPA 92-073 TITLE: Neural Network Techniques for Practical Applications to Time Series Prediction

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate neural network techniques for specific applications involving time series predictions.

DESCRIPTION: Neural networks have demonstrated superior performance relative to classical methods for predicting the future behavior of a pseudo-random time series. There are many practical applications where such forecasting, even if imperfect and short-term, can be of great value. Examples include: adaptively forecasting demand for scarce, high-value resources for dynamic resource allocation; forecasting natural phenomena (weather, ionospheric conditions); and compensating feedback delays in control systems. The Defense Advanced Research Projects Agency (DARPA) is interested in bringing neural network forecasting to fruition for specific, high-value applications, and in identifying additional research needed to broaden and improve the approach. Proposals must address a specific application, must contain a well-defined neural network approach, and must include a plan for practical utilization of the forecasting system developed.

Phase I: Choose a specific application, develop and demonstrate the neural network forecasting system, provide a preliminary comparison with the best competing approaches, and evaluate the practical impact of the system.

Phase II: Perform an in-depth comparison with competing approaches and, if warranted, optimize the design of the neural network forecaster, and develop a plan for installation in a specific system.

DARPA 92-074 TITLE: Neural Network Signal Processing Techniques for Communication Links

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate neural network signal processing techniques for improving the performance of communication links.

DESCRIPTION: Many communication systems require adaptive signal processing for optimal link performance. Examples include data and speech compression, extracting signals from non-Gaussian interference, and correcting non-linear distortions. Neural networks are a general technique for adaptive signal processing. The Defense Advanced Research Projects Agency (DARPA) is interested in developing neural network techniques to improve communication system performance. Proposals must address a specific high-value application, must contain a well-defined neural network approach, and must include a clear rationale for the improvements anticipated from neural network processing.

Phase I: Choose a specific communication link application, develop and demonstrate the neural network signal processing technique, and provide a preliminary comparison with the best competing approaches.

Phase II: Perform an in-depth comparison with competing approaches and, if warranted, optimize the design of the neural network processor, develop and test a brassboard hardware implementation, and develop a plan for implementation on a specific platform.

DARPA 92-075 TITLE: Neural Network Signal Processing Techniques for Radar Applications

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate neural network signal processing techniques for improving the performance of radar systems.

DESCRIPTION: Many radar systems require adaptive signal processing for optimal performance. Examples

include auto-focus compensation for random phase errors, extracting radar signals from clutter, and extracting and tracking designated target types. Neural networks are a general technique for adaptive signal processing. The Defense Advanced Research Projects Agency (DARPA) is interested in developing neural network techniques to improve radar system performance. Proposals must address a specific high-value application, must contain a well-defined neural network approach, and must include a clear rationale for the improvements anticipated from neural network processing.

Phase I: Choose a specific radar enhancement application, develop and demonstrate the neural network signal processing technique, and provide a preliminary comparison with the best competing approaches.

Phase II: Perform an in-depth comparison with competing approaches and, if warranted, optimize the design of the neural network processor, develop and test a brassboard hardware implementation, and develop a plan for implementation on a specific platform.

DARPA 92-076 TITLE: Resists for 193-Nanometer Photolithography

CATEGORY: Exploratory Development

OBJECTIVE: Develop Photoresists for Lithography at the 193-nm Wavelength.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is developing 193-nm projection lithography systems to enable cost-effective fabrication of military application-specific integrated circuits (ASIC) with feature sizes at or below 0.25 microns. These systems require photoresists which exhibit a sensitivity in the range of 2-50 mJ/cm² at the 193-nm wavelength and are capable of producing cleanly defined patterns (e.g., free of residue, bridging, pinholes, or edge roughness). Ideally, these resists must demonstrate feature sizes as small as 0.15 microns, with simple processing sequences which are compatible for low-cost, high yield very large scale integration (VLSI) circuit fabrication. Currently, several surface-imaging silylation resists and bilayer schemes have been identified and initially demonstrated. However, several candidate resists are required to meet process specific manufacturing goals. As examples of the range of sometimes conflicting resists requirements, both positive and negative resists are needed, materials with good dry-etch resistance are essential for some process steps, while a single-layer resist with the lowest processing cost may be desired for other process steps. Having identified candidate resist materials, the development of a manufacturing process capable of producing commercially useful quantities of high-quality resist material is also required. Evaluation of resists should be performed in conjunction with the DARPA 193-nm lithography program; therefore, adequate travel resources should be planned.

Phase I: Provide small quantities of candidate resist materials for evaluation of the 193-nm imaging properties. Demonstrate that the selected resists have the potential to be manufactured in a robust manner and that they have adequate process latitude for semiconductor manufacturing.

Phase II: Scale up production of the most promising material and perform a detailed evaluation of process reproducibility, cost, and yield.

DARPA 92-077 TITLE: Stencil Mask Technology for Ion Beam Lithography

CATEGORY: Advanced Development

OBJECTIVE: Investigate, design and demonstrate novel techniques for the cost-effective fabrication of transmission masks to replicate minimum feature sizes of 100 nm.

DESCRIPTION: The performance parameters of microelectronic circuitry can be significantly improved by further downscaling the device dimensions. Lithography is the pacing step for any advance. Ion beam lithography may be a viable alternative for features around the range of 100 nm. The strategy for the present effort is to explore innovative approaches beyond the channeling of protons through a thin crystalline silicon membrane. Both evolutionary and revolutionary advances in mask technology are needed. Quantitative investigation of all aspects of distortion-prone techniques is required.

Phase I: Address optimization of mask configuration, demonstration and evaluation of pattern replication at the 50 to 100 nm level.

Phase II: Explore the practical implementation of the results achieved in Phase I through the fabrication of circuitry at 100 to 150 nm feature sizes with relevant overlay accuracy.

DARPA 92-078 TITLE: Dictation System for Tactical Environments

CATEGORY: Exploratory Development

OBJECTIVE: Develop hardware and software for dictating reports under field conditions.

DESCRIPTION: Large vocabulary speech-to-text dictation systems suitable for office environments are beginning to appear on the market. Similar systems could be useful in tactical environments, where users might be willing to trade perplexity and vocabulary size for robustness under a wider range of acoustic conditions. Nevertheless, users must be free to create text without artificial grammatical constraints, must be able to use new words, and must be able to operate without keyboards. In addition, users should not have to go through lengthy enrollment procedures to train the system to their voices.

Phase I: Develop a prototype system and evaluate its performance under varied acoustic conditions.

Phase II: Improve the system and demonstrate its effectiveness in realistic tests.

DARPA 92-079 TITLE: Discourse Analysis for Text Understanding

CATEGORY: Research

OBJECTIVE: Develop effective techniques for understanding free text discourse.

DESCRIPTION: Researchers are making good progress in developing automated text understanding capabilities, but discourse analysis remains problematic, especially in texts that encompass multiple topics or events. Novel, generic approaches are sought for addressing this key problem.

Phase I: Develop a preliminary version of proposed techniques. Perform a limited proof-of-concept.

Phase II: Extend and enhance the techniques. Put them into shareable software. Evaluate their performance in a data extraction system operating on a variety of texts.

DARPA 92 080 TITLE: Military Applications of Speech Recognition

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate effective military applications for speech recognition.

DESCRIPTION: Speech recognizers, continually improving and already being used to good effect in the commercial world, could play important roles in a variety of military applications. The challenge here is to find suitable, high-payoff applications and then to demonstrate operational effectiveness in some of them. In order to maximize the chances for success, only the most robust recognition technology should be considered, and serious attention must be paid to human factors issues.

Phase I: Identify several high-payoff military applications for speech recognition, analyze them carefully, and determine which available recognizers will best meet those needs. Develop detailed plans for developing and testing each of those applications.

Phase II: Develop one or more of those applications (as determined by the Defense Advanced Research Programs Agency [DARPA]) and demonstrate effectiveness with military users.

DARPA 92-081 TITLE: Networked Micro-Computer System for Information Retrieval from Large Text Databases

CATEGORY: Exploratory Development

OBJECTIVE: Explore and evaluate the concept of achieving information retrieval from one or more large-scale, unstructured, text databases by distributing the database(s) among a network of micro-computers and servicing retrieval requests from client workstations which are also on the network.

DESCRIPTION: One concept for achieving information retrieval from large, unstructured collections of text is to divide the text among a network of microprocessors having individual storage, and to access the data in a distributed manner from client workstations. Evaluation of this concept requires the development of an appropriate network architecture, interface modules and communication protocols. (Any number of existing, efficient, state of the art retrieval algorithms may be used at each microprocessor.) A prototype will be necessary to test this concept and to evaluate the performance of the architecture and the system.

Phase I: Provide a detailed specification of the proposed system, including its architecture, computational modules, interface modules, and protocols for communication among the distributed parts of the retrieval system and the client workstations. Prescribe an experimental paradigm for evaluating the efficacy of

this concept vis-a-vis other implementations of large-scale text retrieval.

Phase II: Implement a prototype of the system and conduct the evaluation, as specified and prescribed in Phase I. Report on details of implementation not covered in the Phase I descriptions and analyze the performance. A copy of the code is to be included in the report. A magnetic-media copy of the code is to be delivered in ASCII form, in the UNIX tar (tape archiver command) format.

DARPA 92-082 TITLE: Robust Speech Parameterization for Channel Independence and Noise/Interference Immunity

CATEGORY: Basic Research

OBJECTIVE: Explore novel ways to parameterize a speech signal so as to provide measurements which maximize speech-recognition and/or talker-identification scores while minimizing the effects of the channel over which the talker is speaking and the effects of noise and interference.

DESCRIPTION: Concepts are sought for novel signal-processing techniques and new approaches to computing distances in speech-parameter space which isolate the information-bearing elements of the speech signal from noise and interference and which are insensitive to the filtering characteristics of, and to mild distortions caused by, the channel.

Phase I: Provide a conceptual, mathematical, and algorithmic description of the proposed techniques and a discussion of their novelty and advantages over current ones. Design a plan for evaluating the techniques and provide a detailed specification of a system for demonstrating the techniques and for performing the evaluation.

Phase II: Implement the new techniques and the design and evaluation system, and perform the proposed evaluation. Report on details of implementation not covered in the Phase I descriptions, and analyze the performance, particularly the source of errors. A copy of the code is to be included in the report. A magnetic-media copy of the code is to be delivered in ASCII form, in the UNIX tar (tape archiving command) format.

DARPA 92-083 TITLE: Voice Authentication Monitoring System

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel techniques for monitoring and making decisions about a speech signal to ascertain that the talker is the person he claims to be and that he has not, during the course of the conversation, been replaced by an impostor.

DESCRIPTION: Concepts are sought for novel signal-processing and decision-making techniques for parameterizing a speaker's voice, computing the change in those parameters both during a conversation and from a baseline set of parameters for the claimed talker, and making a decision as to whether to terminate the conversation or allow it to continue. The techniques must accommodate normal voice changes over time and during a conversation, while being able to recognize that an impostor has either initiated or "hijacked" the conversation. The decision procedure must be sensitive to speaker change, yet not prematurely terminate valid conversations, as a consequence of repeated testing. It is anticipated that both the selection of an appropriate technique from competing ones, and the determination of operating parameters for a technique, will require empirical evaluation. Therefore, this exploratory development will include the design and implementation of a suitable system for the comparative evaluation of different signal-processing and decision-making techniques, and the design of a paradigm for making such an evaluation.

Phase I: Provide a conceptual, mathematical and algorithmic description of the proposed techniques and a discussion of their novelty and advantages over current ones. Identify and explain the operational parameters for each technique. Provide a detailed specification of a system for demonstrating and evaluating the techniques.

Phase II: Implement the system and the techniques and perform tests for setting parameters and evaluating performance. Report on details of implementation not covered in the Phase I descriptions, and analyze the performance, particularly the source of errors. A copy of the code is to be included in the report. A magnetic-media copy of the code is to be delivered in ASCII form, in the UNIX tar (Tape archiver command) format.

DARPA 92-084 TITLE: Large-Scale Surface Velocity/Pressure Measurement Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Develop a capability at large-scale (preferably full-scale) for measuring high frequency, unsteady surface pressures and velocities over large areas of the hull, appendages, control surfaces, and propulsor components.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating innovative methods for measuring full-scale surface pressures and velocities to provide data for computational fluid dynamics (CFD) code and maneuvering prediction code validation. Conventional methods for measuring surface pressures have been based on laboratory techniques that depended on discrete points such as pressure taps and pitot tubes. New materials now make it possible to make integrated surface measurements over large areas. DARPA considers that developments in signal multiplexing and miniaturization of area sensors should minimize the installation, power, and data processing roadblocks which would be expected of conventional techniques for large-scale implementation.

Phase I: Demonstrate area measurement capability at laboratory scale for proof-of-concept.

Phase II: Demonstrate salability and provide prototype system for application.

DARPA 92-085 TITLE: Analytical/Numerical Modeling of Target Strength in the Intermediate Frequency Range

CATEGORY: Advanced Development

OBJECTIVE: Develop an analytical/numerical model for calculating target strength in the intermediate frequency range.

DESCRIPTION: Analytical/numerical techniques for modeling target strength (TS) in the intermediate frequency range are currently being developed. One approach is to expand the frequency range over which existing TS models apply. Further research, engineering, and analysis needs to be completed in order to determine the extent to which these current TS models can be used.

Phase I: Identify which TS models can be used in the intermediate frequency range, and the frequency band over which each TS model will provide reasonable results.

Phase II: Demonstrate each model over its expanded frequency range and compare the results with experimental or analytical data.

DARPA 92-086 TITLE: Post Processing Visualization of Acoustic Data

CATEGORY: Advanced Development

OBJECTIVE: Develop graphics tools to efficiently correlate and interpret experimental radiation and scattering data.

DESCRIPTION: The Defence Advanced Research Projects Agency (DARPA) is investigating innovative graphics tools for use in a Data Simulation/Visualization (S/V) system for interpreting underwater acoustical data. The data input to the S/V system may be generated either experimentally or analytically. The S/V system will be capable of reconstructing wet surface motions and near-field pressures from either wet surface computed velocities and pressures or measured pressures defined on a near-field enveloping surface.

Phase I: Develop efficient procedures for the display of computed near-field fluid pressure.

Phase II: Demonstrate the capabilities of the graphics tool developed on representative benchmark problems results.

DARPA 92-087 TITLE: Remote Silent Actuation System

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques for producing lift by deflecting control surfaces, fins, appendages, tabs, hinge lines, hydroelastically tailoring the surfaces, or altering the flow using MHD, etc.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating innovative technologies for compact, remote, and quiet actuation techniques for application to marine control surfaces, particularly for submarines. Current submarine control surfaces are deflected primarily by internally mounted hydraulic cylinders. These cylinders are large castings/forgings welded into the pressure hull, typically located

in the end closures. This type of configuration has a significant weight, volume, and cost impact on both ship design and construction. DARPA-developed concepts for innovative methods of vertical plane control, vorticity management, boundary layer flow control, propulsor inflow and intrapropulsor flows require multiple external control force producers remote from convenient internal pressure hull locations. To effectively utilize these concepts, one must consider methods which will minimize current attachment structure, provide for compact external powering systems (single line electrical or external hydraulics, for example), and maximize force production efficiencies (cambered surfaces) while providing for low-level acoustic radiation.

Phase I: Develop physical models that will provide proof-of-concept.

Phase II: Develop configuration (Man-Tech) for salability to full-scale application.

DARPA 92-088 TITLE: Underwater Imaging for Small Object Locating and Identification

CATEGORY: Exploratory Development

OBJECTIVE: Develop a conceptual design for an underwater imaging system for use in search, investigation, and exploitation of underwater objects.

DESCRIPTION: The ability to search and inspect large subsurface areas using underwater imaging is desirable for identification and information-gathering support. Current systems are low resolution, have limited viewing coverage area, or are not real-time capable. The Defense Advanced Research Projects Agency (DARPA) is interested in an underwater imaging system utilizing an illumination system with the ability to reduce backscatter light and non-uniform illumination. As envisioned, the system should incorporate image processing functions to deliver high quality video representation, correct image distortion caused by platform motion, and perform image enhancement. Proposed systems should represent truly innovative concepts, and offer the potential for significant improvement in capability.

Phase I: Define system requirements, capabilities, and top-level designs.

Phase II: Construct and test a proof-of-concept demonstrator.

DARPA 92-089 TITLE: Neural Network Technology in Composite Fabrication

CATEGORY: Advanced Development

OBJECTIVE: Use neural network technology to improve fabrication of thick polymer matrix composites.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is developing advanced techniques for the cost-effective, high rate fabrication of high quality, thick composite materials. This program is pushing the state of the art in manufacturing, quality control, and non-destructive evaluation. Neural networks would meet the requirement of advanced monitoring and control systems. The use of neural networks in fabrication would enable the fabrication system to produce quality thick composite products through an optimal process that can be learned, real-time, by the system. Neural networks would effectively reduce the amount of time required to develop optimum fabrication processes.

Phase I: Develop system architecture and algorithms required for monitor, control, and evaluation of composite material fabrication.

Phase II: Demonstrate neural network capability in subscale composite structure.

DARPA 92-090 TITLE: Air Driven Power Module

CATEGORY: Exploratory Development

OBJECTIVE: Build and demonstrate a 8.4 Watt and 56 Watt Air Driven Turbo-Alternator.

DESCRIPTION: A critical need exists for a small power module to supply 28 volts DC power. Batteries are used at the present time for this application because connecting power lines are prohibited. Bringing power wires into these sensitive areas would defeat the high voltage insulation, provide a path for lightning strikes, and allow the entry of undesired radio frequency radiation. An insulated air hose is permissible, and could supply air power to a small turbine driving a generator or alternator. One application requires a unit no larger than 2 inches in diameter by 2 inches in length that can supply 300 milliamperes (8.4 watts). Another application requires 28 volts DC @ 2.0 amps (56 watts). This unit can be 2.5 inches in diameter and 3 inches in length. The output of each unit must be regulated at 28.0 +/- 0.1 volts. They should be efficient to minimize the air flow required.

Phase I: Provide a suitable design meeting the above requirements and deliver a working prototype together with test data.

Phase II: Improve the prototype designs to increase the efficiency and reduce production costs. Deliver 10 units of each type machine.

DARPA 92-091 TITLE: Automated Testing of Infrared Focal Plane Arrays

CATEGORY: Advanced Development

OBJECTIVE: Enable the Government to become a smart buyer of the technology of Infrared Focal Plane Arrays (IRFPAs) by enhancing in-house capabilities in diagnostic and prognostics for this technology.

DESCRIPTION: With the emergence of second generation Focal Plane Array (FPA) technology, high density staring arrays will soon be approaching a half million pixel elements per array. Automation must therefore be an essential element of the prognostic and diagnostic equipment developed under this program. The equipment should be capable of handling the several staring sensor array configurations in the DARPA IRFPA Initiative, and at the same time provide the potential for growth to arrays with larger numbers of elements. For the immediate future, array technology will be based on mercury cadmium telluride, indium antimonide, and platinum silicide.

Phase I: Perform design tradeoff study that takes into account the FPA operability parameters desired, the industry standards for conducting tests, speed of operations and throughput of the instrumentation, the human operator interface, and cost. Two or more designs may be offered at the conclusion of the Phase I effort.

Phase II: Develop and deliver to the government both the hardware and software for the design option selected from Phase I.

DARPA 92-092 TITLE: Common Intelligent Tutoring System Architecture for Application to a Family of Weapon Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop an Intelligent Tutoring System (ITS) architecture that is flexible, modular structured, and can be efficiently used in a family of tactical weapon systems embedded training operations.

DESCRIPTION: Functional operation of an ITS includes: presenting a knowledge and/or skill task to the student; comparing action of the student with a knowledge-based expert solution; analyzing the difference in student/expert response; generating a corrective knowledge/skill task; selecting an appropriate tutoring strategy for the particular student; tutoring the student with the new task; and comparing student/expert action. This process is continuous until the student's deficiencies in knowledge and skills are corrected or the student achieves a predetermined level of proficiency. ITS operation used in the context of embedded training in tactical weapon systems can enhance weapon system performance by maintaining critical skill at the highest proficiency levels.

Phase I: Select an example family of weapon systems (e.g., air defense systems) and evaluate a basic subset of system operation that could be enhanced with embedded operator training. Conduct an analysis on the subset of weapon systems with operator critical skill requirements for operating in a battlefield environment. Design, develop and implement a preliminary functional prototype of the ITS architecture.

Phase II: Develop, implement and demonstrate, with appropriate simulations, and deliver to the government, the implemented modular ITS architecture. The ITS operation will support the candidate subset of weapons embedded training operations.

DARPA 92-093 TITLE: Composite Material Wet-Braiding Fabrication Technology Development

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate rocket motor component fabrication utilizing wet-braiding methods and braided component response to Insensitive Munitions (IM) requirements.

DESCRIPTION: Composite materials have the potential to meet or exceed the requirements associated with the IM policies, such as bullet, fragment and shape charge jet impacts and fast/slow cook-off thermal environments as defined in MIL STD 2105A. To date, most work in composite materials fabrication has been in the area of filament-winding. This project would examine composite material fabrication by wet-braiding. Proposed concepts should be applicable for use with a 144 carrier Wardwell braiding machine. Specific areas of interest

include: hybrid materials; end closures (i.e., forward domes, overbraided nozzles); design prediction, analysis and verification; and machine/computer interface with sufficient accuracy to braid design.

Phase I: Develop braid machine/computer interface and design software concepts.

Phase II: Fabricate and test a proof-of-principle tactical rocket motor case.

DARPA 92-094 TITLE: Development of a Compact, Minimum Noise, Auxiliary Power Unit (APU) for Lightweight Vehicles

CATEGORY: Advanced Development

OBJECTIVE: Advance the development of a compact, 3-Phase APU for lightweight vehicles.

DESCRIPTION: Army concepts currently under development utilize sub-systems with 3-Phase AC power requirements greater than 30 kilowatts. Currently, such devices are not available in industry to meet these criteria and fit into lightweight vehicles such as the Highly Mobile Multi-Wheeled Vehicle (HMMWV). This development addresses the efforts to lighten the force while allowing the introduction of emerging technology systems. A typical example of such an APU would be a 20"w x 18"h x 42"l package operating at 400Hz, producing 30Kw of 3-Phase AC power.

Phase I: Show through preliminary designs how powers of up to 60Kw could be delivered in minimal package sizes. Select an approach to proposed hardware and provide realistic final designs for a 30Kw unit suitable for assembly in a Phase II effort. Provide a demonstration brassboard of a 30 Kw unit for evaluation.

Phase II: Fabricate and deliver one 30Kw unit and one 60Kw unit fully optimized to integrate into the HMMWV.

DARPA 92-095 TITLE: Earth Penetrating Radar

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate the capability of detecting buried assets such as tanks, mobile missile launchers, Armored Personnel Carriers (APCs), mines, etc.

DESCRIPTION: Show the feasibility of using low frequency radar to detect the presence of tanks, artillery pieces, and APCs under various depths and types of soils. Also, investigate the feasibility of detecting underground bunkers, tunnels, and the possibility of detection and differentiation of decoys from real targets.

Phase I: Design trade-off studies that will select the optimum method to solve the problem within the unique parameters and constraints presented by this effort.

Phase II: Construct a system that can be tested and evaluated under actual field conditions against buried assets.

DARPA 92-096 TITLE: Feature-Based Design Methods for Predictive Design Paradigms

CATEGORY: Exploratory Development

OBJECTIVE: Investigate, develop and demonstrate innovative techniques which utilize feature-based design methodologies in a conceptual design process which is predictive of producibility and manufacturability considerations.

DESCRIPTION: Emerging technologies in Artificial Intelligence/expert systems have shown great promise as tools for evaluation of conceptual designs for producibility and manufacturability considerations. However, conventional Computer Aided Design (CAD) technologies have not demonstrated the capability to adequately capture and manage the design intent knowledge necessary to allow for prediction of subsequent producibility considerations. Feature-based design theory and preliminary efforts have shown the potential for providing a fundamental model for predictive designs.

Phase I: Identify and demonstrate innovative feature-based design methodologies which capture and manage design intent knowledge as a fundamental predictive design model.

Phase II: Develop a feature-based design system which captures and manages the predictive design as a knowledge base suitable for manipulation by a producibility expert system.

DARPA 92-097 TITLE: High Power Laser Pumping of Solid State Lasers

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate and develop efficient, compact, tuneable, high power, solid state laser devices operating in the Infrared (IR) and blue/green spectral regions.

DESCRIPTION: Many interesting laser applications involving remote locations of the laser systems (high altitude aircraft, satellites, submarines), atmospheric transmission, and/or narrow band width, tuneable laser beams would be made feasible or significantly enhanced if compact, lightweight, tuneable and single frequency, solid state lasers at much higher average power levels than now available could be developed. The demonstration of the feasibility of solid state laser systems with average power levels of greater than 100 watts is the goal of this program. One approach to this goal is the use of short wavelength chemical lasers (SWCLs). SWCLs of the type now being developed will: (1) operate in the 450 to 550 nm spectral range; (2) not require an electrical power supply system; (3) have a relatively high chemical efficiency (low gas storage requirement); and (4) be compact and light weight. In addition, SWCLs will operate at power levels up to several kilowatts, so that solid state components and not the pump lasers will limit the high power potential of such systems.

Phase I: Conduct a study of the demonstration and development of new SWCL concepts with performance characteristics attractive for use as pump lasers in high power, tuneable, solid state laser systems and on the synthesis and evaluation of solid state laser systems that incorporate demonstrated SWCLs as the pump lasers.

Phase II: Conduct an experimental program to determine the feasibility and optimized performance characteristics of one or more new SWCL concepts at the power level needed in advanced solid state laser systems. One or more breadboard laser devices using existing SWCL pumps will be experimentally evaluated in view of requirements of key applications.

DARPA 92-098 TITLE: High Speed Electrodes for High Density Optical Guided Wave Devices

CATEGORY: Advanced Development

OBJECTIVE: Develop high speed electrode structures suitable for Electro-optical (EO) devices on guided wave substrates with high packing density and minimum degradation to device performance.

DESCRIPTION: High speed linear guided wave Electro-optical (EO) devices have been demonstrated using traveling wave electrode structures operating in the 10-25 GHz range using EO materials such as LiNbO₃. However, these devices generally consist of one or only a small number of devices on a substrate. In order to increase the packing density, issues such as electrical and optical isolation as well as interconnects must be considered. This may include the development of new optical structures in support of improved device electrodes.

Phase I: Design and develop optical and electrode structures for multiple element devices which optimize performance and isolation at frequencies in the range of 1-30 GHz. Determine performance limitations and trade-offs. Perform a device demonstration for design verification.

Phase II: Develop and demonstrate high density device designs for specialized EO components. Optimize designs for performance trade-offs and comparisons.

DARPA 92-099 TITLE: High Speed Image Capture for Fiber Optics Payout Applications

CATEGORY: Basic Research

OBJECTIVE: Expand video and photographic data collection capabilities in order to gain an understanding of payout dynamics and validate payout dynamics models. It is necessary to determine adhesive rupture characteristics under high strain rates, fiber peel point, takeoff angle geometries, and helix geometry.

DESCRIPTION: In order to reduce costs and improve reliability of fiber optics payout through modeling, it is necessary to determine the values for the input parameters of the models. It has been observed that fiber shape at the peel point varies from the predicted steady state shape. One possible cause may be that the adhesive rupture force under high strain rates differs greatly from the slow pull rate force. The roles played by friction and electrostatic buildup in high speed payout are also unclear. The effects of varying aerodynamic conditions on the helix geometry and the subsequent effects on the peel point area are undetermined. Therefore, it is necessary to collect data which will lead to an understanding of the conditions prevailing in high speed payout.

Phase I: Determine the most feasible method for obtaining adhesive rupture characterization data and

fiber geometry data during high speed payout. Specifically, determine the feasibility, limitations, and hardware availability for visual data collection systems, including systems which could be developed using government-furnished equipment.

Phase II: Develop and Test camera systems found to be most feasible for collecting data that could lead to the determination of adhesive break patterns and fiber geometry during high speed payout. Also, develop a video system to collect fiber peel point data simultaneously in two planes and provide for data reduction and correlation techniques (and limitations) for the collected data.

DARPA 92-100 TITLE: Identification Friend or Foe (IFF) System for Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate a system for providing identification of friendly ground forces to aircraft and other ground forces.

DESCRIPTION: High performance aircraft attacking enemy ground vehicles lack the means of insuring the vehicles are not friendly. The result is that friendly forces are occasionally damaged or destroyed. A system providing positive identification of friendly forces to the pilot must be extremely reliable. A vehicle with a failed IFF would be presumed enemy and would be attacked. It must be nearly impossible for the enemy to counterfeit the IFF device or use captured devices for more than 24 hours to protect themselves from attacking aircraft. The system must operate in all weather conditions that permit attack of vehicles. The IFF device must be passive (emits no signals) until interrogated by a proper code from the attack vehicle. The system must be completely automatic and require no crew action other than possibly entering a new code. Finally, the IFF system must be safeguarded to keep the enemy from teasing the IFF into revealing the code by covertly interrogating the IFF device with all possible interrogation codes.

Phase I: Make a study for an IFF system meeting the stated requirements. Describe operating details and make performance analysis. Provide sufficient field tests to assure that the signal-to-noise for the system proposed will be adequate.

Phase II: Develop and deliver two working IFF systems. Each system must consist of the interrogating and the responding units. Include with each system, operating instructions, schematics, parts lists, and troubleshooting guides.

DARPA 92-101 TITLE: Infrared Signal Combining Techniques for Multi-Color Projector Applications

CATEGORY: Exploratory Development

OBJECTIVE: Design and fabricate a prototype Infrared (IR) signal combiner which utilizes existing or readily available optical components and significantly reduces signal losses for integration with an IR projector for Hardware-in-the-Loop (HWIL) simulations.

DESCRIPTION: Several weapon systems are currently under development throughout all branches of DoD which utilize multiple IR wavebands for target detection and intercept. Conventional beam combiner techniques result in large losses in the two projected IR signals. In addition to difficulties in generating the IR signals, these performance limitations have forced the exclusion of the IR detectors from the HWIL simulations which are necessary to adequately assess weapon system performance. Therefore, innovative IR beam combining techniques are needed to overcome these limitations.

Phase I: Provide conceptual design and laboratory demonstration of a novel IR signal combiner which utilizes available optical components and materials.

Phase II: Provide an extension and upgrade of the laboratory demonstration IR signal combiner system for use with an IR projector in HWIL simulations of multi-color IR missile systems.

DARPA 92-102 TITLE: Innovative Detection and Tracking Techniques for Missile Seekers Engaging Low Flying and Hovering Aircraft in Clutter

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate multi-mode sensors for detecting and tracking low flying targets in clutter.

DESCRIPTION: The application of this technology is for lock-on after launch missiles such as the CORPS-SAM concept which would utilize a remotely launched inertially guided missile with periodic up-links for

guidance corrections and with an autonomous acquisition capability for terminal flight. Approaches to this problem could be to use innovative combinations of sensors and signal processing techniques to enhance detection of low flying targets in clutter. The main challenge is to produce techniques which would allow detection of reduced signature cruise missiles and hovering helicopters and track these vehicles well enough for terminal homing.

Phase I: In this sensor fusion effort, define and analyze candidate concepts for fusing of raw sensor data for detection of targets in clutter and for enhanced tracking.

Phase II: Selected sensor fusion candidates should be tested first using a tower test in which low flying targets are detected using candidate sensors such as active Millimeter Wave (MMW) and passive Infrared (IR), whose raw data is combined for this purpose. Ultimately, a captive flight test would be performed in which low flying targets are detected using a raw data fusion technique and enhanced tracking is also demonstrated.

DARPA 92-103 TITLE: Innovative Utilization of Interferometric Technology to Demonstrate Precision Transfer Alignment

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate the ability to transfer the alignment from a master navigator to an Inertial Measurement Unit (IMU) with the Root Sum Squared (RSS) of the orientation angle errors to be under 0.5 milliradian using available interferometric technology.

DESCRIPTION: A major consideration in the determination of overall missile system performance is the ability to rapidly and accurately transfer the position and orientation information of a master navigator to on-board IMUs. This project seeks to explore and exploit currently existing technology in the communications industry, such as integrated optics, fiber optic cabling, and the interferometric effect for this application. Proposed concepts should be capable of providing a significant payoff in cost and manufacturability with minimal impact on system computational demands.

Phase I: Develop system concepts, build a simplified laboratory proof-of-principle model, and demonstrate performance. Identify performance parameters such as effectiveness, scale factor, accuracy, and noise, along with any noted limitations.

Phase II: Modify the system concept to accommodate lessons learned, implement the concept in a field environment, and evaluate performance parameters and determine advantages/disadvantages of the concept with production cost estimates.

DARPA 92-104 TITLE: Integration of Expert System for Process Planning and Feature-Based Designs

CATEGORY: Exploratory Development

OBJECTIVE: Investigate, develop and demonstrate innovative Artificial Intelligence/expert system techniques which integrate feature-based designs and process planning considerations.

DESCRIPTION: Artificial Intelligence/expert system techniques have demonstrated the ability to address complex reasoning tasks required for process planning. Feature-based design theory and preliminary efforts have shown the potential of providing a fundamental model for capture and manipulation of design knowledge. However, the two technologies have not been sufficiently integrated to allow design features to automatically influence process planning considerations.

Phase I: Identify and demonstrate innovative Artificial Intelligence/expert system techniques which integrate feature-based design and process planning technologies.

Phase II: Based upon Phase I results, provide fundamental model integrating feature-based and process planning considerations into a user friendly tool for capture and manipulation of design knowledge.

DARPA 92-105 TITLE: Millimeter Wave (MMW) Combat Identification Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost MMW combat identification devices for application to ground vehicles.

DESCRIPTION: Recent events have demonstrated the need for combat identification devices for ground vehicles. MMW operation offers the advantage of battlefield obscurant penetration, operation in adverse weather environments, small package size, and low cost potential. Innovative ideas are sought for the design of

millimeter wave cooperative Identification Friend or Foe (IFF) devices. These devices should provide omnidirectional coverage for the ground vehicle and should be able to operate to beyond six kilometers in range. Proposals should contain detailed descriptions of the design of the device as well as a description of the interrogator required for the device to operate. Emphasis will be placed on designs that offer low cost potential.

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

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

DARPA 92-106 TITLE: Millimeter Wave (MMW) Device Models and Computer-Aided Design (CAD) Techniques for Smart Weapons

CATEGORY: Exploratory Development

OBJECTIVE: Predictive models for MMW devices between 35 and 95 GHz are needed that can relate device performance to the manufacturing process parameters. The final objective is to couple these models with existing CAD software packages and work stations.

DESCRIPTION: The higher frequencies of the millimeter region are needed for smart weapons applications to provide narrow tracking beams consistent with the smaller diameters of missiles. Unfortunately, the technology from 35 to 95 GHz is much less mature than the spectral region below 35 GHz, and requires additional investments in research. Although the accuracy of such models is dependent upon the specific circuits, it is reasonable to say that linear models between 1 and 20 GHz are reasonably accurate and mature. The purpose of this work is to achieve a higher level of accuracy and maturity for the millimeter region.

Phase I: Device or circuit configurations relevant for smart weapons application will be selected and models will be developed that predict the device and circuit performance in terms of the manufacturing process parameters.

Phase II: A software program will be written that can be integrated with existing CAD software and work stations.

DARPA 92-107 TITLE: Millimeter Wave (MMW) Sensor Design for Hypersonic Missile Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a terminal homing MMW sensor design for hypersonic missile applications.

DESCRIPTION: Hypersonic missiles are being developed for close combat operation. While these missiles are currently envisioned to be command guided, it is felt that the use of an on-board terminal homing strapdown sensor will improve the accuracy performance of the missile. Innovative ideas are sought for the design of such a sensor. The hypersonic missile will be used against both air and ground targets. The desired sensor outputs include range, range rate, and line of sight rate of the target of interest. The missile diameter will limit the sensor antenna aperture to no greater than two inches. It is desirable that the frequency band of operation for the sensor be W-band. Special consideration should be given to mitigating the effects of multipath and clutter to the performance of the sensor, since the missile will be traveling fairly close to ground level when used against ground targets. Consideration should be given to the environment the hypersonic missile will pose to the sensor. Active or semi-active sensor ideas are acceptable and the proposal must include a detailed description of the possible error sources for the sensor and rationale to support any assumptions made in the development of the design. If a semi-active sensor design is proposed, then the proposal must also contain a description of the illuminator required for operation of the sensor. Special emphasis will be given to designs which offer low cost potential.

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

Phase II: Develop test hardware and perform laboratory demonstrations, field tests, and hardware-in-the-loop tests to verify the technical approach.

DARPA 92-108 TITLE: Millimeter Wave (MMW) Infrared (IR) Synthetic Scene Generation Using Fractals

CATEGORY: Exploratory Development

OBJECTIVE: Development of synthetic MMW and IR scenes using fractals which can be used in Digital and Hardware-in-the-Loop (HWIL) simulations.

DESCRIPTION: Synthetic scene generation of natural backgrounds is used extensively in the evaluation of

MMW and IR weapon systems. The ability of the engineer to accurately predict weapon system performance in the absence of real-world tests is dependent to a large extent on the accuracy and realism of the model being used. The science of fractals is a relatively new area of mathematics which appears to offer tremendous potential in the synthesis of realistic scenes of the real world. The objective of this task is to use fractals to generate a realistic MMW/ Synthetic Aperture Radar (SAR) scene using real SAR images taken at 35 GHz with a Defense Advanced Research Projects Agency (DARPA) MMW radar developed under the auspices of Massachusetts Institute of Technology (MIT)/Lincoln Labs (LL). Because of the high polarimetric quality of the SAR images (1 foot by 1 foot), it will be possible to compare the fractal generated SAR scene with the real scene and determine with a high degree of certainty the ability of the fractal SAR image to simulate the real image.

Phase I: Choose several techniques which appear most promising, and generate synthetic polarimetric 35 GHz SAR images.

Phase II: Compare generated scenes with actual SAR scenes from the MIT/LL database and determine the degree of correlation between synthetic and real scenes. Degree of correlation will be determined by investigating the polarimetric, statistical, and other parameters of the two scenes. In addition, various target detection, false-target rejection algorithms using polarimetric data will be run to compare performance between the synthetic and real scenes.

DARPA 92-109 TITLE: Multiple Beamwidth Millimeter Wave (MMW) Antenna for Direct Fire Missile Guidance Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a multiple beamwidth antenna for use in millimeter command guided direct fire missile applications.

DESCRIPTION: Innovative ideas are sought for the design of an antenna for a MMW command guidance radar application which would have a variable beamwidth capability. Variable beamwidths would allow early missile capture and precision track of the missile after capture. The missile will possess a transceiver capable of receiving a MMW command guidance signal and the transceiver will also radiate a beacon from the missile to augment the missile's tracking signature. The missile will be roll stabilized and travel at hypersonic velocity; therefore, the switching between the beamwidths has to be done very quickly in order to avoid losing the missile. A variable beamwidth antenna would also offer the capability to differentially track a fast crossing target and the missile throughout the flight of the missile. The antenna must operate in the W-band frequency band, and must have monopulse capability as well as a 1% frequency bandwidth.

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

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

DARPA 92-110 TITLE: Optical Fiber Development for Military Applications

CATEGORY: Exploratory Development

OBJECTIVE: Optical fiber is required for military applications meeting specific performance and environmental requirements. The advancement in technology will result in the development of a lower cost fiber suitable for Army, Navy and Air Force programs.

DESCRIPTION: Currently available optical fibers meet only a few of the requirements for military applications. The limitations of the technology result in decreased success of demonstration programs and higher cost. A military optical fiber development program should address the following requirements: low intrinsic loss/loss uniformity, bend insensitivity, minimal dispersion, reduction of buffer coating imperfections, decrease of buffer thickness, minimal buffer coating Coefficient of Thermal Expansion (CTE), high proof strength, high strength splicing/recoating, operation over military temperatures, static fatigue resistance, aging degradation resistance, radiation resistance/fast recovery, adhesive application, and compatibility with existing sources, detectors, and connectors.

Phase I: The first objective for the proposed task is the development of a detailed specification for an optical fiber meeting military requirements. Trade-off studies shall be performed to investigate the effects of optimizing one parameter over another. Preliminary material and processing studies shall be performed to determine the feasibility of producing an optical fiber meeting the specification.

Phase II: The second phase task is to develop the optical fiber in accordance with the established requirement. The performance characteristics of the fiber shall be evaluated to provide verification that

specifications were met. Approximately 100 km of the optical fiber shall be delivered to the Government for further testing and evaluation.

DARPA 92-111 TITLE: Optimal Decision Fusion in Passive Multisensor Target Acquisition

CATEGORY: Exploratory Development

OBJECTIVE: Optimization of sensor fusion processes both at the basic signal processing level and at the decision making level in order to provide improved system reaction time. Attention to the most appropriate target in the minimum time line is critical for fire control platforms. In the multitarget scenario, global sensing to direct local imaging sensors in the most optimal way for either fire control applications or surveillance will provide for maximum system effectiveness and survivability.

DESCRIPTION: A human operator currently acts on the target acquisition information presented to him on an integrated high resolution graphics screen. The targets on this graphics screen have been detected, recognized, or identified based upon lower level data and feature fusion processes. The optimal decision fusion processes to be developed under this effort may make use of any of the target information generated at any of these levels. There are two selectable modes where the operator can be in manual or automatic mode. Manual mode allows the operator to select which target on the graphically generated "World view" screen to cue the Electro-optic (EO) platform. The automatic mode is currently based upon a heuristic process where target priorities are set and then processing proceeds by cueing each target in sequence to the operator. The newly designed decision process shall be capable of providing information to the operator under changing dynamic situations and optimally control the imaging EO sensors cueing position for overall target acquisition efficiency.

Phase I: During this phase an optimal decision fusion methodology shall be developed which is capable of being implemented on a government testbed located at the U.S. Army Missile Command's Sensor Signal Processing Facility (SSPS) at Redstone Arsenal, Alabama.

Phase II: The current heuristic decision fusion implementation which is operating on the SSPS shall be replaced using the contractor developed optimal decision fusion implementation and tests shall be conducted to validate the performance improvement over benchmark and test data sets. Several data sets representing different missile fire control platform, surveillance, and target acquisition platform scenarios shall be used by the contractor and government personnel to exercise the contractor implemented optimal decision fusion processes.

DARPA 92-112 TITLE: Parallel Infrared (IR) Magneto Optical Mapper for Semiconductor Material

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate simultaneous measurement of IR detector material properties over a wafer or film area using Faraday rotation.

DESCRIPTION: Faraday rotation has been demonstrated as a noncontact testing technique for characterizing the electronic properties of semiconductor materials to improve the yields of IR detectors. It is a replacement for the Hall technique which requires contacts on the sample and is incapable of high resolution. Present Faraday rotation mapping technology requires serial sampling of the material area. It is desirable to make Faraday rotation measurements simultaneously over the wafer to rapidly screen material to be used in detector design.

Phase I: Identify approaches for parallel measurement of Faraday rotation in infrared detector material and develop a magneto-optical mapper design. Perform laboratory demonstrations to prove the feasibility of the design.

Phase II: Construct and test a proof-of-principle demonstrator.

DARPA 92-113 TITLE: Perspective Scene Generator/Simulator for Advanced Correlator Analysis

CATEGORY: Exploratory Development

OBJECTIVE: A National Television Standards Committee (NTSC) video-based scene generator is required to analyze the performance of advanced optical correlators for airframe guidance demonstrations.

DESCRIPTION: An NTSC video-based scene generator is required to analyze the performance of advanced optical correlators for airframe guidance demonstrations. The simulator must be capable of interfacing photographs of terrain maps or NTSC video inputs of scenes into a video format. These input photographs will be used to develop a database to simulate flights representative of a helicopter flying over a test region and

releasing a visible seeker over the top of a stationary ground target. The input imagery should include stationary military ground targets such as tanks and Armored Personnel Carriers (APC) located on background terrain representative of the foliage of Redstone Arsenal. The imagery database should be used to develop simulated missile flights over the region. These flights will simulate a "top-down" attack on a stationary ground vehicle. The initial altitude of the simulated flight is 5000 ft and the flight should be simulated to impact. The simulations should account for aspect angles of ± 25 deg. and ± 8 deg. The flights should provide a video-rate update (30Hz frame) of the simulated image based on a modeling of the missile dynamics. The output of the simulator should be an NTSC video signal which simulates in real-time the "top-down" attack. Furthermore, manual control of zoom and joystick control of azimuth and elevation within the above flight constraints should be available to the user. Equipment suggested for this application includes an input video digitizer/scanner, Central Processing Unit (CPU) processors capable of modeling missile dynamics, and a high resolution black & white NTSC video monitor. It is suggested that the simulation system be rack-mounted.

Phase I: The objective of the first phase is to design and specify a prototype system that will interface photographic inputs into a video format. This video imagery will be used to simulate a "top-down" missile attack on a stationary target. The electronics necessary to provide manual control of the zoom and joystick control of azimuth and elevation of a simulated flight should be included in the design and evaluation.

Phase II: The objective of the second phase is to construct and test the prototype designed in Phase I.

DARPA 92-114 TITLE: Polarization Sensitive Infrared (IR) Detectors for Target Discrimination

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate an array of polarization sensitive IR detectors capable of responding to two or more distinct polarizations in a controllable manner.

DESCRIPTION: It has been established that IR energy radiated or reflected from manmade objects has a larger percent that is polarized than energy radiated or reflected from natural backgrounds. This may provide the basis for target discrimination in IR search and track sets, Forward Looking Infrared Sensors (FLIRS), and IR seekers. The polarization sensitive IR detectors developed under the program should be capable of being demonstrated in an existing IR instrumentation system.

Phase I: Identify a specific IR detector configuration and the means for polarization control and carry out engineering calculations to demonstrate performance.

Phase II: Construct a polarization controllable IR detector array and demonstrate in an existing IR instrumentation system.

DARPA 92-115 TITLE: Real-Time Printing of Fine Line Patterns on Printed Wiring Boards

CATEGORY: Exploratory Development

OBJECTIVE: Investigate innovative methods for high speed direct writing of circuit patterns on printed wiring board photoresists.

DESCRIPTION: Printing of fine line patterns onto photographic masters has been possible for several years. Photoplotters capable of imaging fine lines on film are available from several manufacturers. Transfer of the image from the master to the photoresist on the printed wiring board has been difficult when conventional phototools and photoresists are used. A possible solution is to image fine line patterns directly onto the photoresist to avoid the problems inherent in the contact printing approach used to transfer images from the phototool. Several companies have developed laser direct imaging systems, similar to laser photoplotters. These imaging systems had two inherent problems: The lasers used in these systems were inefficient and unreliable, and laser replacement was expensive. The systems were very slow (compared to conventional contact printing) due to the large number of pixels required in the generation of a fine line pattern. To make direct imaging systems compatible with conventional printed wiring board lines, it will be necessary to print patterns at a rate of 5 to 6 sq. ft. per minute with a .2 mil resolution.

Phase I: Evaluate various methods of achieving the speed required for real-time imaging of circuit patterns on printed wiring board photoresists. Evaluate the preferred approach in a breadboard assembly. Complete a design concept for a full-scale real-time imaging system.

Phase II: Complete the detail design and build a prototype system capable of real-time printing of fine line patterns on printed wiring boards.

DARPA 92-116 TITLE: Tank-Mounted Millimeter Phased Array Radar for Self-Defense

CATEGORY: Exploratory Development

OBJECTIVE: Develop a design and demonstrate the millimeter wave (MMW) component and device technology for a tank-mounted MMW radar that can detect and track projectiles that represent a threat to the tank.

DESCRIPTION: The program will focus on monolithic W-Band components that can be assembled into a subassembly of the array for test and evaluation. The overall goal is to achieve a light-weight, reduced aperture size phased array consistent with the low profile design of the tank. The program should capitalize to the maximum extent possible on the investments being made in the Millimeter Wave Integrated Circuits (MIMIC) program to achieve the goal of affordability.

Phase I: The first effort will be to conduct component design trade-off studies within the system constraints to choose the specific phased array concept that also takes into account cost and affordability.

Phase II: A number of fundamental elements of the phased array that can be assembled into a sub-element will be fabricated as the vehicle for demonstrating the basic feasibility of the concept.

DARPA 92-117 TITLE: Wavelet-Transform Representation of High-Range Resolution Radar (HRR) Signatures

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the potential for data compression of HRR signatures with wavelets.

DESCRIPTION: The number of HRR signatures (range profiles) required for radar target identification is enormous; moreover, each signature has enough structure to require a fair amount of computer memory. Hence, signature storage and retrieval pose a major computational problem for HRR target identification. The data compression achieved by wavelet representations in other areas of signal analysis (e.g., speech and image processing) suggests that wavelet transforms could be useful in radar signal analysis.

Phase I: Develop the rationale for applying wavelet theory to radar signal analysis and establish the feasibility for achieving data compression of HRR signatures using wavelet transforms.

Phase II: Develop algorithms for HRR signature storage and retrieval by means of wavelet transforms.

DARPA 92-118 TITLE: Advanced Timing Concepts for Satellite Networks

CATEGORY: Advanced Development

OBJECTIVE: Evaluate system level timing requirements and concepts for advanced space networks which link multiple satellites together with ground and air-based platforms. Identify timing technology deficiencies and develop alternative technologies to correct these deficiencies.

DESCRIPTION: Define and examine timing requirements and design issues for future advanced space applications to include, at a minimum, global networking for navigation, sensor, and C3 platforms. Advanced clocks, measurement systems and techniques, and timing synchronization and management approaches will be assessed to determine if technology shortfalls exist. Technology road maps will be developed to suggest ways to overcome any deficiencies, and critical technology development will be initiated.

Phase I: Assess system level timing requirements for advanced space networks which link multiple satellites, ground and air-based platforms. Identify timing technology shortfalls based on the system level assessment. Formulate a "timing technology road map" that will show the investment path required to correct identified deficiencies.

Phase II: Refine system timing concepts and initiate development of critical timing technologies as identified in Phase I.

DARPA 92-119 TITLE: Positive Combat Identification

CATEGORY: Exploratory Development

OBJECTIVE: Develop suitable methods to discriminate between friendly and enemy forces during combat.

DESCRIPTION: The recent Persian Gulf War highlighted the problems and ramifications associated with unambiguously discriminating between friendly and enemy forces. The problem is complicated by the fact that identification must be accomplished very rapidly, in the heat of battle, during conditions of limited visibility, at

extended stand-off ranges, and between enemy and friendly forces with identical equipment. Positive identification means are sought that are very inexpensive, highly foolproof, not useful to opposing forces to assist in location or identification of U.S./allied forces, and not conducive to counterfeiting or mimicry.

Phase I: Develop methodology and concepts.

Phase II: Provide initial proof-of-principle demonstration.

DARPA 92-120 TITLE: Seismic Waveform Character Representation

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel methods to more completely represent the character of seismic signals needed for optimum performance of the Intelligent Monitoring System (IMS) at the Defense Advanced Research Projects Agency (DARPA) Center for Seismic Studies.

DESCRIPTION: Methods are sought for a more complete representation of the character of the seismic signal than current detection features. This project is aimed at developing methods to improve automatic measures of onset time for regional signals. We know that analysts are influenced by the envelope shape in signal timing and phase identification. Current automated methods are not very good at determining regional signal onset time. Perhaps some kind of waveform correlation would work better than current methods. The methods are to be tested using the IMS at the DARPA Center for Seismic Studies in Arlington, VA.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for incorporating these concepts into the IMS and testing them with data from a seismic network in Eurasia.

Phase II: Develop software to test the new concepts using the IMS, conduct test in cooperation with the analysis and research staff at the Center for Seismic Studies, using a large amount of data from seismic arrays and single stations in Eurasia, and evaluate the results.

DARPA 92-121 TITLE: Genetic Algorithm (GA) Machine Learning of Seismic Waveform Characteristics

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test a GA approach to the problems of implementing machine learning techniques needed for optimum performance of the Intelligent Monitoring System (IMS) at the Defense Advanced Research Projects Agency (DARPA) Center for Seismic Studies.

DESCRIPTION: We are working with knowledge-based systems that represent knowledge with rules, and we are developing techniques for knowledge acquisition that are compatible with this architecture. These techniques are complicated and require much specialized human labor. Some advances are being made with neural nets, which provide the potential for simpler and more straightforward knowledge acquisition (learning). A promising technique that has not been tried is based on GA. It is desired to develop a GA approach to the same problems being addressed by rule-based and neural net approaches.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for incorporating these concepts into the IMS and testing them with data from a seismic network in Eurasia.

Phase II: Develop software to test the new concepts using the IMS, conduct tests in cooperation with the analysis and research staff at the Center for Seismic Studies, using a large amount of data from seismic arrays and single stations in Eurasia, and evaluate the results.

DARPA 92-122 TITLE: Rules from Neural-Nets for Seismic Source-Region Specific Knowledge

CATEGORY: Exploratory Development

OBJECTIVE: Develop and test novel machine learning techniques to gather the station and source-region specific knowledge needed for optimum performance of the Intelligent Monitoring System (IMS) at the Defense Advanced Research Projects Agency (DARPA) Center for Seismic Studies.

DESCRIPTION: DARPA has developed an IMS which applies rule and case-based reasoning to automatically extracted features of data from a network of seismic stations to locate and identify small earthquakes and explosions. The system incorporates audit trails to facilitate performance evaluation and knowledge acquisition. This project is aimed at developing novel machine learning techniques that would enable seismologists (i.e., the domain experts) to effect a steady and controlled increase in the cognitive capability of the IMS to automatically analyze seismic data. The rules are attractive because they include physics. Neural-nets are good because the

knowledge acquisition process is easier. This effort is to combine the two by training a neural-net, then extracting the rules (which might be rules in a "fuzzy logic" sense) that represent the patterns it finds.

Phase I: Provide a detailed description of the proposed concepts, together with a detailed plan for incorporating these concepts into the IMS and testing them with data from a seismic network in Eurasia.

Phase II: Develop software to test the new concepts using the IMS, conduct tests in cooperation with the analysis and research staff at the Center for Seismic Studies, using a large amount of data from seismic arrays and single stations in Eurasia, and evaluate the results.

DARPA 92-123 TITLE: Automatic Contrail Detection & Avoidance/Elimination

CATEGORY: Exploratory Development

OBJECTIVE: Develop means to eliminate contrail production in aircraft.

DESCRIPTION: Low observable operations are thwarted when contrails are produced. Concepts are sought for innovative means to automatically detect when an air vehicle is producing, or is likely to produce, a contrail, and establish means to avoid or eliminate the contrail.

Phase I: Identify means to detect the presence of a contrail or the environmental conditions that can produce contrails. Identify potential means to avoid/eliminate contrail production.

Phase II: Develop and verify measurement and avoidance/elimination equipments identified in Phase I.

DARPA 92-124 TITLE: Electric Propulsion System

CATEGORY: Exploratory Development

OBJECTIVE: Investigate, develop, and demonstrate innovative methods of electric propulsion for unmanned air vehicles (UAVs).

DESCRIPTION: Interest exists in electric propulsion concepts which would be compatible with a wide variety of subsonic aircraft, including long endurance systems operating at high altitudes. Specifically, new concepts are desired for advanced, lightweight, reliable variable speed electric fans capable of achieving high overall propulsive efficiencies. The applications currently of interest require lightweight 270B DC electric motors with outputs on the order of 250 shp. The variable speed electric fan must be efficient at altitudes from SL to 50 KFT. Overall system reliability should be compatible with long duration flights possible with mission times on the order of 100 hours. In terms of an installed system, electrical power would be produced using turbine driven 270V DC generators. The key to developing efficient electric propulsion for long endurance systems lies in the development of efficient, lightweight electric fans.

Phase I: Identify electric motors and fans that could efficiently provide propulsion for UAVs up to 50 KFT at 250 shp.

Phase II: Develop and demonstrate prototype equipments as proof of concept for the electric propulsion system.

DARPA 92-125 TITLE: Optical Interconnect Technology

CATEGORY: Basic Research/Exploratory Development

OBJECTIVE: Develop materials and processes for optical interconnect of electronic multichip modules (MCMs).

DESCRIPTION: Concepts, materials, processes, and devices are sought for optical interconnect of MCMs. In principle, optical interconnect offers numerous potential advantages relative to electrical interconnect for high speed/bandwidth MCM-MCM interconnect, and perhaps for the longer signal lines within MCMs. These include high density with lower crosstalk, immunity to electromagnetic interference, wider bandwidth, and lower power consumption.

Phase I: Develop interconnect concepts. Perform preliminary analysis or experimentation of materials and processes.

Phase II: Investigate promising materials and processes. Fabricate optical interconnect test structure and measure electrical/optical performance.

DARPA 92-126 TITLE: Full-Scale Submarine Control Surface Lift, Drag, and Torque Measuring Devices

CATEGORY: Exploratory Development

OBJECTIVE: Develop a full-scale force and torque measurement device.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is interested in developing and demonstrating full-scale instrumentation for measuring control surface forces (lift, drag, bending moment) and torques. Methods have been developed at laboratory scale for measuring small forces and moments. DARPA has identified the need to develop instrumentation for full-scale submarines in order to use the data for computational fluid dynamics (CFD) and maneuvering prediction code validation. Currently, no method exists to accurately measure the large-scale forces, moments, and torques on submarine control surfaces. Current systems are not scalable to full-scale. A full-scale measurement system would provide, for the first time, the critical data needed to support DARPA's efforts in the development of CFD codes for computation of the highly complex, incompressible, and high Reynolds number submarine flows.

Phase I: Preliminary design of measurement system.

Phase II: Large-scale demonstration of measurement system.

DARPA 92-127 TITLE: Low Lift, Low Drag, Very Low Aspect Ratio (Order 1) Control Appendages

CATEGORY: Exploratory Development

OBJECTIVE: Design concepts for appendages and fairings on bodies of revolution.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is interested in developing innovative concepts for fairing and appendage designs which provide platform system and operational support (i.e., towed array housings, submarine sail) without impacting ship propulsive, maneuvering, or acoustic performance. The example of the submarine sail "snap roll" problem, encountered when a submarine turns, is a specific case of an appendage whose lift contribution impacts the maneuvering trajectory. DARPA wants to explore innovative fairing and appendage designs which can offer fairing and/or operational systems support while reducing any potentially adverse control force contributions, reducing the turbulence/vorticity inflow into the propulsor, and eliminating the detectable non-acoustic wake and vorticity. Any concepts must be demonstrated to be applicable for large Reynolds number, incompressible flows.

Phase I: Analysis of conceptual designs.

Phase II: Experiment to demonstrate proof-of-concept.

DARPA 92-128 TITLE: Blunt Body Separation Control and Vorticity Management and Concept Development

CATEGORY: Exploratory Development

OBJECTIVE: Develop separation delay and vortex control techniques for large scale blunt bodies which can develop high angles of attack while maneuvering.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is investigating innovative concepts for passive or active control of separation and reduced vortex generation on blunt bodies at high angles of attack. For example, hull separation on the blunt afterbody of submarines during maneuvers causes large body forces which impact predictable maneuvering control and subsequently, ship safety. Reliable methods for delaying separation using distributed passive or active controllers would greatly alleviate this problem. In addition, flow separation and vortex ingestion of shed vorticity by the propulsor are extremely acoustically noisy evolutions. These methods should be simple from the standpoint of control systems for active control and potential retractable passive designs. Although they may be demonstrated at small-scale, they must be applicable to the high Reynolds number, incompressible flows of submarine-like bodies.

Phase I: Design and analysis of separation and vorticity control techniques.

Phase II: Large-scale experiment to demonstrate proof-of-concept.

DARPA 92-129 TITLE: Simultaneous, Multi-point, Off-body Flow Measurement Techniques for Unsteady, Very High Reynolds Number Flows

CATEGORY: Exploratory Development

OBJECTIVE: Develop a capability to measure simultaneous, multi-point, off-body velocities and pressures for unsteady, high Reynolds number flows.

DESCRIPTION: The Defense Advanced Research Projects Agency (DARPA) is developing simultaneous, multi-point flow measurement capabilities utilizing laser illuminated, neutrally buoyant particulate. These techniques are needed to measure the highly unsteady, complex vortical flows of maneuvering submarines. At laboratory scale, these methods currently require extremely labor intensive set up, including seeding of the flowfield of interest, detailed laser and camera alignment, and exhaustive postprocessing of data images. DARPA desires, for large-scale flow measurement applications, to develop innovative techniques such as those that measure naturally or chemically reactive aspects of the flow environment to preclude the introduction of particulate matter and to provide a non-intrusive measurement technique. An example may be the sensing and processing of a particular quantum state of flow environment molecules or naturally occurring isotopes, etc.

Phase I: Laboratory demonstration of measurement technique.

Phase II: Large-scale demonstration of measurement technique.

DEFENSE NUCLEAR AGENCY

Submission of Proposals

The Defense Nuclear Agency is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology and operations. (Note: we are not interested in nuclear weapon design or manufacture.) DNA invites the small business community to send proposals directly to the following address:

Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed in the Acquisition Management Office and be distributed to the appropriate technical office for evaluation and action. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Nuclear Agency
ATTN: AM, Ms. P. Brooks
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA has identified 25 technical topics, numbered DNA 92-01 through DNA 92-25, to which small businesses may respond in this solicitation (92.1). Please note that these are the only topics for which proposals will be accepted. A list of the topics currently eligible for proposal submissions (followed by full topic descriptions) is included below. The topics were initiated by DNA technical offices. Questions concerning the research topics should be submitted to:

Defense Nuclear Agency
ATTN: OTA, Mr. J. Gerding
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-1217

DNA selects proposals for funding based upon technical merit, criticality of the research, and evaluation criteria contained in this solicitation document. As funding is limited, DNA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, DNA may fund more than one proposal in a specific topic area of the technical quality of the proposals in question, if deemed superior, or it may fund no proposals in a topic area. Proposals which cover more than one topic need only be submitted once.

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**DEFENSE NUCLEAR AGENCY
FY 1992 SBIR TOPICS**

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DNA 92-03 Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications

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DNA 92-05 Instrumentation

DNA 92-06 Directed and Kinetic Energy Effects

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DNA 92-08 Security of Nuclear Weapons

DNA 92-09 Theater Nuclear Forces (TNF) Survivability

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DNA 92-21 SCARS II Augmentation

DNA 92-22 Dynamic Display Device

DNA 92-23 Hardness Design Methodologies and Protocols

DNA 92-24 Nuclear Weapon Effects Data Fusion Methodologies

DNA 92-25 Conventional Weapon Effects

DEFENSE NUCLEAR AGENCY
FY 1992 SBIR TOPIC DESCRIPTIONS

DNA 92-01 TITLE: Nuclear Weapon Effects Calculation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the accuracy, runtime and or visualization of output of nuclear weapon effects calculations.

DESCRIPTION: The accurate and efficient calculation of nuclear weapon effects and the display/presentation of such calculations are of major concern to DNA. Areas of interest include more accurate calculations, faster running calculations, and new and improved ways to enable users (advanced nuclear weapons effects researchers, weapon systems developers, and managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and the survivability/vulnerability of structures and equipment to these effects. Nuclear weapon effects include airblast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; dust cloud formation; and the interaction of these effects on personnel, materials and structures. Structures of interest include deep underground, land-based, sea-based, and aerospace structures.

During Phase I, the research will demonstrate the feasibility of the proposed methodology to calculate and display/present nuclear weapon effects and/or the response of materials and structures to these effects.

During Phase II, the research concepts developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into appropriate codes.

DNA 92-02 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: 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 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 of these types of systems to nuclear weapons effects are required. New materials with enhanced electromagnetic shielding properties are also of interest.

During Phase I, testing plans and feasibility studies on the material will be completed.

During Phase II, the material will be tested and conclusions from the test results will be drawn.

DNA 92-03 TITLE: Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications

CATEGORY: Exploratory Development

OBJECTIVE: Explore the effects of nuclear weapons, natural space environment, and neutral particle beams on electronics, communications, and photonics.

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation, natural space radiation and neutral particle beams on electronics, photonics, 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 technologies 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 of systems against these nuclear weapon effects, space radiation effects, and neutral particle beams are required.

During Phase I, initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

During Phase II, continue the investigation begun in Phase I to fully develop the proposed approach.

DNA 92-04 TITLE: Nuclear Weapon Effects Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation.

DESCRIPTION: Simulators are needed to: (1) calibrate gauges; (2) use for developing new gauges; (3) provide experimental data for development of numerical simulations of nuclear weapons effects; (4) simulate one or more nuclear weapons effects at laboratory size scale; (5) predict what will occur during an underground nuclear test; and (6) simulate gravity in small scale water shock and dust lofting tests (centrifuges).

Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to the test site. Small scale simulators are needed to provide extensive data to supplement the limited data from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information.

During Phase I, build the basic simulator and demonstrate that it functions properly.

During Phase II, use the simulator to produce useful data and improve the simulator as necessary.

DNA 92-05 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: Instrumentation is used for measuring nuclear weapons effects, phenomenology parameters and the response of test items exposed to real or simulated nuclear weapon effects. 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. Instrumentation is needed for the following types of tests: airblast, dusty flow, dust lofting, water shock, shock propagation in rock, thermal radiation and underground nuclear tests. Facilities are needed to calibrate existing instruments in every environment where they could be used. Any ideas which improve information collection from a test may be submitted under this topic even if the proposed concept is not an instrument per se (i.e. photographic techniques, dust collectors). One particular need is for fast rise time ($> 3\text{ms}$) airblast gage for use on underground nuclear cavity tests.

During Phase I, build a prototype instrument and demonstrate that it functions properly using laboratory tests.

During Phase II, demonstrate that the instrumentation can record useful data in its working environment. This will involve coordination with DNA to schedule testing in a simulator or underground nuclear test.

DNA 92-06 TITLE: Directed and Kinetic Energy Effects

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the effects of directed and kinetic energy and identify materials which may survive effects of directed energy weapons and kinetic energy weapons.

DESCRIPTION: The effects of directed energy sources and hypervelocity impacts on materials, structures and systems are of interest to DNA. Of particular interest are establishing the correlation between nuclear weapons effects and directed and kinetic energy effects, identifying materials which are capable of withstanding these effects, and understanding the interaction of directed energy sources with target materials and structures. Development of analysis tools and advanced computational techniques are also of interest.

During Phase I, demonstrate the feasibility of the proposed investigation.

During Phase II, characterize the effects of directed energy on materials, structures, etc.

DNA 92-07 TITLE: Nuclear Hardness and Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques to improve the nuclear hardness and survivability of defense systems.

DESCRIPTION: Techniques for hardening and improving the survivability of systems and structures against nuclear weapons effects and directed energy effects where compatible, are required. These techniques should protect the structure or system against the combined effects of blast, thermal radiation, and dust/debris, in the cases of structures and materials, and should also provide protection against electromagnetic and nuclear 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, fixed and ground mobile systems, missiles, aircraft, spacecraft and the subsystems and components that make up these systems.

During Phase I, demonstrate the feasibility and usefulness of the proposed technique.

During Phase II, fully develop the proposed technique and characterize its usefulness in both technical and cost terms.

DNA 92-08 **TITLE:** Security of Nuclear Weapons

CATEGORY: Exploratory Development

OBJECTIVE: Improve the security of U.S. nuclear weapons against all types of threats.

DESCRIPTION: 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 equipment designs, security sensors 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.

During Phase I, demonstrate the feasibility and potential usefulness of the proposed security measures.

During Phase II, fully develop the proposed security measures so they can be compared to existing techniques.

DNA 92-09 **TITLE:** Theater Nuclear Forces (TNF) Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Improve the survivability of U.S. nuclear weapons.

DESCRIPTION: 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). Concepts should employ innovative ideas and make use of new and emerging technologies.

During phase I, demonstrate the feasibility and potential usefulness of the proposed survivability measures.

During Phase II, fully develop the proposed survivability measures so they can be compared to existing techniques.

DNA 92-10 **TITLE:** Automated Tools for Planning, Targeting, and Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Improve the ability of U.S. decision makers and commanders to plan for nuclear engagements and target their nuclear weapons.

DESCRIPTION: The nuclear employment planning and analysis capabilities of operational commanders and decision makers 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. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

During Phase I, develop the proposed technique in sufficient detail to demonstrate its feasibility.

During Phase II, continue the development of the proposed technique to the point it can be incorporated into existing planning/targeting methodologies.

DNA 92-11 TITLE: Underground Nuclear Testing

CATEGORY: Exploratory Development

OBJECTIVE: Improve the design, execution, and evaluation of underground nuclear tests.

DESCRIPTION: 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 tests), the design of new experiments which extend the capability of current test beds, and innovative test concepts to meet future needs. Improvements to the mathematical methods used to perform various calculations within the test design and analysis program are needed to improve our understanding of the results. 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, and transmission of data) are also of interest to DNA.

During Phase I, demonstrate the feasibility of the proposed test/experiment improvement. This will be done using laboratory and/or above ground testing.

During Phase II, demonstrate the proposed techniques with underground nuclear testing and/or above ground testing.

DNA 92-12 TITLE: Verification Technology Development

CATEGORY: Advanced Development

OBJECTIVE: Improve/develop U.S. technical capability to verify/ monitor compliance with existing and potential future arms control treaties, e.g., START, INF, CW, CFE, NTT, and SNF.

DESCRIPTION: New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons, chemical weapons, and conventional forces. 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 is being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor. All verification technologies are for use as part of on-site inspections. The technology will be used cooperatively with other nations and must be exportable. Designs must be shared with other nations.

During Phase I, demonstrate the feasibility of the proposed technology.

During Phase II, develop a proof of design to demonstrate the proposed technology.

DNA 92-13 TITLE: Tactical Application of Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Development of new applications of existing pulse power technology.

DESCRIPTION: 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-countermines; high power microwave weapons; and radar applications. Concepts proposed should be highly innovative and make full use of the emerging pulse power technology.

During Phase I, demonstrate the feasibility of the proposed pulsed power application.

During Phase II, continue the development of the concept to an engineering model and conduct tests of the effectiveness of the idea.

DNA 92-14 TITLE: Advances in Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Dramatic improvements in energy storage, switching, and power conditioning state of technology.

DESCRIPTION: Future systems employing pulsed power will require improvements in efficiency, energy density, reliability, 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 megaamperes, and repetition rates from single pulse to 10 kilohertz.

During Phase I, demonstrate the feasibility of the proposed concept.
During Phase II, develop, test, and evaluate proof-of-principle hardware.

DNA 92-15 TITLE: X-Ray Source Development

CATEGORY: Exploratory Development

OBJECTIVE: Innovative concepts for the production of x-ray radiation used in nuclear weapon effects testing.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 kev), warm x-rays (5-15 kev), and hot x-rays (>15 kev). 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.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle x-ray source capability.

DNA 92-16 TITLE: Rise-Time Enhancement for Flash Gamma Ray Simulators

CATEGORY: Exploratory Development

OBJECTIVE: Identify and develop new techniques for substantial reduction of radiation pulse rise-time on flash x-ray simulators.

DESCRIPTION: High fidelity simulation of tactical source region electromagnetic pulse (SREMP) is required to test the vulnerability of critical military systems. To achieve higher performance and versatility than presently available a substantial reduction of the electron rise-time at the converter is required. DNA is seeking innovative approaches which offer significant improvement over existing techniques without reducing dose rate. Hardware reliability and survivability in the harsh simulation environments and shot-to-shot repeatability are of primary importance. Proposed techniques must also be compatible with existing hardware, space constraints, and simulator operational requirements.

During Phase I, demonstrate the feasibility of the proposed concept through calculations and modeling. Perform a preliminary design for concept implementation and testing in Phase II. This will involve coordination with DNA to identify a test facility.

During Phase II, develop hardware and demonstrate concept viability on the simulator identified in Phase I.

DNA 92-17 TITLE: Structural Response to Nuclear Weapon Effects

CATEGORY: Exploratory Development

OBJECTIVE: Improve the design and hardness assessment of structures to nuclear weapons effect.

DESCRIPTION: Improved designs of hardened structures are needed as well as a better understanding of failure mechanisms of structures. Types of structures include deep underground, land-based (fixed and mobile), sea-based (surface and submerged) and aerospace structures. Designs are needed to resist conventional as well as nuclear weapons effects. Improved methods are needed for analysis and model testing of structures to large deflection and collapse damage levels. Models are required for energy deposition and thermomechanical response of heterogeneous and anisotropic composite materials subjected to X-ray exposure. The models for material behavior must be compatible with conventional structural dynamics computer codes.

During Phase I, the research will demonstrate the feasibility of the proposed designs/methodology to determine structural response to nuclear weapon effects.

During Phase II, the research concept developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into other existing methodology/codes.

DNA 92-18 TITLE: Advanced Instrumentation Concepts for Nuclear Effects Testing

CATEGORY: Exploratory Development

OBJECTIVE: To develop an enhanced instrumentation architecture that will effectively incorporate recent computer and instrument technology advances.

DESCRIPTION: Next generation nuclear effects simulators, such as the DECADE X-ray facility, present unique instrumentation

problems in the areas of data acquisition management, system diagnostics and productivity/throughput. The scale of next generation simulators will be approximately ten times greater than present capabilities with an attendant increase in instrumentation requirements complexity. Technology is required to provide on-demand diagnostic and operational support to users. Recent advances in computer hardware and information processing techniques such as digital signal processors (DSP), parallel architectures, neural networks, artificial intelligence/expert systems, hypermedia, and intelligent databases need to be integrated with emerging instrumentation technology such as Virtual Instruments (VIs), very high speed analog to digital converters, Standard Commands for Programmable Instrumentation (SCPI), etc. An intelligent system architecture is needed that will support these diverse but complementary technologies.

During Phase I, a conceptual design for an advanced instrumentation architecture will be developed. Key functions of the design shall be demonstrated through a "proof of principle" prototype.

During Phase II, the advanced instrumentation design shall be implemented including all hardware and software. The system shall be applied to the relevant data acquisition/instrumentation problem identified under Phase I.

DNA 92-19 TITLE: Plasma Sources for Plasma Switches

CATEGORY: Exploratory Development

OBJECTIVE: Improve the quality of plasma generation for plasma opening switches.

DESCRIPTION: The plasma source for plasma opening switches is the critical element for the operation of the switch. The ability to control the plasma density and density distribution from shot to shot is necessary to ensure reliability of the switch. Current techniques for plasma generation involve flashboards or gas puff. Innovative methods for controlling the plasma through flashboard configuration, coatings, gas nozzle shapes, or new methods for generating plasmas of this type will be considered.

During Phase I, feasibility studies and design plans on plasma generation will be completed.

During Phase II, plasma generation techniques will be demonstrated.

DNA 92-20 TITLE: Diagnostics for Plasma Opening Switches

CATEGORY: Exploratory Development

OBJECTIVE: Develop the diagnostics needed for evaluating the plasma in plasma opening switches and plasma sources.

DESCRIPTION: Techniques for making time and space resolved measurements of plasma properties are needed in order to effectively model and optimize plasma opening switches and plasma sources. Important properties include density, gradients, fluctuations in density, magnetic field distributions, ion and electron temperatures, and directed ion drift velocities. Innovative techniques are required for making plasma measurements on plasma densities ranging from 10^{11} to 10^{17} per cm^3 .

During Phase I, feasibility studies and design plans on plasma diagnostics will be completed.

During Phase II, plasma diagnostics will be demonstrated.

DNA 92-21 TITLE: SCARS II Augmentation

CATEGORY: Exploratory Development

OBJECTIVE: Improve coverage and survivability of nuclear command and control by design, development and demonstration of a Status, Control, Alerting and Reporting System, Stage II (SCARS II) Augmentation Terminal.

DESCRIPTION: DNA is assisting SHAPE to improve the coverage and survivability of the SCARS II. SCARS II is the message carrier dedicated to nuclear weapons release procedures (NWRP) in Allied Command Europe (ACE). Earlier DNA analysis recommended enhancing these attributes of SCARS II through the design and development of a terminal which is compatible with the existing SCARS II terminals. DNA is investigating two variations to accomplish these goals.

Plan A: It is anticipated the communications system will be replicated on a personal computer. A variant of the early Link Access Protocol (LAP), a form of the High-level Data-link Control (HDLC) protocols, and the packet layer above the LAP must be implemented. An automatic calling arrangement using Hayes-compatible modems must be implemented. A NATO cryptographic device must be controlled in the manner specified in NATO documentation.

Plan B: A SCARS "Type A" gateway is being developed under the NATO Nuclear Planning System program. This gateway will be an 80386 based PC-compatible computer. It is anticipated that an encrypted communications path would be established from the proposed SCARS II Augmentation terminal to the gateway and software developed to input SCARS messages into the gateway in such a form that the gateway could retransmit them on the SCARS II network.

During Phase I, design will be accomplished and a prototype will be built to test for compatibility.
During Phase II, a functional terminal will be produced and a man-machine interface will be developed.

DNA 92-22 TITLE: Dynamic Display Device

CATEGORY: Advanced Development

OBJECTIVE: Develop the technology required to build display devices capable of presenting dynamic imagery, in the ultra-violet through infrared bands, to a sensor system.

DESCRIPTION: The Defense Nuclear Agency (DNA) is interested in display devices that can be used in optical effects simulators. The ability of optical sensors to properly function in the optical clutter created by a nuclear burst is a question that needs to be resolved before fielding a system. A means of simulating the nuclear background clutter is needed to test these sensors and their mitigation algorithms. Displaying the simulated nuclear background clutter is a difficult task. A device, or devices, is needed that is capable of displaying a time-varying (dynamic) scene in the wave-bands of interest: ultraviolet, visible, and near- through long-wave infrared. It is expected that one device will not be able to accurately portray the nuclear scene in each of these bands, but a wide bandwidth is desired.

During Phase I, characterize the capabilities and usefulness of the proposed technology in both technical and cost terms.

During Phase II, build a display device(s), demonstrate its performance and determine the producibility of the display device(s).

DNA 92-23 TITLE: Hardness Design Methodologies and Protocols

CATEGORY: Exploratory Development

OBJECTIVE: Develop Design Methodologies and protocols which provide high confidence in the nuclear survivability of advanced technology offensive and defensive systems.

DESCRIPTION: Future U.S. space-based assets and strategic defense systems will employ advanced technologies on a scale never before attempted. These systems will have very high performance requirements - sensor blinding or system upsets even in the millisecond range could adversely affect system performance and effectiveness. Protocols and methodologies are needed to ensure that hardening technologies being developed by the nuclear survivability community can be effectively and cost efficiently integrated into prototype hardware being developed by SDIO and other defense agencies. These protocols must concurrently address approaches for ensuring high confidence hardness validation through test, modeling, and simulation. The technologies of most immediate interest are space- and ground-based optical sensors, inertial measurement units, processors, and stiffened structures.

Phase I - Identify the critical issues that must be addressed to develop a hardness validation protocol for a space- or ground-based system protocol. Develop a first-order draft protocol that addresses these issues.

Phase II - Expand the first order protocol to include risk and confidence considerations. Perform an appropriate experiment to test validity of the protocol.

DNA 92-24 TITLE: Nuclear Weapon Effects Data Fusion Methodologies

CATEGORY: Exploratory Development

OBJECTIVE: Develop the data management technologies needed to provide high confidence assessments of weapon and system survivability.

DESCRIPTION: DNA urgently needs data management tools and methodologies to provide more accurate, higher confidence assessments of the survivability of critical grounds and space-based systems. There are too few underground nuclear test to develop the statistical base needed to perform survivability assessments employing classical mathematical approaches. Aboveground test facilities cannot replicate the complete spectral output of nuclear events, and cannot support testing to full scale. Current simulation tools do not fully exploit existing models, or data to provide the highest confidence assessments. However, there is a large array of test, model and simulation data which could be applied to survivability assessments if application tools were available. New methods are needed that facilitate the application of all relevant data, models, and simulations in nuclear survivability assessments.

Phase I - Research will assess current DNA approaches for performing nuclear survivability assessments, and will identify weaknesses in data management and fusion techniques.

Phase II - State of the art knowledge-based and/or artificial intelligence techniques will be developed to enable the more powerful application of existing data to nuclear survivability assessments.

DNA 92-25 TITLE: Conventional Weapon Effects

CATEGORY: Exploratory Development

OBJECTIVE: Better understand the interaction of conventional weapons with structures, improve the capability of structure hardness assessment, and develop counter-measure concepts.

DESCRIPTION: Improved understanding of conventional weapon interaction with structures is needed to support offensive and defensive warfare requirements. Included is the requirement for a better understanding of the structure penetration and failure mechanisms, and improved designs of hardened facilities to resist conventional weapon effects. Improved methods are needed for analysis and model testing of structures to penetration, internal damage, and collapse damage levels. Models are required for standard materials and for advanced materials as they become available. Additionally, improved methods of causing penetration, internal damage, and structure damage are needed.

During Phase I, the research will demonstrate the feasibility of the proposed methodology or design concept.

During Phase II, the research concept developed in Phase I will be further developed and demonstrated through small scale testing.

**STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals**

Send Phase I proposals (five copies of the full proposal, PLUS three copies of Appendices A and B only) by US mail to:

Strategic Defense Initiative Organization
ATTN: TNI/SBIR
Pentagon, Room 1E167
Washington, D.C. 20301-7100

For Administrative Help Only: Call 800-937-3150

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.** 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.

Topics on the following pages broadly state SDI's 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 need of lighter, faster, smarter, more reliable components. The proposer need not know details of possible SDI systems. SDI will also consider highly innovative technology that does not clearly fit into any specific topic.

SDI SBIR seeks a demonstrable product that makes a leap in capability. SDI seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably commercial) and a measurable SDI benefit. SDI SBIR will not fund ordinary research or studies (including surveys, assessments, data collection, or systems studies). Nor will it further develop concepts already mature enough to compete for venture capital or government development funds.

Phase I will show the concept feasibility and the merit of a Phase II that will demonstrate a prototype or at least show proof-of-principle. The development must be appropriate for a small firm. Principal Investigators who are tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any waiver must be requested explicitly with a justification showing a compelling national need. SDI expects to grant no waivers.

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SDIO

FY1992 TOPIC DESCRIPTIONS

SDIO92-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy beams. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, free electron lasers, and hybrid approaches. Interests include the full range of embodiments, i.e., low mass spaced-based, ground-based, and pop-up systems. Included are such topics as weapon pointing, beam control, acquisition, tracking and pointing, mirrors technology, beam propagation through natural and disturbed environments, optics, and countermeasures.

SDIO92-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons candidates presently include a variety of ground and space based interceptors including their propulsion. Approaches are sought which extend, facilitate, or reduce the cost of the concepts. Elements of the systems include ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: the 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; target discrimination, seeker operational environments, lethality/miss distance; aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-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.

SDIO92-003 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 materials. Entirely new approaches as well as approaches that expand and improve present concepts are sought.

SDIO92-004 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 tens of kW to one hundred kW for electric propulsion, continuous tens to hundred kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems. The energy conversion approaches include thermionic and Rankine cycles. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 92-007, 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.

SDIO92-005 TITLE: Non-Nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of Topic SDIO92-04, non-nuclear approaches are sought for high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained tens of kW to MW power for electric propulsion, continuous tens of W to a few kW for house keeping, communications, etc. Specific topics include novel very long life battery concepts, chemically driven systems for burst power, advanced solar collectors and high efficiency multibandgap or thin film converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, plasma

switches, and high temperature power electronics. Also, concepts and systems that improve maintainability and reliability of space power systems (e.g. low loss insulation and cable) are sought. Very light weight and affordable technologies are also sought.

SDIO92-006 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 operation of the spacecraft have been major factors in the determining the life cycle costs of space-based assets. 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 effluent, 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 and solar power demonstration missions incorporating arcjet thrusters, SDI seeks 10 to 30 kW arcjet thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). With the advent of small surveillance satellites, low power (0.5 to 2 kW) electric propulsion is being considered for station keeping and orbit transfer; for such systems emphasis is being placed on achieving higher power densities of the integrated system. Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid).

SDIO92-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations must dissipate heat. 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 years of storage of large amounts of cryogenics with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

SDIO92-008 TITLE: Survivability

DESCRIPTION: The Strategic Defense System elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is needed for threat sensing, creation of false aim points and passive hardening. Contributions are sought in analytic methods, computer simulation/modeling, materials development and processing, component hardware, systems, design and analysis.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors which can characterize the threat according to direction of attack, and spectral characteristics are particularly noteworthy. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. SDS elements have common mission critical subsystems. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, R and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and rejection of R energy are of particular interest. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and R radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality are essential.

SDIO92-009 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 of 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.

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 concurrent, real-time, distributed large-scale software systems. Examples include sensitivity analysis, data flow testing, mutation testing, static concurrency analysis, and dependency analysis.
- 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 decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.
- Software architectures for embedded computer networks that especially facilitate incremental system and software integration, hardware and software maintenance, and system evolution, without significant performance degradation.
- Hardware and software self-diagnostic capabilities for monitoring the operational readiness and performance of space and ground systems incorporating embedded computer networks.

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.

SDIO92-012 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 with experimental verification. New types of miniaturized sensors, and low power actuators are needed for embedment in or attachment to space structure components for health monitoring, vibration control, and real time structural performance tailoring. Innovative lightweight power conditioning and information processing techniques are also being sought.

SDIO92-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 91-012 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. Surface launched interceptors must withstand high g loads and extreme aerothermal heating without degradation.

Specific goals require advanced techniques and processes that 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. Innovative tribology technologies 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. The following are sought: innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e., aluminum or magnesium), or thermoplastic matrix composites; innovative procedures for the production of instrumentation, sensors and software for on-line process monitoring and evaluation of high modulus, fiber-reinforced composites during fabrication; novel approaches to modify surfaces to promote fiber/matrix adhesion in advanced composites; innovative surface modifications to promote wear resistance; innovative tooling techniques for net-net shape production of advanced composites; novel, low-to-no outgassing joining/bonding techniques for advanced composites; novel instrumentation for determination and telemetry of material properties and data from space; improved materials for low power embedded actuators capable of large displacements; and new methods for integrating instrumentation (i.e., embedded sensors) into advanced composite materials and structures. Proposals involving these as well as other space structure and material-related research and innovative technology topics are sought.

SDIO92-014 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/superlattice 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.

SDIO92-015 TITLE: Superconductive Materials

DESCRIPTION: Interest in these high temperature superconducting materials includes 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.]

The principle SDIO interest in superconductor technology is in the development and demonstration of both high temperature superconductor (HTS) and low temperature (LTS) devices significantly enhancing the performance of strategic defense systems. Primary emphasis in HTS technology is in components integrated with state-of-the-art cryoelectronics for communications systems at K- and V-bands and radar systems in the X-band. The emphasis in LTS technology is the development of high sensitivity IR

detectors, digital electronics and memory enabling on-FPA signal processing and operating at temperatures greater than 10 K. Efforts should address packaging and interface issues and systems integration with cryocoolers and stored cryogens.

SDIO92-016 TITLE: Surprises and Opportunities

DESCRIPTION: Since SDI is an exploration at technology's leading edge, it recognizes that surprises and opportunities may arise from creative minds. SDI will consider proposals in other technologies where they present an unusual opportunity for SDI. The proposer should take special care to describe the technology and why SDI would benefit from exploring it. Proposers should note that proposals in this topic will receive preliminary screening that may reject them as too far afield without the full technical review received by proposals in the topics already listed. This open call is for new technology, not for recycling of old ideas.

Reference A

TO: _____
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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, please order early.

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DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, North
Suite 104
Birmingham, AL 35203-2376
(205) 226-4304

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, 640
P.O. Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMAO Orlando
ATTN: Russell Nielson
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-51153

DCMAO Puerto Rico
ATTN: Victor Irizarry
P.O. Box DLN-N.S.G.A.
FPO Miami, FL 34053-0007
(809) 261-3202

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street
P.O. Box 1040
San Antonio, TX 78294-1040
(512) 229-4650

DCMD NORTHEAST

ATTN: Edward Fitzgerald
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318

DCMAO Boston

ATTN: Gerald Hyde
495 Summer Street
Boston, MA 02210-2184
(617) 451-4109

DCMAO Bridgeport

ATTN: Otis Wade
555 Lordship Boulevard
Stratford, CT 06497-7124
(203) 385-4412

DCMAO Buffalo

ATTN: William Bickelman
1103 Federal Building
111 West Huron Street
Buffalo, NY 14202-2392
(716) 846-4260

DCMAO Garden City

ATTN: John Richards
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5724

DCMAO Hartford

ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7707/7705

DCMAO New York

ATTN: John Castellane
201 Varick Street, Room 1061
New York, NY 10014-4811
(212) 807-3050

DCMAO Syracuse

ATTN: Robert Hunter
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 423-5405/5207

DCMD WEST

ATTN: Renee Deavens
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free) (CA only)
(800) 624-7373
(Toll Free-AK, HI, ID, MT, NV, OR, WA))
(213) 335-3260

DCMAO San Francisco

ATTN: Robert Lane
1250 Bay Hill Drive
San Bruno, CA 94066-3070
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