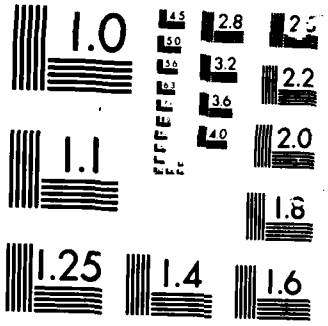
AD-A166 037 PROGRAM SOLICITATION NUMBER 861 SMALL BUSINESS INNOVATION RESEARCH PROGRAM(U) DEPARTMENT OF DEFENSE WASHINGTON DC 31 JAN 86 1/3

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The Department of Defense

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Defense Advanced Research Projects Agency

Defense Nuclear Agency

Strategic Defense Initiative Organization

PROGRAM SOLICITATION

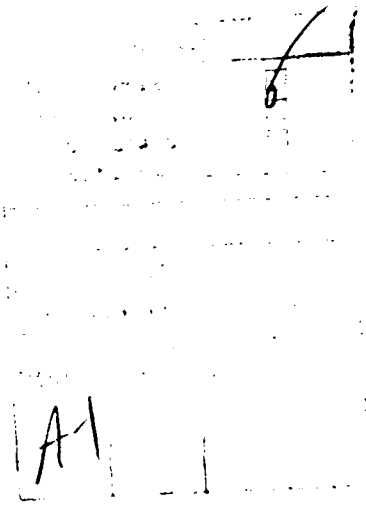
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FY-1986 DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

PROGRAM SOLICITATION
Number 86.1
Small Business
Innovation Research
Program



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Issue Date: 1 October 1985

U. S.Department of Defense

SBIR Program Office

Washington, DC 20301

Closing Date: 31 January 1986

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DOD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Nuclear Agency (DNA), and Strategic Defense Initiative Organization (SDIO), hereafter referred to as DOD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to the availability of funds, DOD and its Components will support high quality research or research and development proposals on innovative concepts related to important 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 Law (PL 97-219). The basic design of the DOD SBIR program is in accordance with the Small Business Administration (SBA) National Directive, #65-01.1. The DOD program presented in this solicitation brochure strives to encourage scientific and technical innovation in areas specifically identified by DOD components. The guidelines presented in the next section incorporate and exploit the flexibility of the SBA National Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD, rather than proposals focused on and built around a specific dollar level. In accordance with the National Directive, the DOD-SBIR Program is a three phase program as described in the text that follows. Results from prior years are shown in paragraph 1.5.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Department Act of 1982, Public Law 97-219. Under Phase I, DOD Components anticipate making 550 awards during fiscal year 1986 to small businesses typically of one-half to one man-year effort over a period generally not to exceed six months, subject to negotiation. The legislative history of PL 97-219 clearly envisioned that the Phase I awards would be in the neighborhood of $50,000 each, adjusted for inflation. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DOD support in Phase II. The measures of Phase I success include evaluations of the extent of which Phase II results have the potential to yield a product of continuing importance to DOD.

Subsequent Phase II awards will be made only to firms on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. In FY-87 DOD anticipates making 150 Phase II awards from the Phase I awards in FY-86. Phase II awards will typically cover 2 to 5 man-years of effort over a period generally not to exceed 24 months, subject to negotiation. The legislative history of PL 97-219 clearly envisioned that the Phase II awards would be in the neighborhood of $500,000. The number of Phase II awards will depend upon Phase I results and availability of funds. Phase II is the principal research or research and development effort; it will require a more comprehensive proposal which outlines the proposed effort in detail.

Under Phase III, non-Federal capital is expected to be used by the small business to pursue commercial applica-

tions 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. 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.

Both Phase I and Phase II contracts may include a profit or fee.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will *not* be considered under this soliciation; 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 sources that were awarded Phase I contracts will be considered (see 6.3 and 7.1).

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 and development, another important goal of the solicitation is the 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 the 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 II, subject to the patent policies as stated in this solicitation (Section 7.6).

1.4 Eligibility and Limitations

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 his proposal. In addition, a minimum of two-thirds of each SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the several 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 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.

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 the Ethics in Government Act of 1978 (P.L. 95-521, as amended by P.L. 96-19 and P.L. 96-28). Such proposers should contact the cognizant Ethics Counsellor of the DOD component for further guidance.

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1.5 Prior Years Results

FY-83	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	182	1246	96	20
Navy	131	944	67	40
Air Force	75	496	100	50
DARPA	8	128	12	8
DNA	10	88	8	2
	406	2902	283	120

FY-84	Number of Topics	Proposals Received	Phase I Awards
Army	111	758	81
Navy	147	861	99
Air Force	283	1208	163
DARPA	17	107	15
DNA	8	80	12
	566	3014	370

FY-85	Number of Topics	Proposals Received	No. Selected for Phase I Negotiations
Army	111	808	117
Navy	138	851	58*
Air Force	218	1272	231
DARPA	17	130	14
DNA	7	95	18
SDIO	18	414	0*
	509	3570	438

(*Selections made as of Aug 85)

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development — Any activity which is (A) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (B) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (C) a systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. In DOD's R&D Program the definitions A, B, and C above correspond respectively as follows: (A) Basic Research, (B) Exploratory Development, and (C) Advanced Development or Engineering Development.

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

(1) 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;

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

(3) Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 U.S.C. 661, *et seq.*, are affiliates of one another when either directly or indirectly (A) one concern controls or has the power to control the other; or (B) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and 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:

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 business, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

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

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

2.5 Subcontract — A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Goverment contract awardee calling for supplies or services required solely for the performance of the original contract.

3.0 TECHNICAL TOPICS

3.1 Phase I Topic List

Topics for each DOD Component are listed and numbered separately. Topics and topic descriptions are provided in Appendix D.

4.0 PHASE I PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

4.1 Proposal Requirements

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

Those responding to this solicitation should contact the Defense Technical Information Center (DTIC) for scientific and tehnical information assistance as described in Section 8.0. Background information available from DTIC on each of the topics listed in Appendix D can facilitate better informed decisions to bid or not to bid and may enhance the technical quality of a proposal by demonstrating more thorough knowledge of related work already completed or underway by DOD Components and others.

A proposal should be self-contained and written with care and thoroughness. Each proposal should be reviewed carefully by the offeror to ensure inclusion of all data essential for evaluation.

The scientific or technical merit of the proposed research or research and development is the primary concern for all research and development supported by the DOD. *A proposal must respond to only one of the topics listed in Appendix D.* An organization may submit separate proposals on different topics or different proposals on the same topic but each proposal must be limited to one topic. Where similar research and development is discussed in more than one topic description, the proposer should choose that topic the description of which appears most relevant to the proposer's technical concept.

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

If a proposal substantially the same as the one submitted in response to this solicitation has been previously funded or is either funded by, pending with, or about to be submitted to another Federal agency or another DOD Component, or to the same DOD Component as a separate action, the proposer must so indicate and provide the information required by Section 4.4(12).

4.2 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 7.7.

4.3 General Content

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of *no more than 25 pages*, (no type smaller than elite on standard 8 1/2" × 11" paper with one (1) inch margins, 6 lines per inch) including proposal cover sheet (Appendix A), Project Summary (Appendix B) and Cost Proposal (Appendix C) and any enclosures and attachments. Promotional and non-project-related discussion is discouraged. *Cover all items listed below in Section 4.4 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 them briefly as described in Section 4.4, items 2 and 8.

4.4 Phase I Proposal Format

All pages shall be consecutively numbered.

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

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

3. **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.)

4. **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.

5. **Phase I Work Plan.** This section must provide an explicit, detailed description of the Phase I approach. The plan should indicate not only what is planned but how and where the work will be carried out. 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 substantial portion of the total proposal.

6. **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.

7. **Relationship with Future Research or Research and Development.**

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

8. **Potential Post Applications.** Briefly describe:

a. Whether and by what means the proposed project appears to have potential commercial application.
b. Whether and by what means the proposed project appears to have potential use by the Federal Government.

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

10. **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.

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

12. **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 to the same DOD Component, the proposer must provide the following information:

a. The 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.
b. Date of proposal submission or date of award.
c. Title of proposal.
d. Name and title of principal investigator for each proposal submitted or award received.
e. 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.
f. If award was received, state contract number.
g. Specify the applicable topics for each pending SBIR proposal submitted or award received.

Note: If Section 4.4(12) does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."

13. **Cost Proposal.** Complete the cost proposal in the form of Appendix C for the Phase I effort only. Under the direct labor category, list all key personnel by name as well as by number of hours dedicated to the project. (See also Section 7.8).

4.5 Bindings

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

5.0 SUBMISSION OF PROPOSALS

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

5.1 Address

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

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

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

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

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

5.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DOD Component is 2:00 p.m. local time, January 31, 1986. 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: (1) it was sent by registered or certified mail not later than January 22, 1986; or (2) 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.

The only acceptable evidence to establish (1) 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; (2) 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 prior to award. (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.

6.0 METHOD OF SELECTION AND EVALUATION CRITERIA

6.1 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 says 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 6.2. 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, development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DOD.

6.2 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 number one which will receive twice the weight of any other item:

(1) The 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.
(2) Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.
(3) Anticipated benefits of the research or research and development to the total DOD research and development effort.
(4) Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.
(5) Cost to the Government, including reasonableness of cost.

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 identified in the proposal.

6.3 Evaluation Criteria—Phase II

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is *not* initiated by a solicitation. Detailed instructions regarding Phase II proposal submission will be sent by DOD Components to all Phase I award winners. Listed below are some of the principles upon which those instructions can be expected to be based.

A Phase II proposal can be submitted at any time when progress attained under Phase I is deemed sufficient to justify the effort to be proposed for Phase II. (See Section 7.1.) It must contain enough information on progress accomplished under Phase I by the time of Phase II proposal submission to enable an evaluation of the project's promise if continued into 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 one, which will receive twice the value of any other item:

(1) The scientific/technical quality of the proposal, with special emphasis on its innovation and originality.
(2) The qualifications of the principal investigator and other key personnel to carry out the proposed work.
(3) Anticipated benefits of the research or development to the total DOD research and development effort.
(4) Degree to which the Phase I objectives were met at the time of Phase II proposal submission.
(5) The adequacy of the Phase II objectives to meet the problem or opportunity.
(6) Cost to the Government, including reasonableness of cost.

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

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.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for 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.

7.0 CONTRACTUAL CONSIDERATIONS

7.1 Awards

The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim period Phase I modifications, and Phase II contracts.

No Phase I contracts will be awarded until all qualified proposals (received in accordance with section 5.2) 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 31, 1986. The names of those firms receiving awards will be announced.

The number of the Phase I awardees that will receive Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. Phase II is to further develop ideas explored under Phase I. Specific instructions for the preparation of Phase II proposals will be sent to Phase I awardees by the DOD Components. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government, covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated. 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.

Offerors for Phase II work who do not elect to submit a proposal 30 days prior to the expiration date of the Phase I contract, have the option to submit a proposal after the completion of the Phase I contract. The final date for receipt of a Phase II proposal will be not later than 60 calendar days after the completion of the Phase I contract.

The period of performance under Phase II will depend upon the scope of the effort, but generally will not exceed 24 months. Phase II award decisions will be based upon evaluation of progress attained under Phase I and of the Phase II proposal. Phase II awards will typically cover 2 to 5 man-years effort, depending upon the scope of research or development.

7.2 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 effort. The final report shall include a single-page project summary 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.

7.3 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon negotiations between the DOD and the successful Phase I offeror. SBIR performers may be paid under an applicable, authorized progress payment procedure or in accordance with a negotiated price and payment schedule. When progress payments are authorized the participating small business will be required to submit interim progress reports to the contracting officer. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Advanced payments are optional and may be made under appropriate public law when it is determined to be in the best interest of the Government.

7.4 Technical Data

Rights in technical data, including software, developed under the terms of any contract results 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 funding agreement whether patented or not.

7.5 Copyrights

With prior written permission of the contracting officer, and 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.

7.6 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 patentholder 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 two-year period to allow the awardee a reasonable time to pursue a patent.

7.7 Markings of Proprietary or Classified Proposal Information

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

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

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information 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 following legend appears on the title page of the proposal:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to 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 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 he will be requested to expeditiously submit to the DOD Component a detailed listing of all information in his proposal which he 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 classified material with the [illegible] may submit classified material with the [illegible]. Any classified material shall be marked and handled in accordance with applicable regulations. [illegible] and unwarranted use of this restriction is discouraged. Offerors must follow the Industral Security Manual for Safeguarding Classified Information (DOD 5220.22M) procedures for marking and handling classified material.

7.8 Cost Proposal

A firm fixed price or cost plus fixed fee Phase I proposal must be submitted in detail in the format shown in Appendix C. Note: The firm fixed price type is the preferred method for Phase I proposals. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information for 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. Phase I contract may include a profit or fee.

1. **Special Tooling and Test Equipment, and Material.** 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. They 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.

2. **Travel.** Cost for travel funds must be justified and related to the needs of the project.

3. **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.

7.9 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.

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

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

3. **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.

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

5. **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.

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

7. **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).

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

9. **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.

10. **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.

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

12. **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.

13. **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.

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

15. **Military Security Requirements.** The Contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

8.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

8.1 DOD Technical Information Services Available

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

Many of the 3000 small business requestors who responded to FY-84, and FY-85 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 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.

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

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

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

DTIC Boston On-Line Service Facility
AFGL Research Library/SULL
Building 1103, Hanscom AFB
Bedford, MA 01731
(617) 861-2413

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
11099 South LaCienega Boulevard
Los Angeles, CA 90045
(213) 643-1108

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

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible.

8.2 Other Technical Assistance Program

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

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

University of Connecticut
New England Research Application Center (NERAC)
Mansfield Professional Park
Storrs, Connecticut 06268
(203) 486-4586

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

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

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

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

NASA Industrial Applications Center
701 LIS Building
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-5211

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

NASA/Florida State Technology Applications Center
State University System of Florida
500 Weil Hall
Gainesville, Florida 32611
(904) 392-6626

9.0 CONTACT WITH DOD

9.1 Oral Communications

Oral communications with DOD Components regarding this solicitation during the Phase I proposal preparation period are prohibited for reasons of competitive fairness, with the exceptions as stated in Sections 1.4, 8.0 and 9.7.

9.2 Questions Pertaining to This Solicitation

Questions pertaining to this solicitation should be addressed in writing to the address listed at the beginning of each DOD Component listing of topics (See Appendix D). No telephone requests will be accepted except as stated in Section 9.1.

9.3 Requests for Additional Copies of This Solicitation

Additional copies of this solicitation can be ordered from the Defense Technical Information Center. Attn: DTIC/SBIR, Building 5, Cameron Station, Alexandria, Virginia 22304-6145; (telephone (800) 368-5211 (toll free)/(202) 274-6902 (commercial for Virginia, Alaska and Hawaii).

9.4 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.

9.5 Debriefing of Unsuccessful Offerors

After final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals only, upon written request.

9.6 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 each topic number.

9.7 Counseling Assistance Available

Small business firms interested in participating in the SBIR Progam may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout 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 DCAS Activities.)

9.8 Notifications of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self addressed and stamped envelope and a copy of the notification form (reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the goverment 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 5.2.

10.0 ADDITIONAL INFORMATION

10.1

This Program Solicitation is intended for informational 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.

10.2

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.

10.3

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

10.4

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.

10.5

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.

10.6

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.

10.7

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

Appendix A
Solicitation No. 86.1
Proposal Cover Sheet

DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

Topic Number: _____ ☐ Army ☐ Navy ☐ Air Force ☐ DARPA ☐ DNA ☐ SDIO ☐ DCA ☐ DMA

Title Proposed by Firm: _____

_____

Submitted By: Firm _____

Address _____

City _____ State _____ Zip Code ____

Submitted To: (Activity identified with the topic) _____

_____

Address _____

City _____ State _____ Zip Code ____

Small Business Certification:

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C. 631 and in the Definition Section of the Program Solicitation.

"The above firm certifies that it ____ does ____ does not qualify as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement."

The above firm certifies that it qualifies as a woman-owned small business firm :
Yes ____ No ____.

Disclosure permission statement as follows:
All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

"Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment?
Yes ____No ____."

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

Proposed Cost (Phase I): _____

Proposed Duration: ____months (not to exceed six months).

Project Manager/Principal Investigator	Corporate Official (Business)
Name _____	Name _____
Title _____	Title _____
Signature _____	Signature _____
Date _____	Date _____
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, use, 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 in page(s) _____ of this proposal. Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

Nothing on this page is classified or proprietary information/data

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH PROGRAM
PHASE 1 — FY 1986
PROJECT SUMMARY

Topic No. _____ Military Department/Agency _____.

Name and Address of Proposing Small Business Firm

Name and Title of Principal Investigator

Title Proposed by Small Business Firm

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

Anticipated Benefits/Potential Commercial Applications of the Research or Development

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

APPENDIX C
COST PROPOSAL
DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

Background:

The following items, as appropriate, should be included in proposals responsive to the DOD Solicitation Brochure. As an alternative to the following items, the Standard Form 1411 (Department of Defense Contract Pricing Proposal) may be used.

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

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DOD Solicitation Brochure
6. Total Dollar amount of the proposal (dollars)
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost) (dollars)
   d. Total direct material (dollars)
8. Material overhead (rate _____%) × 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 (specify company cost center)
   a. For each cost center 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. Transporation (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. Royalites (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 States Government performed any review of your accounts or records in connection with any other government prime contract or subcontract with 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-free or firm-fixed price.

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

SUBMITTING PROPOSALS ON ARMY TOPICS

PHASE I PROPOSALS (5 COPIES) SHOULD BE ADDRESSED TO:

TOPICS	
Topics A86-1 - A86-35	Commander Armament Research and Development Center U.S. Army Armament, Munitions and Chemical Command ATTN: SMCAR-RAM SBIR Program Dover, NJ 07801
Topics A86-36 - A86-39	Commander U.S. Army Armament, Munitions and Chemical Command ATTN: AMSMC-PC-B(A) Mr. Henry Procurement Directorate Edgewood Site/Bldg. E4455 Aberdeen Proving Ground, MD 21010
Topics A86-40 - A86-46	Commander U.S. Army Aviation Systems Command ATTN: AMSAV-PSRS SBIR Program Building 102 4300 Goodfellow Blvd. St. Louis, MO 63120-1798
Topics A86-47 - A86-76	Commander U.S. Army Communication-Electronics Command ATTN: AMSEL-PC-CM-E SBIR Program Fort Monmouth, NJ 07703-5008
Topics A86-77 - A86-95	Commander U.S. Army Laboratory Command ATTN: AMDEL-TI SBIR Program 2800 Powder Mill Road Adelphi, MD 20783-1145

Topics A86-96 - A86-104	Commander U.S. Army Belvoir R&D Center ATTN: STRBE-PM/P&P Division SBIR Program Ft. Belvoir, VA 22060
Topics A86-105 - A86-112	Commander U.S. Army Missile Command ATTN: AMSMI-IYBA BLDG 4488 SBIR Program Redstone Arsenal, AL 35898-5280
Topics A86-113 - A86-123	Commander U.S. Army Tank-Automotive Command ATTN: AMSTA-IRD SBIR Program Warren, MI 48090
Topics A86-124 - A86-132	Director U.S. Army Materials and Mechanics Research Center ATTN: AMXMR-PP Program Planning Division Bldg. 131 Room 143 405 Arsenal Street Watertown, MA 02172-2719
Topic A86-133	Commander U.S. Army Armament, Munition and Chemical Command Procurement Directorate-Edgewood Site ATTN: AMSMC-PR-B(A) Bldg. E4455 SBIR Program APG-EA, MD 21010
Topic A86-134 - A86-140	Director U.S. Army Natick Research and Development Center ATTN: STRNC-P SBIR Program Kansas Street Natick, MA 01760

Topics A86-141 - A86-156	Director U.S. Army Ballistic Research Laboratory ATTN: AMXBR-PM-B Bldg. 328, Room 229A SBIR Program Aberdeen Proving Ground, MD 21005-5006
Topics A86-157 - A86-183	Commander U.S. Army Test and Evaluation Command ATTN: AMSTE-PR SBIR Program Aberdeen Proving Ground, MD 21005-5005
Topic A86-184	Commander Directorate of Contracting Bldg. 46 ATTN: ATZE-DOC SBIR Program Carlisle Barracks, PA 17013-5002
Topics A86-185 - A86-190	Commander U.S. Army Engineering Topographic Laboratories ATTN: ETL-PRO Plans & Programs Office Building 2592, Room AG SBIR Program Ft. Belvoir, VA 22060
Topics A86-191 - A86-200	Commander U.S. Army Construction Engineering Research Laboratory ATTN: Chief Procurement and Supply Branch 2902 Newmark Drive Building #1, Room 175-1 SBIR Program Champaign, IL 61821
Topic A86-201	Commander U.S. Army Cold Regions Research and Engineering Laboratory ATTN: CRREL-AL 72 Lyme Road SBIR Program Hanover, NH 03755-1290

Topics A86-202 - A86-208	Commander U.S. Army Waterways Experiment Station P.O. Box 631 SBIR Program Vicksburg, MS 39180-0631

Topics A86-209 - A86-220	Commander U.S. Army Medical Research and Development Command ATTN: SGRD-RMA SBIR Program Ft. Detrick Frederick, MD 21701

Topics A86-221 - A86-225	Commander U.S. Army Research Institute For The Behavioral And Social Sciences ATTN: PERI-BR SBIR Program 5001 Eisenhower Avenue Alexandria, VA 22333-0001

ARMY RESEARCH TOPICS FOR FY86 SBIR SOLICITATION

A86-1. TITLE: FEASIBILITY STUDY FOR A ROBOTIC CONTROL SYSTEM FOR A ROBOTIC HOWITZER

CATEGORY: Exploratory Development

DESCRIPTION: A study is required to determine the possibility of upgrading the robot control system presently in use on the Integrated Smart Artillery Synthesis (ISAS) robotic howitzer into a multipurpose system. The new system should be able to perform all the functions currently being performed by the fire control system and the robot control system autonomously.

A86-2. TITLE: FEASIBILITY STUDY FOR APPLICATION OF ROBOTIC VISION IN A WEAPON SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: The (ISAS) Robotic Ammunition Handling system is presently controlled by activiation of preprogrammed routines which allow the robot to maneuver and perform its required tasks. This system provides little adaptability to a changing environment and requires a large data base of programmed routines. A vision (not necessarily optical) capability would allow the robot to make its own decisions, should a change in environment occur, without a programmer inputting a new routine.

A86-3. TITLE: NEW ANALYTICAL PROCEDURES FOR ENERGETIC MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for rapid analytical analysis during production processes to insure quality control.

A86-4. TITLE: NEW SYNTHETIC ROUTES FOR ENERGETIC MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: The expense of chemical energy munitions is, among other things, related to production. Costs could be reduced by

simpler chemical
routes to end products. A cheaper simpler synthesis is HMX would be desirable.

A86-5. TITLE: NEW ENERGETIC MATERIALS TO IMPROVE PERFORMANCE, COST-EFFECTIVENESS, AND SAFETY

CATEGORY: Exploratory elopment

DESCRIPTION: It is desirable to improve the energy output and decrease the sensitivity without increasing costs of chemical munitions.

A86-6. TITLE: NEW LOADING PROCEDURES FOR ENERGETIC MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: It is necessary to develop loading procedures to minimize defect structure in resulting casts.

A86-7. TITLE: NEW HIGH-SPEED/HIGH-RESOLUTION DIAGNOSTIC EQUIPMENT

CATEGORY: Research

DESCRIPTION: In order to experimentally study the effect of physical design such as shape on the detonation wave, new high-speed/high-resolution diagnostic techniques are needed.

A86-8. TITLE: COMPUTER MODELLING OF DETONATION PHENOMENA

CATEGORY: Research

DESCRIPTION: New more sophisticated models taking into account actual chemical steps and kinetics are required to properly model detonation.

A86-9. TITLE: CREATION OF DATA BASE ON ENERGETIC MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: In order that charge designers have ready access to data, there is need for a centralized computer, rapidly accessible data bank of basic characteristics of energetic materials.

A86-10. TITLE: EPOXY COATINGS

CATEGORY: Research

DESCRIPTION: Methods of determining stresses due to epoxy coatings on thin films.

A86-11. TITLE: COMPUTER SIMULATION OF TWO CENTER TUNED ESCAPEMENTS

CATEGORY: Research

DESCRIPTION: A computer model which would simulate the motion of the type of escapement found in may fuzes (e.g. XM772) in order to predict arming time and improve performance.

A86-12. TITLE: COMPUTER SIMULATION OF INVOLUTE ESCAPEMENT

CATEGORY: Exploratory Development

DESCRIPTION: A computer model which would simulate the motion of the type of escapement found in the Copperhead S&A (M740 Fuze) in order to predict arming distance and improve performance.

A86-13. TITLE: TURN COUNTER

CATEGORY: Exploratory Development

DESCRIPTION: The use of pendulum to count turns in an S&A to measure safe separation distance.

A86-14. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - EXPERT SYSTEM FOR TEST PROGRAM SETS

CATEGORY: Exploratory Development

DESCRIPTION: Test Program Sets (TPS) consist of all the hardware and software necessary to assure that the Unit Under Test (UUT) is working correctly. The TPS includes the UUT program and the necessary documentation to test, fault detect, and fault isolate the Line Replaceable Units (LRU) and the Shop Replaceable Units (SRU) to the required level. There is a need to achieve minimal qualification/verification testing by minimizing the number of fault insertions necessary, while maintaining an acceptable level of quality, to verify and validate Test Program Sets (TPS). An expert system is needed to provide assistance in determining which faults need to be inserted in order to adequately qualify the TPS's go/no-go chains.

A86-15. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - INCIPIENT FAILURE DETECTION DEVICES.

CATEGORY: Exploratory Development

DESCRIPTION: Reliability is a major concern on today's battlefield. Low reliability reduces the probability of mission success and increases logistics costs. There are two major types of reliability failures. One type is predictable and is due to wearout of components/sub-systems while the other is of the random variety. Much work is currently under way to improve maintenance techniques to deal with wearout related failures. Also, built-in-test (BIT) is used to query the system for failures that have already occurred. If the weapon system fails without warning, as in the case of a random failure, both mission and lives are jeopardized.

No methodology currently exists to any great extent to identifying impending (incipient) failures in weapon systems. The intent of this proposal is to establish an incipient failure detection capability through the generation of a generic failures data base and the establishment of a relationship with computer/sensor capability and capacity and desired prediction goals.

A86-16. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - AUTOMATED SOFTWARE REQUIREMENTS SPECIFICATION ANALYZER

CATEGORY: Exploratory Development

DESCRIPTION: The process for reviewing requirements specifications has in the past been achieved through manual techniques. For example, the analysis of a requirements spec for the identification and traceability of system requirements is a labor intensive effort, even when automated trace tools are applied. The idea behind this effort is to formulate an expert system which will be able to scan a requirements specification and identify at least 80% of the system requirements stated. By use of an optical character reader (OCR), one can input a requirements specification automatically and apply the expert system. The desired output will then be a data base of requirements formatted such that it can be used as direct input to SMCS or TAGS tools.

A86-17. TITLE: ARMAMENT SYSTEM SOFTWARE QUALITY - SOFTWARE TEST HOOKS

CATEGORY: Exploratory Development

DESCRIPTION: In today's software intensive weapons systems, it is required to provide software test points, or test hooks, which permit the diagnosis of hardware, software and/or operator induced faults. These hooks are to be identified early in the development of the software, utilized during testing, and provide support assistance to fielded systems. There is a need to develop a generic test hook design concept and considerations checking for items such as memory overhead, computation speed, a potential linking to build in test (BIT), etc.

A86-18. TITLE: THE DEVELOPMENT OF AN ADA PROGRAM DESIGN LANGUAGE EVALUATION METHODOLOGY AND DEFINITION

CATEGORY: Advanced Development

DESCRIPTION: Ada is a programming language designed in accordance with requirements defined by the U.S. Department of Defense for its mission-critical embedded real-time systems. Overall, these requirements call for a language that is portable, has real-time capabilities, modularity, facilities parallel processing and exception handling. With the declaration of Ada as the single standard programming language for DoD embedded real-time applications, a number of questions and controversy have arisen regarding the use of Ada as the Program Design Language (PDL). These questions generally pertain to the scope of using Ada as a PDL, the detailed mechanics of the PDL description, as well as the criteria for evaluating an Ada PDL. The objective of this research is to define the scope of use for Ada as a PDL by determining if Ada can be used for system architectural definition, as a software requirements definition or simply for detailed software design representation. In addition, this research effort will answer the following often asked questions pertaining to an Ada PDL and use the questions and answers as an evaluation methodology for Ada PDL submissions.

*Does the Ada PDL aid in the Ada learning process?
*Does the Ada PDL encourage design instead of coding?
*Should the Ada PDL be a sub-set or superset of Ada?
*Is the Ada PDL easily converted to Ada?
*Should an Ada PDL be compilable?
*What is the real advantage of using an Ada PDL and does the Ada PDL being evaluated/reviewed meet convey this advantage?
*Does the Ada PDL provide suitable documentation for both the development and maintenance phases?

A86-19. TITLE: PREDICTION ALGORITHM

CATEGORY: Exploratory Development

DESCRIPTION: Advanced filtering and prediction algorithms development for Air Defense application based on technology in computer hardware, sensor and software techniques. The capability that VHSIC technology offers should be considered in the development of algorithms. The algorithm development should examine parallel processing of various target models versus a single target model, game theoretics, dynamic modeling and other modeling techniques. Advanced sensor technology should also be evaluated which could be provided for non-standard target of these measurements, i.e. target dimensions and aspect angle, and the utilization of these measurements for algorithm development.

A86-20. TITLE: AMMUNITION LOGISTICS

CATEGORY: Advanced Development

DESCRIPTION: There is an urgent requirement for non-system advanced development programs in support of Ammunition Logistics. These programs should provide for the development, demonstration, and evaluation of new ammunition logistic, resupply, and packaging concepts and initiatives.

These efforts, when coupled with other ongoing programs, are intended to produce an improved ammunition logistics system capable of supporting Army 21. This system will be characterized by:

o Improved ammunition packaging for current and future ammunition; i.e., lighter, less cube, user friendly, cheaper, ease of decontamination, and NBC protection.

o Improved ammunition handling - improved materials' handling equipment, including automated and/or robotic operations.

o More efficient wholesale transportation from CONUS plants to OCONUS ports.

o Better user inventory control and management of ammunition stocks.

o New/improved armored resupply vehicles and tactical transportation systems.

o Improved storage methods and techniques for rapid outloading of stocks.

o An ammunition logistics command, control, and communication (C3) system integrated with the tactical user systems network.

o Improved methods to reduce ammunition vulnerability and improved survivability.

A86-21. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL ACCELERATION SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches for acceleration sensors are needed with improved performance capabilities. Improvements in guidance technology are dependent on development of acceleration sensors with wider ranges of operation and capabilities for multi-dimensional resolution of motion. New concepts for acceleration sensors are sought which may have applications for angle of linear rate sensing and which will encourage digital signal processing. The acceleration sensor should be of minimal size and weight while retaining the performance requirements for guided projectile applications.

A86-22. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL SAFE SEPARATION SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: Existing technologies applied to acceleration sensors for detection of safe separation distance and timing are unsuitable due to limited range, size, reliability, ruggedness and cost. Novel concepts for an intrinsically stable and simple accelerometer for safe separation sensors for guided and smart munitions are therefore sought. The desired accelerometer should be a micro-miniature device of absolute minimum dimensions. Its range of operation should be within fractions of a G to tens of G's. By design, the proposed concept should be able to withstand rough handling, wide ranges of ambient temperatures, and random launch and flight vibrations.

A86-23. TITLE: MICRO-MINIATURE ELECTRONIC/OPTICAL MAGNETIC MOMENT SENSOR FOR IMPROVED SMART MUNITIONS PERFORMANCE

CATEGORY: Exploratory Development

DESCRIPTION: The development of compact, high sensitivity, moderate magnetometer technology. Large magnetic moments generally represent real targets which are not as easily or cheaply produced as other decoys. Thus, incorporation of magnetic moments sensors into a "smart" projectile targeting system could improve overall performance by rendering it less vulnerable to decoys. Innovative concepts are sought which will encourage this sensing technology. Other potential applications include magnetic antennas for detection of EM signals and compass headings.

A86-24. TITLE: DYNAMIC HIGH PRESSURE - HIGH TEMPERATURE DIAGNOSTICS

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches are solicited for the measurement of pressure and temperature in the hostile environments of gun interiors. Diagnostics which are applicable at temperatures in the range of 3000 K and pressures 700 MPA are required. The sensors must respond to dynamic fluctuations with risetimes of 0.1 msec or less. The proposals should address novel approaches to the requirement for rugged sensors and techniques which can be used to measure interior ballistic parameters such as pressure, temperature and heat transfer in large caliber (105mm and greater) guns.

A86-25. TITLE: ADVANCED GUN PROPULSION TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: Development of advanced solid and liquid propellant gun systems offers the potential for application of new technology in several areas. Characterization of liquid propellant systems is of considerable interest including ignition and combustion aspects and flow visualization. Proposals are solicited which address the design, improvement, and development of gun propulsion systems and propelling charge design. Areas of interest include development of novel energetic materials for igniters and propellants, novel methods of ignition, application of advanced diagnostics to ignition and combustion and muzzle flash characterization, measurement of in-bore projectile acceleration and other new technology which can be applied to develop more efficient and higher performance gun systems.

A86-26. TITLE: MATERIAL REPLACEMENT

CATEGORY: Basic Research

DESCRIPTION: Develop a suitable replacement for Nylon 6/6 for ammunition applications that will not be affected by explosives, propellants, or humidity.

A86-27. TITLE: GUN BARREL DEVELOPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Develop a composite/ceramic gun barrel that will be substantially lighter and have the same service life as the steel barrels now used on small caliber ammunition.

A86-28. TITLE: ARTIFICIAL INTELLIGENCE ROBOTICS

CATEGORY: Basic Research

DESCRIPTION: A basic research program which has been initiated encompasses the fields of Artificial Intelligence and Robotics for applications to weapon platform control and fire control systems. The thrust of the program is to develop a fundamental understanding of symbolic processing with specific applications to machine learning, adaptive control, machine vision and expert systems.

A86-29. TITLE: MACHINE VISION

CATEGORY: Exploratory Development

DESCRIPTION: Techniques or mathematical algorithms applicable for machine recognition of patterns are desired in support of fire control subsystems capable of recognizing targets on the battlefield. Emphasis is placed on efficient coding of target controls and on fast (real time) processing algorithms.

A86-30. TITLE: THERMAL DESTRUCTION TECHNOLOGY FOR HAZARDOUS WASTES

CATEGORY: Engineering Development

DESCRIPTION: The Sherco Incinerator (using infrared type of heating) will be used for the disposal of the various toxic material generated at Radford and other plants. Work may be extended to include controlled incineration of red water and chemicals resulting from the binary chemical processes.

A86-31. TITLE: SURVEY OF CURRENT TECHNOLOGY FOR NOx ABATEMENT

CATEGORY: Management & Support

DESCRIPTION: The contractor will conduct a thorough survey of the market for NOx abatement technologies and will match specific abatement processes to the NOx emission sources. A cost analysis will be made and investigation protocol will be established for pilot task.

A86-32. TITLE: ASSESSMENT OF HAZARDOUS OPERATIONS

CATEGORY: Management & Support

DESCRIPTION: Survey of hazardous production operations at the Army munition plants with the objective to assess need for performing function as currently done and eliminating personnel from the operation. The assessment will result in recommendations for process modification and the removal of operators from hazardous environment.

A86-33. TITLE: AUTOMATED CUP INSPECTION

CATEGORY: Engineering Development

DESCRIPTION: This effort is proposed to develop a piece of equipment to inspect dimension and hardness of the incoming case cups. This system should possess the ability to inspect and conduct the data analysis for 5.56mm through .50cal.

A86-34. TITLE: MUZZLE FLASH DIAGNOSTICS

CATEGORY: Exploratory Development

DESCRIPTION: There is a need to characterize muzzle flash with respect to intensity; chemical composition; and temperature. This will require developing a portable system with fast time-resolution capabilities.

A86-35. TITLE: LIQUID GUN DIAGNOSTICS

CATEGORY: Exploratory Development

DESCRIPTION: Characterization of liquid propellant gun systems is of considerable interest including ignition and combustion aspects and flow visualization. Proposals are solicited which address the design and diagnostics which are applicable to understanding ignition and combustion in liquid propellant gun systems.

A86-36. TITLE: AIR FILTRATION OF TOXIC GASSES USING MEMBRANE TECHNOLOGY

CATEGORY: Research, Exploratory development

DESCRIPTION: Innovative methods for the removal of toxic vapors such as hydrogen cyanide, cyanogen chloride, phosgene and the nerve agent GB, using state-of-the-art filter membrane technology is needed. Candidate systems should be capable of removing toxic vapors to a level of one part in one hundred thousand or less. Size, weight and operational power requirements are important considerations.

A86-37. TITLE: SUPERADSORBENTS FOR GAS FILTERS

CATEGORY: Research, Exploratory development

DESCRIPTION: Superadsorbents with dyamic adsorption and equilibrium absorption capacities for the removal of toxic vapors from contaminated environments greater that ASC whetlerite activated carbon are being sought. Power, size, and weight requirements for collective and individual protection filters utilizing these superadsorbents are important considerations. Ability to perform in humid atmospheres and stable shelf life are important considerations in the selection of these superadsorbents.

A86-38. TITLE: DEVELOPMENT OF MICROSENSOR-COMPATIBLE RECEPTOR-BASED ASSAYS

CATEGORY: Exploratory Development

DESCRIPTION: Receptor-based assays presently fall into two main categories--radioligand binding and patch clamp electrodes. For various reasons, neither of these techniques is especially conductive to interfacing with current concepts for fieldable microsensors (i.e. small devices capable of transducing an optical or electrochemical signal into an electronic output). Alternate assays schemes are desired and should meet thel following criteria:

1. utilize a naturally occuring, well-characterized receptor (eg, the acetylcholine receptor).

2. monitor receptor binding or response to specific agonist/antagonists by generating a fluorescent, optical, or electrochemical signal which can be interfaced with a microsensor.

3. exhibit low background (less than 10 per cent).

4. exhibit relative stability (minimum of 3 days storage at ambient temperature).

5. exhibit rapid kinetics (less than 10 minutes)

6. exhibit rapid kinetics (less than 10 minutes)

7. exhibit sensitivity to at least 1 microgram per ml for receptor ligands.

A36-39. TITLE: DETECTION OF PATHOGENIC MICRO-ORGANISMS

CATEGORY: Research

DESCRIPTION: Investigate factors which determine virulence among human pathogens as opposed to non-infective organisms which could serve as the basis for the rapid detection of hazardous airborne biological organisms. What are the common characteristics which determine virulence? Are there genetic "common denominators" which could be exploited in separating them from innocuous organisms? What does a pathogen "lose" during serial tissue culture passes in the process of making an attenuated live vaccine? How do pathogens differ as a group from the non-infective organisms? Is rapid, generic biodetection based on these differences feasible?

A86-40. TITLE: DEVELOPMENT OF INTEGRALLY STIFFENED WOVEN STRUCTURAL PREFORMS

CATEGORY: Research

DESCRIPTION: The cost of composite structures is limiting their application in the next generation aircraft. Application of textile weaving technology to fabricating integrally stiffened composite structures has potential for significantly reducing the fabrication cost of composite structures. Woven structural preforms, including multiple stiffeners, need further investigation. The integrally stiffened woven preforms should include fiber orientations consistent with conventional composite structural designs. Structural performance needs to be demonstrated using aerospace grade graphite and Kevlar reinforcements with 350o cure resins and compared with state-of-the-art composite structures.

A86-41. TITLE: THERMOPLASTIC COMPOSITES FOR AIRCRAFT

CATEGORY: Research

DESCRIPTION: Aerospace grade fiber reinforced thermoplastic composite materials offer significant cost and performance benefits as compared to conventional thermoset materials. The application of thermoplastic to woven integrally stiffened structural preforms requires thermoplastic reinforced material to have handlability similar to the bar fiber reinforcements. Techniques to coat individual fibers with fiber reinforcement need to be investigated. Typical fiber reinforcements of graphite and Kevlar with PEEK, K polymer and Eyton thermoplastics should be considered for study. Coated and blended thermoplastic composites need to be demonstrated through fabrication and testing of woven specimens. Studies should also be conducted to study the wetting efficiency.

A86-42. TITLE: REAL-TIME ROTORCRAFT SIMULATION

CATEGORY: Exploratory Development

DESCRIPTION: The sophistication of mathematical models used in real-time simulation of rotorcraft aeromechanics characteristics is typically listed by the capabilities of the simulation computer system. There is a need to develop an innovative solution to this limitation. Specifically, a simulation system which has the following attributes is needed: affordability, parallel processing with high-speed/pipelined processors, a processor instruction set and numerical precision tailored to engineering problems, rapid and low-overhead data transfer between processor, programmability in high-order language(s), ability to interface the system easily with other devices, appropriate system software, and expandability of the system hardware to meet the needs of the math model.

A86-43. TITLE: COMPUTATIONAL FLUID MECHANICS CALCULATIONS

CATEGORY: Exploratory Development

DESCRIPTION: Depending on the computer system used, calculations associated with computational fluid mechanics (CFD) frequently require excessive time to complete. There is a need to develop an innovative approach to reducing the time required for CFD calculations and to expand the computer system to match the requirements of the CFD problems. Specifically, a system for solving CFD problems which have the following attributes is needed: affordability, parallel processing with high-speed/pipelined processors, a processor instruction set and numerical precision tailored to engineering problems, rapid and low overhead data transfer between processors, programmability in high-order language(s), and appropriate system software.

A86-44. TITLE: COMPUTER ARCHITECTURE FOR ON-LINE PROCESSING OF ACOUSTIC SIGNALS

CATEGORY: Exploratory Development

DESCRIPTION: Recent advances in signal processing are utilizing new system architectures for on-line processing of large amounts of discrete acoustic data. New developments in acoustic detection will require specialized computer designs to maximize the effectiveness of the total sensor array. The 6.2 research will integrate the sensor and computer requirements to yield improved data processing techniques for the Army. The requirement is for new and efficient micro-processing and acoustic sensor designs that would provide near real time direction and identification of rotary-wing aircraft signatures.

A86-45. TITLE: UNIVERSAL ENGINE HISTORY RECORDER

CATEGORY: EXPLORATORY DEVELOPMENT

DESCRIPTION: Separate history recorders are developed for each engine. Current electronic capability has reached a point where it would be feasible to develop a recorder which could be common to several engines with an attendant development and acquisition cost savings. A small business electronic firm should be able to survey engine requirements and define and develop a unit which could be used on any turboshaft engine.

A86-46. TITLE: EVALUATION OF FIBROUS/ELASTOMERIC MATRIX COMPOSITES

CATEGORY: Exploratory Development

DESCRIPTION: The recent development of elastomeric matrix materials offers significant potential for innovative design concepts in composite aircraft structures. There is a need to identify candidate elastomeric (flexible) matrix systems and evaluate their application for aircraft primary structures. Test coupons would be fabricated of promising matrix systems combined with typical reinforcing fibers for evaluation of static and fatigue mechanical properties. Following this evaluation, ballistic test specimens of selected elastomeric and epoxy matrix composites could be fabricated and tested.

A86-47. TITLE: EM PROPAGATION IN IONIZED MEDIA - STATE OF THE ART ASSESSMENT

CATEGORY: Research

DESCRIPTION: The Army 21 concept as related to real time battlefield communications has underscored the need for reliability, insured connectivity and enhanced survivability of strategic, operational and tactical reciprocal communications modes (links) among national command authority, theater commanders and the battlefield arena. Electromagnetic propagation in an adverse electronic environment is an integral part of the communication network, and it impacts directly on these needs. In particular, the following specific EM propagation considerations are of interest:
1. Reliability of HF radio (from short to extended distances) through better use of the frequency spectrum and adaptive HF techniques which automatically vary power and frequency selection.
2. HF frequency spectrum management system based on changing propagation conditions predictions and/or real time channel evaluation.
3. Propagation aspects of spread spectrum HF techniques (frequency hopping and direct sequence)
4. Meteor burst and other anomalous propagation for ECM resistant communication.
5. Propagation aspects of digital signals across the electromagnetic spectrum (multipath, dispersion, fadings, etc.)
6. Propagation aspects of satellite/earth communications.
7. Propagation in the nuclear environment across the electromagnetic spectrum
8. Radio noise (natural and manmade).
9. Propogation media characteristics (ionosphere, space environment)
10. Natural/man made propagation media modification.
11. Techniques for assessment of ionized propagation media state.
The objective of the task is to perform state-of-the-art assessment of the

above subjects with a view towards the relation of these to the Army's goal of real time, reliable, continuous and survivable communications goal. Gaps of knowledge in these fields which need addressing to meet the Army's requirements should be identified.

A86-48. TITLE: ADVANCED FACILITIES TO EXPEDITE DESIGN AND EVALUATION OF COMMUNICATIONS SYSTEMS.

CATEGORY: Research

DESCRIPTION: Facilities are needed which will significantly reduce the time and cost to design, test, and evaluate Army Communications systems. These facilities must provide the ability to quickly create realistic test cases to predict and evaluate system performance in a way that could be easily understood by combat developers as well as communications engineers. The dynamics of the battlefield must be easy to represent in an accurate manner, including air and ground vehicle motion, propagation effect in densely foliated and rough terrain based on Defense Mapping Agency data, threat systems and strategy, and user communications traffic needs. Communications systems must be easy to represent to the degree of accuracy desired, including adaptive antennas, wire and glass cable, signal processors using various spread spectrum techniques, message and voice processors, virtual circuit and packet switches, concentrators, network controllers/managers, etc. The ease with which these items can be represented and modified for quick reaction use, and shared by many organizations is paramount.

A86-49. TITLE: DIRECT GROWTH/FUSION CIRCUITRY DEVICES ON OPTICAL FIBER

CATEGORY: Research

DESCRIPTION: There has been rapid acceptance of fiber optic communications systems. These systems consist of discrete components which include the fiber, a transmitter, and a receiver. In these systems an electrical signal is converted to an optical signal, fed thru the fiber and then converted back to an electrical signal. The next stage in the development of these systems is in the area of integrated optics; the aim of which is to be able to do as much signal processing as possible directly on the the optical signal itself. It is of interest to explore the possibility of fabricating active and passive device elements, such as switches, guides, couplers, sources and detectors on or around optical fibers. Such on-line detection and signal processing would be extremely useful in the long term for fiber optic data bus/network communication and result in physically smaller sized systems. The developed technology would have far reaching implication in optical computer techniques. Specifically, the proposed work would investigate the growing or fusing of emitter, detector, or modulator devices directly onto the optical fiber.

A86-50. TITLE: ARTIFICIAL INTELLIGENCE FOR COMMAND AND CONTROL

CATEGORY: Exploratory Development

DESCRIPTION: The tactics and doctrine of the modern battlefield dictate the need for intelligent machines to assist human operators. The technology associated with encapsulating knowledge and techniques used in AI to capture the reasoning process that human experts perform promises to provide a significant impact on future computer system for the military.

Future military systems will be required to be self-learning and interactive. Self learning systems are systems that are able to make significant changes in their internal processing logic in response to user commands or based on demands which have been placed on the system in the past. These systems are extremely important in the military environment because they create significant operational capabilities across a diverse set of applications. They are fundamentally superior and inherently more reliable than the conventional rigid systems because they can be made more fault tolerant and possibly can be given limited properties of self-diagnosis and self repair.

In addition to self-adapting systems, the following AI technology advances are required to insure the adequacy of future military systems:

(1) improved man/machine interfaces, such as natural language understanding and generation.
(2) the ability to represent and reason with data that is imprecise, incomplete, and not totally reliable.
(3) improved methods for knowledge acquisition and
(4) methods for maintaining/enhancing expert systems once they are fielded out.

A86-51. TITLE: OPERATOR-FRIENDLY DATA BASE MANIPULATION

CATEGORY: Basic Research

DESCRIPTION: A computer program utilizing an authoring language needs to be developed on a SIGINT Data Base. Situational scenarios need to be developed that guide the computer operator through a decision tree based on the type and amount of intelligence available through the computer aided instruction (CAI). Critical Nodes and conditional decisions are to be developed that define the conditions that exist based on the SIGINT Data. The computer program shall include modeling for tactical, fixed station strategic, airborne, ground, and multi-intelligence sensor information for a rapid application development system. Computer program development shall allow for inputting data base information for different missions at different geographical locations. Loading of the data base shall be by simple load of floppy disks with a minimum of operator entries. Computer program shall be on an IBM Personnel Computer or equivalent. Work to be performed shall require TS/SI clearances.

A86-52. TITLE: INTEGRATED POWER CIRCUITS

CATEGORY: Exploratory Development

DESCRIPTION: Jammer amplifier and transmitter circuits need to be lighter and cheaper. Integrated circuit technology has made low power analog and digital circuits extremely cheap. It is desired to perform similar integration on power circuits, handling 100-400 W output power per basic power module. These power modules would be in the HF and VHF bands, e.g., 1-100 MHz, 80-400 MHz. The basic power modules would be used alone or in assemblies to make up a large transmitter. The use of integrated circuit concepts should increase reliability and decrease costs. The circuit substrate could be used for a cooling surface and the circuit could be designed mechanically to have modular, self-aligning cooling passages for liquid or air cooling when assembled in large transmitters.

A86-53. TITLE: SKYWAVE HFDF CRITICAL NODES

CATEGORY: Basic Research

DESCRIPTION: A computer model needs to be developed of critical HF communications occurring within the rear echelon of the enemy force area. Methods that require investigation to determine emitter location accuracy include azimuthal, Single Station Location (Elevation), and DTOA. Computer model shall be developed on an IBM Personnel Computer or equivalent. Model shall be based on four station DF system with time to compute location, throughput, distance to transmitters, S/N, capability of DF system, CEP, condition of ionosphere plus other parameters to be controllable from the computer input terminal. A possible model to be used for the condition of the ionosphere would be through the use of oblique ionograms determine relative heights of the ionosphere throughout the area of interest. Using virtual heights of the ionosphere a computer algorithm would be developed to allow for spatial interpolation to a point of interest to each of the DFDF net stations. Predictions of emmitter location accuracy would then be computed based on three dimensional model of the ionosphere. Various conditions and types of signals of interest shall be simulated tc allow for proper investigation of DF net accuracy and importance of data. Model shall simulate high priority HF signals that occur given different state of readiness for the enemy forces. Work to be performed shall require TS/SI clearances.

A86-54. TITLE: IBM-PC EXPERT/DB INTERFACE MECHANISMS

CATEGORY: Exploratory Development

DESCRIPTION: Develop a software mechanism for the IBM-PC family of computers that would allow a resident AI/Expert functionality to control the processing of raw input data into an independent large Data Base (20,000+ records). This work would seek to provide interfaces for Expert Systems with vast amounts of processed information which would be maintained by a standard DBMS and then call upon standard graphic routines to display data in appropriate formats. The Expert System should be in an AI language (LISP based) and the DBMS/Graphics software should be a commercially available package. Purpose of this effort will be to allow integration of AI/Expert functions into existing systems that have Data Bases being maintained on the IBM-PC family of computers. The AI/Expert technology would perform the critical time consuming tasks involved in Data Base maintenance, update, and interface.

A86-55: TITLE: Adaptive Jammer

CATEGORY: Exploratory Development

DESCRIPTION: Present jamming system are broadband, e.g., 10-80 MHz to handle a variety of threats. Extension of this bandwidth capability to handle the entire HF/VHF, 3-300 MHz, is a very desirable but an extremely difficult design problem to handle power efficiently and to minimize spurious outputs, harmonics, efficiently couple to an to an antenna, etc. In many military problems the presented threat may only occupy a portion of the jammer's bandwidth, hence the system is in a sense overdesigned. It is desired that the jamming system be able to automatically reshape its output frequency response to match a given threat. The system should also be able to change its class of operation, e.g., from Class A to Class D, when it might be allowable to produce more

harmonics in order to produce more power vs a given threat. This reconfiguration capability should be executable in seconds under software/firmware control, i.e., under an artificially intelligent system controller. When the system reconfigures itself relatively slowly, it should retain a reasonable instantaneous bandwidth. In the case of, for example, 3-300 MHz range, the instantaneous bandwidth could be 1 MHz one time, 30-80 MHz the next, so that in any dense RF subband, instantaneous jamming response would be available. A benefit of this approach to transmitter design is that one variable 3-300 MHz jammer could replace several fixed narrow band jammers. Hence, logistics costs can be significantly reduced.

A86-56. TITLE: HF Emitter Identification

CATEGORY: Basic Research

DESCRIPTION: HF transmissions need to be identified to the transmitter and platform causing the emanation. Basic research needs to be conducted that rapidly scans the frequency band of .5 to 30 MHz in two seconds or less. Resolution of different signals must be determined to 50 Hz. A historical data base of all signals on the air of up to 2000 emitters must be maintained and properly cataloged. New births must be identified and mode analysis performed to a proper call to better than 90% confidence with a S/N of 10db. Signal features must be developed to allow proper recognition of emitters to a specific transmitter with better than 95% confidence. Possible features that could be used to identify the emitters are modulation, passband, apparent ripple, modulation index, over modulation, carrier drift, envelope rise time, ringing, assymetry plus any additional data that results in the ability to identify the specific emitter. All of the above will be computerized with a second order capability of recording the signal (pre-detected IF and demod output) and allowing for human recognition. Signals must be stored in digital memory with a recall capability of better than 25 msec from digital memory and greater storage capacity when using a combination of digital and analog memory. Recall from digital memory must be performed within 2 msec. Digital and analog memory require 65 db dynamic range and two MHz bandwidth. Work to be performed shall require TS/SI clearances.

A86-57. TITLE: MILITARIZED 3.5 INCH WINCHESTER DISK DRIVE.

CATEGORY: Engineering Development

DESCRIPTION: The overall weight of this drive should be under 20 lbs. The number of platters used is left to the designer, but a capacity of at least 10 Mbytes and a transfer rate of at least 1 Mbps are expected. The power dissipation of the drive and formatter should be no more than 100 watts. In addition, the formatter should allow for the connection of several of these drivers.

Discs must be easily and quickly removable for secure transportation and storage of classified data. The unit must comply with NACSIM 5100A.

A86-58. TITLE: SMALL MILITARIZED PRINTER

CATEGORY: Engineering Development

DESCRIPTION: The printer should print 80 columns with a speed of at least two lines per second. The characters printed should include alphanumeric, graphic, and special characters. The printer's weight should not exceed ten pounds, after being militarized. The printer should run of DC supply of 5, 12, 24, or 28 volts with current not exceeding six amps. The overall power requirements should not exceed 150 watts. The interface should accept an RS-232 connector for serial communications, or a NTDS connector for parallel communications.

A good starting point might be a printer similar to a panasonic EUY-5E which weighs under two pounds.

The unit must comply with NACSIM 5100A.

A86-59. TITLE: COMPUTER-AIDED JAMMING CALCULATIONS FOR RANGE AND DOPPLER CORRELATED RADARS

CATEGORY: Exploratory Development

DESCRIPTION: This effort is directed at developing software that will calculate the jamming modulation parameters to counter radars with doppler velocity gates and doppler plus range correlated tracking gates. The next generation of radars use both range delay and doppler to determine target range. Target data that does not provide a time delay plus doppler that correlates to a particular range can be removed from the tracking data and thus remove elementary jamming. There is a need to develop software that can calculate the correct doppler and range rates for jamming. The software should be written in Basic, run on an MS-DOS computer and the source code should be included with unlimited rights to the government.

A86-60. TITLE: PASSIVE SINGLE-SITE TARGET RANGING TECHNIQUES

CATEGORY: Exploratory Development

DESCRIPTION: Passive ground based Electronic Support Measures (ESM) direction finding (DF) systems normally require the use of multiple, spatially separated, coordinated collection/DF sites in order to range on ingressing airborne targets. Multiple site DF triangulation techniques are used to estimate target aircraft effective range. The use of multiple ground based DF sites represents significant operational complexity and expense. The purpose of this task is to develop passive ESM/DF processing techniques which will permit effective real-time estimation of target aircraft range from a single collection site. The work task should include simulation of the technique and determination of performance bounds.

A86-61. TITLE: RESEARCH IN ARTIFICAL INTELLIGENCE FOR ELECTRONIC WARFARE SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: In the EW Mission, there are several application areas that appear as likely candidates for the use of AI-techniques. Some these include:

ELINT System Management, Jammer Power Management, Threat Warning, Management of Unmanned Systems, Simulation, Maintenance, and Training. In each of these areas, there is a significant need for human expertise in terms of background, experience, and judgement. The primary goal in the application of AI techniques to EW systems is to capture the knowledge of experts and replicate it for use by non-experts. An extension of this goal is to replace the human operator, especially when logistic or hazardous considerations make replacement appropriate.

A86-62. TITLE: AIRCRAFT MULTI-SPECTRAL RADIO FREQUENCY/ELECTRO-OPTICAL INFRARED COUNTERMEASURES

CATEGORY: Exploratory Development

DESCRIPTION: Analysis need to be performed to determine how to counter weapon systems that have integrated RF/EO/IR target acquisition and tracking systems. Successful jamming of these systems may require integrated Multi-Spectral Countermeasures.

A86-63. TITLE: RF FILTERS FOR MULTICHANNEL STEERABLE NULL ANTENNA PROCESSOR (MSNAP)

CATEGORY: Exploratory Development

DESCRIPTION: A bank of tunable RF bandpass filters shall be developed for use in the Multichannel Steerable Null Antenna Processor (MSNAP). The bank of six filters will tune over the 225 to 400 MHz band, providing isolation between the receive and transmit signals of a band I AN/GRC-103 radio. Each of the six filter channels will protect one of the antenna element receive paths of the MSNAP, in order to permit duplex operation through the MSNAP antenna array. The filters must be phase matched to permit null processing, and must occupy a total volume of no more than one cubic foot.

A86-64. TITLE: IMPROVED MOISTURE-RESISTANT POTTING MATERIALS/TECHNIQUES FOR IMAGE INTENSIFIERS

CATEGORY: Advanced Development

DESCRIPTION: An image intensifier tube assembly consists of an image intensifier vacuum tube module, a miniature high voltage power supply, and an inert filler (i.e., potting) material inside a metal or plastic housing. The power supply, which runs off of a battery, provides voltages to the tube module ranging from several hundred to six thousand volts, at currents up to nearly ten microamperes. To do this, the power supply typically draws anywhere from ten to fifty milliamperes of current from this battery. The purpose of the potting material is to provide the mechanical stability and electrical insulation needed to sustain stable intensifier operation. The problem with the present potting material (RTV-11) is that in humid environments, moisture penetrates the RTV encapsulation and causes leakage currents along the tube module high enough to overwhelm the power supply and shut the intensifier down. The development program will address new potting materials, such as addition-cure RTV's and new potting techniques, such as coating the tube module with a hydrophobic material prior to potting. The efficiency of new materials and techniques will be

evaluated by monitoring intensifier operation in a minimum 95% relative humidity environment over periods of up to several days. Up to twenty-five (25) tube modules and miniature power supplies, along with Level III drawings for intensifier housing, will be furnished by the Government for this development program.

A86-65. TITLE: INFRARED DETECTOR ARRAYS

CATEGORY: Exploratory Development

DESCRIPTION: Infrared photovoltaic diode arrays in the 3-5um and 8-12um spectral band are being developed for military applications. Detector arrays are processed on thin film epitaxially grown layers. The detectors are very sensitive to processing conditions and the surfaces of epitaxial layers must be carefully prepared to minimize surface leakage and noise. Low frequency (one-over-f) noise due to surface leakage and bulk defects is a detector performance problem. High quality diodes are characterized by high resistance at zero bias, large reverse bias breakdown voltage, low reverse leakage current, and response uniformity across the array. Arrays are typically arranged in a two dimensional format with from 500 to 5000 individual elements.

Processing infrared arrays involves photolithography, metalization, thin film insulator deposition, wet chemical etching, and plasma etching. Each process must be carefully controlled to achieve uniformity across the detector chip and minimize process induced defects.

A86-66. TITLE: TUNABLE LASER MATERIALS DEVELOPMENT FOR THE NEAR INFRARED

CATEGORY: Research

DESCRIPTION: The Army has a current need for efficient solid-state tunable laser materials operating in the near infrared and at room temperature. Transition metal ion dopants in oxide and fluoride host materials have been known to exhibit tunable laser activity over bands extending from the visible to the near infrared. The proper selection of the dopant ion and lattice host combination is critical to achieving a stable crystalline environment for enhanced tunable laser efficiency. A competing and deleterious process that must be avoided may take place through excited state absorption and may reduce the dopant ions's lasing intensity and tunability range.

The present effort is oriented towards the selection of possible tunable laser materials candidates that would operate under the most favorable conditions in the near infrared band. Small samples of selected tunable materials would be made or purchased and tested spectroscopically, and for possible laser behavior in the near infrared band. Such a study would aid in the theoretical understanding of tunable laser materials and in better prediction of their behavior.

A86-67. TITLE: TUNABLE LASER PARAMETER OPTIMIZATION

CATEGORY: Research

DESCRIPTION: The Army is involved in the development of efficient solid state tunable laser materials. The parameters that are of importance in this development are: quantum efficiency, fluorescence band wavelengths, stimulated emission cross-section and energy transfer between sensitizer ions and lasing ions. The conditions for optimizing these parameters are not fully understood at the present.

The proposed work would initially concentrate on a limited number of crystals selected for their potential ease of characterization. In these crystals the effort would be to study the mechanisms which optimize the above-mentioned parameters in order to gain leverage on the ultimate goal of achieving high efficiency in these solid state tunable laser materials.

An example of a crystal that could be studied for parameter optimization is gallium scandium gadolinium garnet. This crystal is known for its high efficiency at one micron wavelength. However, it is not as well understood for its vibronic tunable laser output when singly doped with an element such as chromium.

A86-68. TITLE: IMPROVEMENTS IN MATERIALS AND DESIGN OF HOLOGRAPHIC OPTICAL ELEMENTS

CATEGORY: Exploratory Development

DESCRIPTION: Innovations are needed to provide increased performance of holographic optical elements. Investigation of the feasibility of new materials which offer environmental stability advantages is needed. Applications include holographic mirrors, filters and lenses. Flexible substrate configurations are also of interest. The reliable production of high quality optical elements suitable for use in imaging equipment needs to be examined with emphasis on the optical advantages of diffractive elements, low cost mass production and environmental stability.

A86-69. TITLE: TUNABLE FILTERS FOR THE VISIBLE/NEAR INFRARED

CATEGORY: Research

DESCRIPTION: Fast tuning filters are needed to reflect or transmit narrow bands of laser energy between 0.4 microns and 1.2 microns while transmitting or reflecting (respectively) a high percentage of the remainder of the band. Tuning times of 1 microsecond or less are desired with optical densities of 4 or greater (reflection mode). This device should be self-activating, i.e., respond to unknown input light and reflect it within 1 microsecond. Also, it must not degrade the optical quality of an image transmitter through the device. Fields of view up to 20 (+10) are desirable even through smaller fields of view are acceptable in certain applications. These devices will be used in various Electro-Optic applications involving lasers.

A86-70. TITLE: INTERFACE AND DIGITAL RECORDING ELECTRONICS FOR AIRBORNE TEST SYSTEM

CATEGORY: Advanced Development

DESCRIPTION: The work will be in support of the Army's ASSET Program. ASSET is an airborne test system installed on a UH-1 helicopter. The system consists of a special turrent to stabilize electro-optical sensors, a computer based controller, and high speed recording equipment. The system will be used to obtain high quality airborne infrared image data and will also act as a test bed for next generation sensors and automatic target cuers.

The proposed contract would be to design, build and write software for interface electronics to the ASSET computer and recording equipment. The ASSET computer is an HP9826S with RS 232, IEEE-488, Mil Std 1553 interfaces as well as a high speed data bus and other custom electronics. The effort would include:

a. Maintain existing custom interfaces and high speed digital reformatter.
b. Design and fabricate an interface to a Litton LR 80 Inertial Navigation System.
c. Hardware and software required to automate the collection of aircraft position, heading, velocity, etc, for data logging purposes.
d. Provide a fiber optic link for high speed sensor data from the ASSET turrent.
e. Design and fabrication of custom interfaces from ASSET sensors to a variety of NVEOL sensor processors (PATS II, MTAP, ATC).
f. Design and fabrication of special electronic interfaces for recording of image data from next generation infrared imaging sensors.

A86-71. TITLE: DEVELOPMENT OF RADIOCHROMIC DOSIMETER

CATEGORY: Engineering Development

DESCRIPTION: Develop reproducible radiochromic waveguide dosimeter elements and then use tis technique to produce a limited number of dosimeter assemblies suitable for a thorough evaluation and testing. Such dosimeters would be self contained and would read the combined gamma plus neutron dose. They should contain the associated excitation (LED) and sensing (photo-diode) devices. Several active sensors of such dosimeters were built in the laboratory and were evaluated. They are described e.g. in the US Patents Nos. 4247 775 and 4489 240. This work would have to be done in close coordination with the scientists of this activity. Should lead to engineering development and eventually to mass production of these devices.

A86-72. TITLE: GAMMA/BETA RADIATION DETECTOR

CATEGORY: Exploratory Development

DESCRIPTION: A program to develop a solid state detector/matched preamplifier capable of detecting gamma radiation to background level. The detector should be operable at voltages at or less than 10 volts. It should be small, capable of being incorporated in an instrument of cigarette package size, and cover a dose-rate range from approximately 0.1 Rad/h to .01 mRad/h.

It should ultimately be capable of being manufactured (detector only) for less than $50. It should show promise of being operable over the full range of military environments. It should be sufficiently survivable to be operable even after an appreciable neutron or gamma dose.

A86-73. TITLE: TACTICAL PATH INTEGRATING TEMPERATURE GRADIENT SENSOR

CATEGORY: Basic Research

DESCRIPTION: The vertical aiming accuracy of direct fire weapons can be adversely affected by atmospheric refraction. This is particularly important in desert environments where there are strong temperature gradients within

the first few meters of the earth's surface. It is the temperature gradient which causes the refractive effect. The refractive effects only become important for path lengths of 2 km or more. The optical path represents an integrated value of the temperature gradient between the receiver and the target.

A need exists for a sensor which will remotely determine an integrated temperature gradient between a direct fire aiming system and a target. This device should be a passive sensor and should be capable of being incorporated into the fire control system of a tank's computer.

A86-74. TITLE: ARTIFICIAL INTELLIGENCE FOR TACTICAL WEATHER EFFECTS

CATEGORY: Exploratory Development

DESCRIPTION: The explosive growth in the ability to collect data on the modern battlefield dictates that computers will have to assume an ever increasing role in the analysis of these data and in assisting the commander with reaching optimal decisions. AI technology offers a promising solution to this problem by providing a means to structure knowledge and solve problems in much the same way as a human expert.

Much of the work presently accomplished in the Intelligence Preparation of the Battlefield, meteorological effects in particular, is conductive for transfer to an AI "expert" system. The ability of these systems to represent and structure complex data, cope with non-linear effects, and manipulate data that is both incomplete and unreliable offers a significant assistance to the military analyst. The design of modular knowledge bases dealing with the environment and its effects on military systems will have a significant impact as a force multiplier on the future battlefield.

A86-75. TITLE: LOW TEMPERATURE HUMIDITY MEASUREMENT

CATEGORY: Basic Research

DESCRIPTION: A need exists for the accurate measurement of the wet bulb or dewpoint temperature to determine relative humidity when the ambient temperature is between 0 and -70 Fahrenheit. It is known that the relative humidity or the amount of moisture in the atmosphere has an important impact upon systems and materials being tested in an Arctic environment.

The relative humidity parameter is a required input to surveillance and performance testing of many systems and materials. For example, the long term effect of the presence of humidity on missile systems must be measured in order to determine future storage requirements. Another example is the testing of electro-optical weapons and sensors. The observation parameters such as fog and smoke depend upon the amount of moisture in the air for their formation and life span. A satisfactory technique for obtaining accurate measurements of dewpoint or wet bulb temperature at ambient air temperatures between 0 and -70 does not exist.

A86-76. TITLE: HIGH-RELIABILITY SOFTWARE

CATEGORY: Advanced Development/non systems

DESCRIPTION: One very important component of computer software quality is reliability. Software reliability means that the software performs its required functions correctly and does not behave in an unexpected fashion. Unlike hardware, software does not wear out or perform at a degraded level due to age. There have been many examples of reliability problems with software and, in each case, further testing, program changes, and improved operational procedures have corrected the problems so they did not recur. With the growing population of computer weapons systems taking on increasingly critical functions, software reliability takes on progressively greater importance. Improved procedures/tools to build highly reliable software are needed.

A86-77. TITLE: COMPONENTS FOR RECHARGEABLE AMBIENT TEMPERATURE HIGH ENERGY BATTERIES

CATEGORY: Research and Exploratory Development

DESCRIPTION: The Army requires a high energy battery chemistry with the following characteristics:

1) Operation over the full military temperature range.
2) Theoretical energy density over 250 W hrs/lb based on active materials.
3) Internal current density over 2 mA/cm2 over full temperature range.
4) Low materials costs to make use as a throwaway battery feasible under some conditions.
5) Reversibility of electrodes to allow use as a rechargeable battery under some conditions.
6) Indefinitely long storageability at ambient temperatures.

The goals listed above will be furthered through the development of new or improved cell components including:

1) Improved Negative Plate

Lithium is normally chosen as the negative plate material in such cells. R&D activities should focus upon the improvement of recyclability of lithium (for rechargeable batteries) and the stability of lithium in electrolytes (for good battery storage). Approaches include alloying of the lithium, application of coatings to the lithium surface and addition of reagents to the electrolyte which will generate useful coatings on the lithium electrode.

2) Improved Electrolytes

Electrolyte must be compatible with the highly reducing lithium electrode and the highly oxidative cathode. Improved electrolytes meet the two latter conditions and provide increased electrolyte conductivity and higher lithium cycle life and storageability. New electrolyte formulations may comprise mixtures of organic and inorganic solvents and organic and inorganic lithium salts.

3) Improved Cathodes

One of the most successful cathodes for ambient temperature rechargeable lithium batteries has comprised the active material, TiS2, the polymeric binder, polytetrafluoroethylene, the electronic conductor, graphite and a conductive screen. In improved cathodes, the replacement for TiS2 would possess higher Gibbs free energies for formation of the corresponding lithium-insertion reduction product and improved kinetics for that process. The electronic conductivity of the active material would be high, eliminating the need for an inert conductive powder (e.g., graphite). A "binder" superior to PTFE would provide good cohesion of the active material with enhanced cathode flexibility, increased ease of manufacture (particularly for very thin electrodes) and enhanced resistance to mechanical expansion-contraction cycles.

4) Improved Separator

Most separator materials are based on the use of glass or polyethylene as the raw material. These materials are limited with respect to reactivity with lithium (particularly molten lithium) compatibility with organic and inorganic electroltyes and ability to withstand lithium dendrite penetration (during re-charge). Improvements will address those problems and also present the possibility of preparing very thin sheets of separator either freestanding or adhered to the lithium electrode.

5) Charge/Overdischarge Controls

Improved electronic charge and overdischarge control systems are required which have very low drains (microamps) during standby, are insensitive to transients and are accurate, precise and reliable over a wide range of environmental conditions.

A86-78. TITLE: NEW CONCEPTS FOR MILLIMETER WAVE ELECTRONIC SCAN ANTENNAS

CATEGORY: Exploratory Development

DESCRIPTION: Design and develop a unique, low-cost electronic scan antenna for operation in the 35 GHz frequency region. A new and novel design approach should be proposed for a two dimensional planar array utilizing electronic phase scan capability in one plane. This approach would be required to be less complex than conventional phased array designs employed at microwave frequencies in order to insure cost-effectiveness and ease of fabrication at millimeter wavelengths and permit scaling up to the 94 GHz frequency region. The thrust of the program therefore should be to develop a low-cost, reliable antenna for compact, rugged, high performance munition guidance.

A86-79. TITLE: ADVANCED 94 GHz SOURCES

CATEGORY: Research

DESCRIPTION: Investigate a number of advanced GaAs electronic device structures for possible application as 94 GHz sources in Army MLRS-TGW systems. Investigation to include, but is not limited to, notch front, graded drift region, heterojunction, and ballistic launched Gunn structures in both discrete (conventional) and planar (surface orientated) configurations. Research shall

consider device concept, design, and modeling with subsequent processing into a final structure and evaluation at 94 GHz. Operation at 94 GHz can be second harmonic with parameters of interest being power output, frequency, and efficiency.

A86-80. TITLE: MILLIMETER WAVE GaAs IMPATT DIODE MATERIAL DEVICES AND TECHNOLOGY

CATEGORY:

DESCRIPTION: GaAs IMPATT devices generate more power, both pulsed and CW, with higher efficiency than any other microwave/millimeter wave solid state device. To exploit this advantage, improvements are necessary in the technology of GaAs epitaxial materials growth, device chip processing and packaging. Additionally, to realize the full potential of better doping profiles, improved materials on accurate model of the IMPATT diode operation is necessary. For millimeter wave operation this is particularly true because many physics of device limitations remain unknown.

The principal goals of the program will be 1.) to develop tighter controls over epitaxial material growth, device processing, metallization and packaging to produce higher yields, wafer-to-wafer uniformity and reproducibility; 2.) to develop a large signal model of IMPATT operation using computer aided analysis to correlate GaAs IMPATT performance with various doping profiles. This then provides the basic guidance for the design of optimum, high power, high efficiency devices and 3.) to develop an accurate thermal model which will predict the means both through device and circuit technologies to minimize frequency and phase "chips" in IMPATT oscillators and amplifiers, respectively.

A86-81. TITLE: PHYSICS AND CHEMISTRY OF SUBMICRON CIRCUIT FABRICATION AND OPERATION

CATEGORY: Research

DESCRIPTION: Integrated circuit (IC) devices must be reduced to submicron and ultrasubmicron dimensions to enable fastest possible signal processing speeds in a variety of military electronic systems. Important problems bearing on successful production and application of these advanced IC are (a) the delineation of small elements on the semiconductor chip, (b) control of atomic-scale defects arising in manufacture or in high-stress operation, and (c) development of comprehensive theoretical models for optimal operation. Some pertinent research areas are (a) electron-beam lithography, resists, and dry etching methods; (b) spectroscopy and atomic-scale definition of defects; (c) carrier transport in the ballistic regime, in 2-dimensional structures, and in quantum supermatrix arrays.

A86-82. TITLE: PATTERNING OF GaAs AND AlGaAs ULTRA-SUBMICRON DEVICE STRUCTURES

CATEGORY: Research

DESCRIPTION: Future military requirements for real-time information acquisition and processing in tactical EW, DC3I, and smart munitions establish a need for ultralarge-scale and superhigh-speed integrated circuit micro-

electronics. New classes of solid-state devices, for example, quantum-well supermatrix structures, promise the possibility of ultrahigh-speed (picosecond) switching and high-frequency (10-100 GHz) mm-wave components for microwave/ microelectronic integration. These devices exploit the concept of one-, two-, and three-dimensional electron confinement through the use of molecular beam epitaxy (MBE) and ultrafine-lithographic techniques. Research into the formation of ultra-submicron device structures in GaAs and GaAlAs from 1,000 to 100 A is required. Techniques such as wet etching and/or plasma etching (RIE, RIBE, CAIBE, etc) and their associated chemistries are to be evaluated in terms of ultimate resolution, aspect ratios, ease of use, etc. Knowledge of concomitant processing procedures such as lithography, masking and surface preparation is requisite.

A86-83. TITLE: LOW-LOSS SURFACE ACOUSTIC WAVE (SAW) FILTERS USING MONOLITHIC CONSTRUCTION

CATEGORY: Exploratory Development

DESCRIPTION: Investigate, develop and demonstrate compact, high performance SAW bandpass filters operating in the 200-400 MHz frequency range. The filters are to utilize monolithic undirectional transducers with an apodized electrode design for narrowband (1%) performance, less than 6 dB insertion loss and greater than 40 dB out-of-band signal rejection. SAW IF filters are finding increasing usage in communications systems (both ground and satellite). To make these filters even more cost effective, it is important to reduce their insertion loss to eliminate the need for an amplification stage to recover the loss.

A86-84. TITLE: DIGITAL SPECTROSCOPY OF PIEZOELECTRIC CRYSTALLINE MEDIA

CATEGORY: Exploratory Development

DESCRIPTION: Apply the methods of digital spectroscopy to the precision determination of the effective permittivity and attenuation tensors of single crystal and composite structures comprised of piezoelectric crystalline media at microwave, millimeter wave and optical frequencies as functions of temperature and orientation. These basic material properties are required to be known to greater precision in order to more accurately design acoustic wave devices at higher frequencies and take full advantage of advances in circuitry. The objective is to achieve improved low noise oscillator designs for air defense radar receiver applications.

A86-85. TITLE: CRYSTAL PLATE ANGLE CORRECTION

CATEGORY: Exploratory Development

DESCRIPTION: The frequency versus temperature characteristics of crystal resonators depend primarily on the angles of cut of the crystal plate. State-of-the-art cutting techniques cannot provide the angles of cut accuracies required for the high yield fabrication of precision resonators. Cost effective methods of correcting and maintaining the angles of cut subsequent to cutting need to be developed. Of special interest are SC-cut resonators, for SC-cut resonators are expected to be the principal cut used in future C3, navigation, radar and IFF systems. Angles of cut accuracies of a few seconds of arc are required in some applications.

A86-86. TITLE: RADIATION HARDENED OSCILLATORS

CATEGORY: Exploratory Development

DESCRIPTION: Evolving C3, navigation, radar and IFF systems require ever tighter tolerances on frequency standards and clocks. As the tolerances become tighter, the radiation induced frequency shifts become an increasing portion of the tolerances. For some systems currently under development, the radiation induced frequency shifts are a major limitation on the achievable system performance.

Novel methods of reducing the frequency shifts due to low and high levels of ionizing radiation, and due to energetic neutrons need to be developed.

A86-87. TITLE: PACKAGING OF HIGH PRECISION RESONATORS

CATEGORY: Exploratory Development

DESCRIPTION: High precision quartz crystal resonators are the key frequency determining element in the frequency standards and clocks used in modern military C3, navigation, radar and IFF systems. One of the major causes of instabilities in resonators is due to the support structure of the resonator. Improved methods of supporting the resonators need to be developed. The method can include novel plate geometries, and improved mounting and bounding techniques. The method must minimize the instabilities due to stress relief and contamination, while providing a rugged resonator. Ultraclean, low cost methods of hermetically sealing resonators are also sought.

A86-88. TITLE: MILITARIZED WATCH (MILWATCH)

CATEGORY: Exploratory Development

DESCRIPTION: A militarized wristwatch (MILWATCH) is required that is capable of both accurate timekeeping and accurate time transfer. The goal is to provide a convenient means of transferring time to the clocks of tactical spread spectrum systems. The initial timekeeping accuracy goal is three seconds per month. Methods of conveniently and rapidly transferring time to and from the MILWATCH need to be developed. Although the initial accuracy goal could be achieved with a manual time transfer method, automated time transfer methods are desired in order to accommodate future improvements in low power clock technology, and in order to minimize the errors introduced by the time transfer method.

A86-89. TITLE: VIBRATION INSENSITIVE CRYSTAL OSCILLATORS

CATEGORY: Exploratory Development

DESCRIPTION: Vibration induced phase noise significantly degrades the phase noise attainable with crystal oscillators. This degradation limits the performance of military systems, among which are coherent radar and navigation systems that must operate on vibrating platforms, e.g., on aircraft. Methods are required for reducing the vibration sensitivity of crystal oscillators to below 1 X 10-11 per g.

A86-90. TITLE: TERMINAL PROTECTION DEVICE ACTIVE MEDIA

CATEGORY: Research

DESCRIPTION: Develop a solid-state nonlinear medium that will be highly conductive to large voltages and highly resistive and low in capacitance to low voltages. The figure of merit is the reciprocal of the product of the resistance while conducting and the capacitance at low voltages as expressed in GHZ. This function is presently performed by MOVs which are a bulk device with a figure of merit of 1 GHZ, zenerdiodes which are junction with a figure of merit of 20 GHZ, and PIN diode limiters which are also junction devices with a figure of merit of 1000 GHZ. The medium must respond without delay to instantaneous voltage surges. PIN diodes have the disadvantages that they limit only at 0.7V, and are tiny junction devices Zener diodes have the disadvantage that their figure of merit is too low. A new media is needed like the MOV which is a bulk device providing for high energy absorption, having an adjustable threshold in the 5 - 150 V range, instantaneous response, and high figure of merit, 100 - 1000 GHZ. Once the media is developed it must be tested in configurations that provide pig-tails (as the present MOVs) and in a 50-ohm TEM through PVT.

A86-91. TITLE: LOGISTICS SUPPORT OF NUCLEAR SURVIVABLE EQUIPMENT

CATEGORY: Management & Support

DESCRIPTION: The objective of this program is to develop and document the integrated logistic support (ILS) concepts for nuclear survivable, tactical Army equipments/systems. Once hardened equipment is developed, steps need to be taken to ensure that it is produced, maintained, repaired, supported and product improved in ways which will not degrade the equipment hardening. Nuclear hardening designs, data and analysis, hardness assurance, hardness surveillance and hardness maintenance information needs to be translated and integrated into the appropriate ILS documents and procedures. Some important issues are manpower requirements, training plans, maintenance procedures, parts procurement, and development of foolproof methods to control changes to the designs or replacement of parts which might jeopardize the equipment hardening. Additionally, other nuclear survivability issues may need to be protected, e.g., redundant equipment, crew vulnerability mitigation techniques and equipment-restoration measures.

The Army has developed Data Item Descriptions which are used to collect the supporting data, plans, analyses and reports during the equipment development phases. However, we have not learned enough about ILS to know how to integate this information into the plans, manuals, reports, procedures, etc., that the ILS system requires. Our strategy is to find a contractor who knows about the Army's ILS procedures, have him learn about nuclear weapons effects or work with a subcontractor who has experience with nuclear weapons effects. The result of this program would be a report which shows how nuclear weapons effects information is to be integrated into the ILS program, showing how specific types of information goes into manuals, reports and other documents, naming the sections and paragraph numbers, as appropriate.

A86-92. TITLE: NUCLEAR SURVIVABILITY OF NON-DEVELOPMENTAL ITEMS (NDI)

CATEGORY: Advanced Development

DESCRIPTION: The objective of this program is to develop the concepts and techniques to harden NDI to the initial nuclear radiation (INR). The deliverable is a guideline, how-to-do-it report.

A current major thrust of the DoD is wherever practical to buy NDI. NDI can range from off-the-shelf commercial equipment to militarized equipment. It would be the rare case where these NDI equipments are nuclear hardened. For other than the INR, hardening of equipment can oftentimes be done without changing the internal design or construction of the equipment. With the INR threat,detailed design and performance specifications are required before hardening can proceed (INR shielding is impractical for mobile equipments). Sometimes these specifications are not available because the manufacturer considers the information to be proprietary. Moreover, the manufacturer can refuse to identify the JEDEC equivalent numbers for his coded semiconductor pieceparts and then refuse to sell quantities of parts for radiation testing. Radiation testing of whole equipments without an analytical understanding of what controls the equipment responses leads to problems in defining hardness assurance (HA) and hardness maintenance (HM) programs. HA/HM is also a special problem for NDI since when buying equipment we buy the functions and not the fixed internal designs. When the manufacturer can freely change the internal designs during production, repair, maintenance or product improvement, there is no control over the nuclear radiation hardness of the equipment.

In this program, we would like a contractor who is knowledgeable about nuclear weapons effects to survey manufacturers of NDI which have actual or potential applications in the Army. Interviews with user representatives and system developers would provide another useful perspective. In particular, the Project Manager Mobile Subscriber Equipment is a recommended interviewee. In this survey, the contractor would explore those issues and options for procurement of nuclear survivable systems; present all the possible options, to include hardware modifications and other approaches, such as, redundant equipment, operator intervention, software modifications, etc.; and recommend the preferred risk, cost-performance tradeoff.

A86-93. TITLE: SINGLE PULSE, HIGH POWER MICROWAVE DIAGNOSTICS

CATEGORY: Research

DESCRIPTION: The new field of High Power Microwaves has provided 1-100 GHz low rep rate sources wit gigawatt peak powers and pulse lingths of 1-100 ns. This active field of research needs diagnostic instrumentation capable of ascertaining the spectral content, power, pulse width, mode and bandwidth for a single pulse.

A86-94. TITLE: WIDEBAND ELECTROMAGNETIC FIELD SENSORS

CATEGORY: Engineering Development

DESCRIPTION: Design and fabricate electric and magnetic field sensors to operate over a 10 kHz to 1 GHz frequency range. The electric field sensor (or sensors) will be capable of sensing electric fields in the range of 0.01 V/m to 150 kV/m. The magnetic field sensor (or sensors) will be capable of

sensing magnetic fields in the range of 0.1 mA/m to 800 A/m. Each sensor will output a voltage that is directly proportional to the measured field and will work into a 50 ohm load impedance. Both active and passive sensors are acceptable. Active sensors will operate on internal low-voltage dc batteries (e.g. 12 Vdc). The volume of each sensor must be less than 400 cm3. These sensors will be interfaced to fiber-optic transmitters (Government-furnished equipment, GFE). The total package, sensor plus fiber-optic transmitter, will have a geometry for which the sensor enhancement factor can be computed analytically. Computation of the enhancement factor for each sensor in the geometry selected to house the sensor and the fiber-optic transmitter is required.

A86-95. TITLE: EW VULNERABILITY

CATEGORY: Exploratory/Advanced Development

DESCRIPTION: The US Army has an extensive program designed to stress its weapon systems to electronic warfare (EW) environments to establish their limits to hostile EW. This limit is called a system's EW vulnerability and this vulnerability is reduced by the incorporation of electronic counter-countermeasures (ECCM) into the system being develop to harden it to hostile EW. The EW environments consist of electronic countermeasures (ECM) and electronic support support measures (ESM) that are used to direct, locate, and identify systems on a modern battlefield. The Army EW vulnerability assessment program requires advances in all three of these areas (ECCM, ECM, and ESM). Further, these advances must be matched with advances in the use of the electromagnetic spectrum which now encompasses radio frequency (RF), millimeter wave (mmw), infrared (ir), optical (O), and ultraviolet (UV) portions of the spectrum. The use of three or more of these regions is defined as multispectral and, because of the costs required to conduct EW vulnerability assessments, all advances are to address as much broadbanded or multispectral frequency coverage as possible.

A very broad base of scientific knowledge exists regarding magnetic fields, but, because of the short range and low field densities, magnetic fields have found small application in Army ESM techniques. Thus, we need to develop magnetic field applications that can be used to complement existing ESM techniques across the spectrum. Multispectral sensor concepts need to be developed to permit simultaneously across RF, mmw, ir, O, and UV frequencies in an NKC-135A aircraft environment are required for air-to-air and air-to-ground measurements.

Two major areas of ECM advancement are required. These are advanced chaff and smart munitions ECM techniques. Advanced chaff techniques are required for multispectral ECM environments. The chaff techniques proposed should consider the type of material, form, and development techniques. The smart munitions ECM techniques must be as broadbanded (multispectral preferred) as possible to minimize the costs in applying them to a wide variety of munitions currently undergoing development.

The ECCM advances required are for electro-optical (EO) devices. These ECCM techniques should be used to reduce effects of lasers used as ECM against the EO devices. Emphasis should be placed on ir, television, nightsight, and UV systems.

A86-96. TITLE: LOW EMISSIVITY SURFACE COATINGS

CATEGORY: Research

DESCRIPTION: A need exists for thin surface coatings exhibiting low emissivity (high reflectivity) in the thermal infrared (2-14 microns). Innovative research is required to formulate practicable coatings having emissivity values in the 0.5 to 0.7 range. This research may include, but is not limited to, synthesis of infrared transparent binders and highly reflective pigments. This research should also investigate the feasibility of producing coatings exhibiting a variety of emissivity values in a controlled manner.

A86-97. TITLE: LIGHT WEIGHT COMPOSITE ROADWAY SURFACING SYSTEM

CATEGORY: Research

DESCRIPTION: A lightweight, mobile and durable roadway surfacing system is needed to provide trafficable approaches to and from bridge and fording sites for military vehicles up and including MLC 70. The current aluminum extrusion panel systems are to heavy for high mobility (6.5-7.0 lb/ft2). The composite panels must be compatible with existing Access/Egress Roadway Dispensing System. This system incorporates panels 14 feet wide and 2 feet long in aluminum connected together by a hinge to form a roadway of approximately 100 feet. The panels fold out and off the dispenser in an accordian manner requiring 180 of rotation. The individual panels are replaceable when damaged. The roadway will be used to support vehicles over poor soil conditions (CBR 1.0) and water affected areas for upwards of 3000 crossings (10% MLC 70). Goal weight for new panel system is 5 lbs/ft2 or less. Work is anticipated to encompass materials and unique geometric configurations.

A86-98. TITLE: NOVEL CONCEPTS FOR RAPIDLY DEPLOYABLE ELECTRIC POWER DISTRIBUTION SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: Electric power usage in the field Army today continues to rise with the increased use of sophisticated weapon systems and equipment. This trend, coupled with decisions aimed at reducing total numbers of generator sets in the field, has resulted in increased interest in the distribution of electric power. In particular, consolidation of multiple loads of greater and lesser critically and multiple sources (some in standby) on the same cable-type distribution system appear a viable approach even for some tactical units. The high degree of mobility envisioned as essential on the modern battlefield mandates that these cable-type electric power distribution systems be rapidly deployable and redeployable. The objective of this work is to develop and evaluate new concepts for electric power distribution under field conditions which will yield rapid deployment/redeployment and high mobility. Specifically, connector systems are found to be a major problem area in that they are usually somewhat fragile and susceptible to environmental degradation and to be both slow to engage/disengage and cumbersome to handle. New ideas are needed which will provide for low loss, multiple conductors, resistance to environmental effects and rapid fault resistant connection/ disconnection. Other novel approaches in the area of cable-type electric power distribution systems are encouraged.

A86-99. TITLE: NOISE REDUCTION OF IC ENGINE DRIVEN GENERATOR EQUIPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Innovative Techniques are sought to reduce the noise emissions and to attenuate the emitted noise from internal combustion (priority diesel) engine driven electrical power generation equipment. Objectives are to significantly reduce the aural signature while having minimum impact on weight, volume and performance.

A86-100. TITLE: INNOVATIVE CONCEPTS FOR COOLING TACTICAL SHELTERS

CATEGORY: Exploratory Development

DESCRIPTION: Devise method(s) for removing electronic heat loads from shelters during air over pressure environments created by chemical/biological air filtering systems. Use of contaminated outdoor air for cooling is not permissible.

A86-101. TITLE: DEVELOPMENT OF A LUBRICANT QUALITY MONITOR

CATEGORY: Exploratory Development

DESCRIPTION: Automotive lubricants used within the military are procured on the basis of their meeting specific performance criteria at the time of qualification. These performance tests involve rather complex, time-consuming, and costly engines dynamometer and component testing. Once qualified and identified on the appropriate Qualified Products Lists, only laboratory type tests (i.e., physical properties, additive constituents, etc) are utilized to insure product conformance.

In many instances, there could be changes within the formulations that could alter the resultant performance. These changes may or may not be detectable via the standard laboratory analyses. What is needed is a device or testing protocol that would define the overall product quality without the requirement for follow-on engine testing. This would be a mechanism to bridge the gap between the engine and component testing versus the laboratory physical/ chemical property analyses. The device or testing protocol should be capable of defining lubricant quality in terms of additive package content, viscosity grade, and selected performance criteria such as anti-wear protection, detergency-dispersancy protection against high temperature oxidation, etc.

A86-102. TITLE: WELDING BRUSHES, DEVELOPMENT OF STANDARDS (QPL)

CATEGORY: Research

DESCRIPTION: The technology of welding is improving very rapidly moving from highly controlled environments to field automated applications. The use of improper welding joint brushes to clean weld joints for specific material alloys can result in contaminated joint material and thus in defective welds. Also contributing to this problem is the fact that brush manufacturing is mostly a proprietary type industry with new brush materials being introduced; for example, ceramic imbedded polymer fiber brush material. Answers (data) are needed on the effect of brush induced materials (polymers, ceramics, alloy elements) on weld joint surfaces and their effects on weld quality both good and bad. A more detailed selection of welding brush materials is needed to match the developments in welding alloy compositions and filler metal welding wire development. Qualified products listing for welding cleaning brushes is needed.

A86-103. TITLE: STABILIZATION OF THE SHIP/LIGHTER INTERFACE

CATEGORY: Advanced Development

DESCRIPTION: The Army Logistics-Over-The-Shore (LOTS) mission requires the capability to offload containers and breakbulk cargo from large oceangoing ships onto a variety of small lighterage, including landing craft, causeways, and air cushion vehicles. This must be accomplished in all types of weather conditions, including periods of high seas. During especially high sea states (Int'l SS 3 and above) problems are encountered due to the relative motion between ship and lighter, resulting in delay, damaged cargo and lighterage, and safety hazards to personnel. A need exists for innovative techniques and/or equipment to stabilize this interface, which includes the ship, the lighter, and the cargo handling equipment (crane), whether it be integral to the ship, the lighter, or mounted on a third platform.

A86-104. TITLE: SEASIDE OPERATION OF REVERSE OSMOSIS WATER PURIFICATION UNIT

CATEOGORY Exploratory Development

DESCRIPTION: In future field operations, the US Army will probably be required to produce potable water from the sea. The equipment of choice will be the standard 600 gals/hr Reverse Osmosis Water Purification Unit (ROWPU), or the 3000 gal/hr ROWPU under development. Unfortunately, opertion of a water point along the ocean has always been difficult. The usual problems revolve around shallow water; tides; heavy breakers; and the presence of sand, silt, and shell fragments in the raw sea water. Specific difficulties include (1) clogging of the raw water pump, (2) lack of raw water due to a receding tide, and (3) damage of the entire intake system due to heavy seas. The problem is unquestionably a difficult one. What is needed is a new innovative idea that might solv the problem, plus a feasibility study to establish the practicality of the idea.

A86-105. TITLE: DEPOLARIZATION EFFECTS OF RADOMES

CATEGORY: Exploratory Development

DESCRIPTION: Dual-polarized receiving systems have the potential of providing a wider range of discriminants in microwave and millimeter sensors, but the depolorization effects caused by the shape and materials of the sensor radome may impair performance. This depolarization effect varies from point-to-point over the wave-front in such a way that it is difficult to assess without modeling the effects and simulating the sensor performance in a computer program. Computer-aided radome analysis is needed to help evaluate these depolarization effects and provide the basis for compensation techniques.

A86-106. TITLE: MILLIMETER WAVE SEEKER-IN-THE-LOOP SIMULATION TECHNOLOGY

CATEGORY: Exploratory Development

DESCRIPTION: In order for hardware-in-the-loop (HWIL) simulators to be able to effectively test and evaluate current and future state-of-the-art Army missile systems, the capabilities of current simulators must be modified and improved and proposed simulators must be designed with cost effective, innovative simulation tools and techniques. Currently known HWIL simulation

techniques such as the matrix array, ellipsoidal reflector, and passive reflector array have fundamental limitations in displaying the electromagnetic environmental phenomenology to millimeter wave (MMW) missile systems. A wide field of view matrix array is cost prohibitive; the ellipsoidal refector suffers from chamber reverberations; and the passive reflector array provides only passive track in the end-game. The requirement is to investigate cost effective solutions that will provide a wide instantaneous field of view to MMW seekers and sensors continuously from detection through acquisition, track, guidance and active/passive terminal phases.

A86-107. TITLE: ENHANCED CATALYSIS OF NITRIC OXIDE ACTIVATION AT MODERATE TEMPERATURES (150 to 400 C)

CATEGORY: Applied Research

DESCRIPTION: Minimum smoke propellant compositions have a limited burning rate range believed to be caused by the slow activation/reaction of nitric oxide (NO), a major decomposition product of key ingredients. Catalysts or techniques are needed to cause NO to be activated and enter into reactions near the decomposition zone of the propellant to produce energy release and effective heat transfer to the surface. This is in a temperature region of approximately 150 to 400 C. Hence, practical catalysts, combustion modifiers or techniques are sought that will promote NO decomposition or NO reactions with fuel fragments in this temperature regime. Catalysts, modifiers or techniques must be cost effective and be capable of being incorporated into solid propellant grains.

A86-108. TITLE: LOW COST 8-12 MICRON OPTICS AND DOME MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: Long wavelength infrared optical materials are expensive and limited in available materials. Missile optical domes in this spectral band are expensive and heavy. There is a need for alternative materials to provide lower cost and lighter weight domes for planned Army missile seeker developments. The investigation should include a plan to develop new optical materials which meet these objectives.

A86-109. TITLE: ADVANCED POLYMERS

CATEGORY: Exploratory Development

DESCRIPTION: There is an immediate requirement for a new generation of polymer matrix materials for advanced fiber reenforced composite rocket motor components. Current matrix materials have limited resistance to the service environment. This new technology would require the development of a matrix polymer capable of the following:

- Maintaining structural usefulness at temperatures greater than 700 F
- Be resistant to low temperature (-40 F) degradation
- Have vastly improved fracture toughness for damage tolerance
- Pfovide easy processability with the reinforcing material
- Be cost effective

Emphasis should be given not only to developing improved materials, but also to understanding the composite behavior at the molecular level.

A86-110. TITLE: ORDERED POLYMERS FOR COMPOSITE STRUCTURES

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for high specific strength sheet and tape reinforcement for composite structures. Ordered polymers are a viable approach; however, the commerical feasibility has not been established. A form of ordered polymer suitable for filament winding would enhance the processability of ordered polymers in composite structure applications.

A86-111. TITLE: ADAPTIVE RADOME BORESIGHT ERROR COMPENSATION

CATEGORY: Applied Research

DESCRIPTION: A need exists for a universally applicable means of real-time compensation of the effects of radome induced boresight errors on missile guidance. This task is to develop a description of the function space represented by a typical boresight error slope map, develop a dynamical model to describe the radome error inputs to the guidance loop, design a real-time observer to estimate the errors and design an adaptive controller to provide real-time compensation of the errors. This procedure should also account for the effects of aerodynamic heating and ablation and should be universal in its application, i.e., not tailored to an individual radome. One of the payoffs from this task should be to preclude the necessity for use of prescription grinding and individual radome error mapping, thereby generating a savings in both time and cost in the radome manufacturing process.

A86-112. TITLE: EMBEDDED INTELLIGENT TUTORING SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: Effective operation of high technology weapon systems in a modern complex battlefield requires developing and maintaining high skill levels in the system operators throughout the life of the weapons system. Embedded training devices are intended to provide this function, but provide little or no identification of skill level weakness and no prompting of the student in maintaining specific skill levels. However, significantly improved results are obtained when a human instructor is available to tutor the student and emphasize skill level deficiencies. The need exists to develop an Intelligent Computer Assisted Instruction (ICAI) system that functions as an embedded intelligent tutoring system. The ICAI should be able to capture the human tutor expertise and effectively interact with individual students to identify specific skill level deficiencies and choose an appropriate tutoring strategy for prompting and training to correct the identified deficiencies.

A86-113. TITLE: ROBOTIC VEHICLE ENHANCEMENTS

CATEGORY: Exploratory Development

DESCRIPTION: To fulfill the Army requirements for all classes of robotic vehicles, tailored communication and navigations systems are required for unmanned systems. Several subsystems applicable to robotic vehicles require additional investigation and proof of concept demonstrations. Communication

and navigation systems tailored specifically to robotic vehicles are required. Various communication links now being employed in manned combat vehicles can be tailored for robotic vehicle control link. Techniques for band width reduction, communication security, improved operator interface should be developed.

Integrated land navigation systems that couple internal inertial systems with external land or satellite based reference systems are required for accurate knowledge of unmanned vehicle positions. Landmark recognition may be used to augment both systems.

The above technology would supplement ongoing joint DARPA/Army programs in robotic vehicles. Potential enhancements after laboratory testing would be demonstrated during Army User Field Tests.

A86-114. TITLE: MILITARY DIESEL ENGINES.

CATEGORY: Exploratory Development

DESCRIPTION: The general needs of military diesel engines include extended fuel tolerance, extended environmental tolerance, increased RAM-D, increased fuel economy, improved transient response, high power density and reduced specific heat rejection.

Some key technology areas which will allow advancements in the above areas to be accomplished include: (1) high in-cylinder capable materials and tribology systems, (2) fuel injection systems for better light load and idle fuel economy, (3) fuel and air systems for combustion control, (4) high efficiency turbomachinery, (5) full authority engine control systems, (6) techniques for friction minimization.

Work efforts which address the above areas would be most relevant to the enhancement of military diesel engines.

A86-115. TITLE: COMBAT VEHICLE CREW RESTING SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: Study vehicle crew resting system concepts for combat vehicles. Some type of resting techniques is needed to allow the vehicle crew to take rest while on the overwatch mission. At present, it is a general practice to dismount the vehicle and find a place where one can laydown to get fatigue break to fulfill the physiological needs. The Army 21 concept will require crew member to stay in their vehicle up to 72 hours.

A86-116. TITLE: DUAL LEVEL HIGH COOLANT TEMPERATURE WARNING SWITCH

CATEGORY: Exploratory Development

DESCRIPTION: Cooling system failures that result in engine and transmission overheating, are a major cause of engine and transmision failures. Single temperature warning switches set at 225 F are not adequate for detecting cooling system overheating. When system pressure is low due to loose or failed radiator pressure caps. A solution to this deficiency is a dual level temperature warning switch that has the following characteristics.

The high coolant temperature warning shall provide dual warning temperatures depending on engine coolant out pressure. The warning shall be activated with coolant pressure below 7 PSIG and coolant temperature greater than 250 F and it will also activate with coolant pressure greater than or equal to 7 PSIG and coolant temperature greater than 225 F.

A single high coolant temperature warning sensor is desired, which will perform as specified above. This sensor must comply with Military Standard MIL-S-12285/2C, Installation and Enviromental Considerations.

A86-117. TITLE: COOLING SYSTEM DEGRADATION INDICATOR

CATEGORY: Exploratory Development

DESCRIPTION: A major cause of engine failure in combat and tactical vehicles is cooling system degradation. No indicator of cooling system degradation now exists.

A solution is envisioned in a meter that would measure the air temperature difference between ambient air entering the engine and coolant temperture out of the engine and then compute a ratio of it to a present maximum temperature difference, so that a percent degradation in cooling system performance could be displayed when the coolant temperature exceeded 205 F.

A86-118. TITLE: ON-BOARD AUDIO TROUBLESHOOTER

CATEGORY: Exploratory Development

DESCRIPTION: The on-board audio system would complement the STE display and sensor system. It would enable lesser trained crew members to determine and resolve component and systems problems. This would be in the order of the audio troubleshooting systems now being installed in automobiles offered by the general public.

A86-119. TITLE: LOW COST, NON-INTRUSIVE TORQUE SENSOR

CATEGORY: Exploratory Development

DESCRIPTION: The availability and effectiveness of combat and tactical vehicles could be significantlyl increased by further improvement in engine prognostics and diagnostics techniques. These would be enhanced by a direct measurement (rather than synthesis from the measurement of other parameters) of engine output torque. A low cost and non-intrusive (easily applied in permanent installation, without impact on driveline layout) device or technique is needed for cost-effective incorporation in future Army engines. Accuracy of 2.5% at full scale and 5% at "idle" would by quite acceptable; frequency response in excess of 6400 Hz (4000 RPM x 12 cyl X 720 - 90o) would be desirable but even 10Hz would be very useful.

A86-120. TITLE: EXHAUST EMISSIONS SENSING WITH SIMPLIFIED TEST EQUIPMENT (STE)

CATEGORY: Exploratory Development

DESCRIPTION: Environmental Protection Agency requirements will be imposed on military vehicles in the foreseeable future. An ability to inspect engine exhaust emission levels will be needed. It is necessary now to develop state-of-the-art technology emission sensors that are most suitable for use with the STE Family of test sets.

A86-121. TITLE: DATA-CHIPS

CATEGORY: Exploratory Develoment

DESCRIPTION: Engine and other equipment design and RAM-D development would greatly benefit if detailed statistical data were available from actual and extended field operations. Based on such data, significant savings in development time and cost as well as life cycle cost of the entire system would be possible as a result of designing to true requirements and directing corrective development to the root cause of the problems.

The complexity and expense of conventional data (parameter) sensing, recording, and processing prevent its mass application. A variety of ultra-sophisticated but very low cost devices would be needed to fill this void. These devices might be called: "Data-Chips". A variety of Data-Chips might be sensitive to frequency, temperature, pressure, stess, etc.; to discrete levels of these; and/or to associate time intervals. They might detect maximum values and/or they might accumulate (integrate) data. Data storage would be accomplished by some "solid state" property change which could be "decoded" at a suitable time and place.

An illustration of the concept, would be a self-energized strain gage with memory, logic, perhaps a timer, but not wires attached.

A86-122. TITLE: ISOLATED MULTIPLEX INTEGRATED CIRCUITS (IC)

CATEGORY: Exploratory Development

DESCRIPTION: In test equipment utilization, overvoltaging due to attempts by the user to measure voltages above the test equipment supply voltage and high transient voltage encountered during measurements can cause damage to the multiplexer IC(s) and associated electronic devices following the multiplexer in the test equipment circuitry.

Isolated (Opto, FET, etc.) multiplexer ICS substantially reduce or eliminate these hazzards. It is necessary to develop these kinds of ICs to directly replace existing non-isolated ICs in Simplified Test Equipment test sets.

A86-123. TITLE: HYBRID/LSI BUBBLE MEMORY POWER DOWN CIRCUIT FOR STE-X

CATEGORY: Explortory Development

DESCRIPTION: Currently, discrete electronic components are used in the bubble memory power down circuitry design for STE-X. Hybrid/LSI technology could provide improvements in the failure rate, parts count and actual space claimed by the discrete circuit. A hybrid/LSI integrated circuit chip equivalent to the discrete circuit is required for the STE-X test set hardware design.

A86-124. TITLE: HIGH IMPACT STRENGTH, LOW TEMPERATURE CURING ADHESIVES

CATEGORY: Exploratory Development

DESCRIPTION: Although many adhesives have desirable properties over a wide range of temperature, commercially available adhesives must be cured at or above ambient temperature. A high impact strength adhesive which cures in less than two hours (to a reasonable fraction of full strength) at temperature as low as zero degrees Fahrenheit would find applicability in expedient field repair of combat tanks.

A86-125. TITLE: EFFECT ON RESIDUAL ELEMENTS ON THE WELDABILITY OF ARMOR STEELS

CATEGORY: Exploratory Development

DESCRIPTION: Recent changes in the steel making industry and the shift from fully integrated steel facilities to 100% scrap electric furnance operations has resulted in an increase in both the total quantity and number of residual elements. While the effect on ballistic performance may be minimal the effect on weldability may be substantial. A program is needed to determine the effect of residuals such as tin, copper, antimony, zinc, etc. on the weldability of armor steels.

A86-126. TITLE: QUIESCENT HIGH TEMPERATURE MELTING SOURCE FOR PRODUCING HIGH INTEGRITY FOILS AND/OR SURFACE LAYERS WITH SURFACE DAMAGE RESISTANCE

CATEGORY: Exploratory Development

DESCRIPTION: The use of a laminar plasma jet melting sources for controlled fusion of materials for deposition of surface layers or for chill block melt spinning is desired. A laminar plasma jet is capable of providing a dimensionally stable melt puddle that is a fundamental prerequisite for adequate process control to produce uniform products.

A86-127. TITLE: NOVEL METHODS TO PRODUCE THIN FOILS OF WEAR RESISTANT MATERIALS

CATEGORY: Exploratory Development

DESCRIPTION: Use chill block melt spinning techniques to produce continuous thin foils of wear resistant materials. These materials frequently contain high solute contents of metalloids and are consequently hard or impossible to process by conventional thermo-mechanical processing techniques and thus must be processed by inefficient powder metallurgical techniques. Foil preforms could be conveniently placed on and easily bonded to wear sites (eg. tank threads, forming die surfaces) on new or to be rejuvented parts. Both labor and materials savings would be envisaged when forming such high integrity wear surfaces.

A86-128. TITLE: IMPROVED OPTICAL/ELECTRO-OPTICAL MATERIALS AND MATERIALS PROCESSING METHODS

CATEGORY: Exploratory Development

DESCRIPTION: Innovative technology is required to increase performance, availability and reduce costs of optical/electro-optical materials for Army systems. Areas of importance include:

a. Hard Optical Coatings: Broadband sensors require hard, erosion-resistant coatings which are transparent from ultraviolet, through the visible, well into the infrared radiation wavelengths. New concepts for such coatings compatible with state-of-art optical materials are desired. Such concepts should also address the practicality of operating reliably and being reproducible in production mode.

b. Single Crystal Growth: Many applications for single crystal optics are limited by size, perfection and cost of currently available single crystals. New or innovative methods of crystal growth aimed at addressing the above issues for materials such as Lithium Niobate, Stiontium Barium Niobate, Gallium Arsenide, Indium Phosphide, or Magnesium doped Lithium Niobate are desired.

A86-129. TITLE: COATED TUNGSTEN POWDER

CATEGORY: Exploratory Development

DESCRIPTION: The heavy alloy grades of tungsten have been successful because they combine high density with relatively low processing temperatures. Although these alloys have significant strength and ductility compared to pure tungsten, it is desired to further enhance these properties. Impurities play a role in the final properties of the tungsten heavy alloy and are most harmful when segregated to the interface between the tungsten particles are the alloy matrix. Therefore, reducing the amount of impurities as well as grain size control will improve the properties of tungsten heavy alloy.

A86-130. TITLE: CERAMIC MATERIALS FOR LOW HEAT REJECTION DIESEL ENGINES

CATEGORY: Exploratory Development

DESCRIPTION: Advanced diesel engines with minimal or no forced cooling are desired for Army applications. Key to obtaining such engines are structurally sound ceramics and ceramic coatings capable of maintaining mechanical and physical properties and dimensional stability with time in an engine environment. Innovative materials and processing techniques are sought.

A86-131. TITLE: IMPROVED PERFORMANCE IN RESIN-MATRIX COMPOSITES

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches are necessary to improve the performance of resin matrix composites. Areas which are being considered for study are:

a. Development of resin matrices exhibiting minimal or zero shrinkage during cure. Minimal shrinkage being less than 1/2 percent when cured at 117 C (350o F). Approaches such as the incorporation of spiro compounds into epoxy matrices will be considered. The resins should also exhibit mechanical and physical properties suitable for use in structural composites.

b. The mechanical properties of resin matrix composites produced by wet laminating techniques such as filament winding and pultrusion are often degraded by void formation. A method to eliminate or reduce the formation of voids due to entrapped air is required. Innovative approaches compatible with wet laminating processes are being sought and would be considered under this topic.

c. Formulation and testing techniques for producing ambient-temperature, lwo viscosity (300-600 cp), rapid-cure (2 hours or less) repair kit resins for use in multiple woven glass and graphite repair patches. Resultant repair kits must have a long shelf life (over 1 year) and when cured exhibit chemical and mechanical properties typical of 350o F cured epoxies.

A86-132. TITLE: NONDESTRUCTIVE EVALUATION TECHNIQUES

CATEGORY: Exploratory Development

DESCRIPTION: Innovative approaches are necessary to improve the nondestructive evaluation (NDE) techniques for applications to structural materials of interest to the Army. Areas being considered for study are:

a. Develop a NDE technique for the analysis of the signatures of flaws which are induced into ceramic materials during processing, e.g., porosity inclusions.

b. Develop a NDE technique to predict the grain sizes in sintered materials.

c. Develop a NDE technique for the measurement of case depth in steels. Consideration should be given to both carburized and induction hardened cases in the range of 0.2mm to 2.5mm.

d. Develop a functional relationship to describe the reflection of ultrasound at a flat, variable roughness interface of a bulk material which considers the spectral content of the transmitted and reflected signal.

A86-133. TITLE: ADVANCED TOOLS FOR HUMAN FACTORS RESEARCH

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for advanced research tools that will allow evaluations of soldier-machine interface for systems in concept evaluation and later phases of development at a minimum of personnel and equipment resource cost. Specific requirements are to identify advanced tools that are adaptable to military research needs, easily operated, reliable, and flexible enough to be operated in different research settings (e.g., cockpits, combat vehicles, indoor laboratories, and outdoor test ranges). Advanced tools that could be useful in human factors engineering research and development include; bio-mechanical motion analyzers, computer-aided design packages, portable computing systems for data collection and immediate analysis, high-speed video analysis, portable biotelemetry equipment and generic simulators. Advanced research

tools are important ingredients of the Manpower and Personnel Integration (MANPRINT) program to impose human factors engineering considerations on the entire materiel research and development process. MANPRINT is one of the Army materiel research and development initiatives.

A86-134. TITLE: TESTER - INSULATED COLD WEATHER BOOT

CATEGORY: Exploratory Development

DESCRIPTION: A device is presently available and has been for 20 years which is capable of determining when water has penetrated the elastomer of the cold weather boot. It is based upon a capacitance charge and an electromechanical balancing of a bridge. The need is for an upgraded version which will cost less, be easier to repair and which can be shipped around the country without disturbing the operation.

A86-135. TITLE: HEAT-SEALABLE SEWING THREAD

CATEGORY: Exploratory Development

DESCRIPTION: To develop a heat-sealable coating for either nylon or polyester sewing thread for the purpose of sealing the material needleholes subsequent to sewing by heat process to create a water-repellent and vapor impermeable seam. The coating shall not degrade the thread's physical properties, impede sewability, be affected by needle heat, or be tacky after a seam from the thread has been sewn and heat-sealed.

A86-136. TITLE: IMPROVED COLD WEATHER HANDWEAR SYSTEMS

CATEGORY: Advanced Development

DESCRIPTION: Current Army handwear systems, when worn in conjunction with the appropriate standard clothing, will provide environmental protection in a 40 F to -60 F temperature range. At -60 F, current systems will provide one hour of protection to a moderately active soldier. New handwear systems must be developed, or the current handwear systems modified, to maintain or improve this level of protection while simultaneously effecting improvements in several of the following areas: dexterity, waterproofness, elimination/ absorption of perspiration, durability, fit, sizing, comfort, weight, bulk, maintenance wind protection; grip/grasp, ease of donning and doffing, adequacy of fit adjustments, adequacy of ventilating adjustments, compatibility with the new extended cold weather clothing system, compatibility with other handwear, appearance, and troop acceptance.

A86-137. TITLE: DEVELOP A RETORTABLE NON-METALLIC SQUEEZE FOOD TUBE

CATEGORY: Exploratory Development

DESCRIPTION: Develop a 8-fluid ounce non-metallic squeeze tube capable of being retorted at 250o F. after being filled with food product or liquid supplement drink. The tube would be used for feeding NBC and aircraft personnel. The neck of the tube shall be 0.430" diameter and 0.312" high. The thread size shall be 9/16 - 12 UNC (14.288 x 205 mm). The diameter of the body of the tube shall not exceed 2 inches, and shall be heat sealable on the bottom. The materials may consist of aluminum foil as a metal laminate.

A86-138. TITLE: LIFE INDICATOR FOR CHEMICAL PROTECTIVE UNIFORM

CATEGORY: Exploratory Development

DESCRIPTION: Present and proposed chemical protective uniforms rely on activated carbon to absorb toxic agents such as liquid and vapor mustard and nerve agents. Environmental contaminants, e.g. water, perspiration, exhaust smoke, surfactants, etc, may poison the activiated carbon over time - whether the uniform is packaged or worn and laundered - and a convenient means is needed to indicate or determine whether the carbon still has the capacity to protect against toxic agents. The indicator may change color when the carbon activity has been depleted or the indicator may be in a portable kit which will measure the carbon activity. Such a portable kit, or indicator attached to the uniform, may reply on chemical, physiochemical, electrical, mechanical or other practical means. It should be easily maintainable and durable/usable under field conditions. The task of this effort is to develop and test such a life indicator or kit.

A86-139. TITLE: CHEMICAL PROTECTIVE FABRICS

CATEGORY: Advanced Development

DESCRIPTION: Present and proposed chemical protective uniforms rely on activated carbon to absorb toxic agents. The degree of protection is basically directly proportional to the amount and/or configuration of the activated carbon in or on the fabric of the protective uniform. However, the weight and density or compactness of the carbon inversely affect factors which relate to comfort, such as fabric weight, flexibility, air permeability, moisture vapor, transmission, etc. The objective of this task is to apply activated carbon spheres, having a diameter of approximately 0.40 mm and a surface area of approximately 1000 m2/g to a standard military fabric, such as MIL-C-44031A, Cloth Camouflage Wocdland, NYCO Class 2, quarpel or MIL-C-43858A (GL), Nylon tricot black, in several patterns or densities, e.g. from 50 to 250 g/m2 in increments of 50 g/m2, and to measure comfort and chemical agent protection properties of these modified fabrics. The goal is to establish a relationship between protection and carbon configuration.

A86-140. TITLE: SORPTIVE, CHEMICAL PROTECTIVE UNDERGARMENTS

CATEGORY: Advanced Development

DESCRIPTION: Present and proposed chemical protective uniforms rely on activated carbon to absorb toxic agents. An undergarment material containing activated carbon spheres at a density of approximately 200 g/m2 has been developed, but little has been done to optimize the design and fit of undergarments made from this material in order to maximize comfort, ease of donning and doffing, agent protection and body waste elimination. The objective of this task is to design undergarments from government supplied, carbon-containing fabric - incorporating these features - and to quantitatively test the designs on human subjects and/or instrumented manikins. The undergarments shall be tested for comfort and functionality alone and with outer garments such as the battledress uniform, combat vehicle crewman uniform and aircrewman uniform.

A86-141. TITLE: MUNITIONS LOGISTICS DECISION SUPPORT SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: The impact that munitions characteristics (such as weight, cube, sensitivity, etc.) have on the logistics system needs to be explored early in the development of a new or product-improved munition. Programs are currently ongoing to determine the relevant areas of concern within each part of the munitions logistics system, along with the data required to quantify the impacts munitions have on each other of these areas.

A decision support system capable of supporting the evaluation of the impacts munitions characteristics have on the numerous nodes and interfaces in the munitions logistics system is required.

A86-142. TITLE: IMPROVED RDX CRYSTALS

CATEGORY: Exploratory Development

DESCRIPTION: As presently manufactured in the US, RDX crystals contain intragranular cavities which may affect the sensitivity of explosive formulations containing RDX. The present manufacturing process involves precipitation from cyclohexanone. Other solvents or procedures may produce a better quality material. We would like to compare the present RDX with RDX of a similar particle size which is free of intragranular cavities. The comparison could be made with various particle sizes, but it would be convenient to use a particle size distribution similar to present Class A RDX (particle size distribution similar to present Class A RDX (particle size in the range of 100 to 150 microns). Tests would be done at the USA Ballistic Research Laboratory. The contractor would develop the process for making cavity-free crystals and produce a few kilograms of material for test purposes.

A86-143. TITLE: INERTIAL REFERENCE SYSTEM TO MEASURE BLAST INDUCED DISPLACEMENTS

CATEGORY: Engineering Development

DESCRIPTION: An inertial reference system is needed to measure the displacement of targets during blast test in large shock tubes or high explosive simulations of nuclear weapons. The system would supplement photographic coverage when the target was obsured by dust. The system, composed of accelerometers, roll rate sensors, analog to digital converters and on board memory would be mounted on the target and record its displacement and orientation during the blast test. The system would be integrated from off the shelf hardware. The system would be bench tested, then turned over to DoD for field testing.

A86-144. TITLE: HIGH PRESSURE EQUIPMENT FOR OPTICAL LIQUID PROPELLANT STUDIES

CATEGORY: Basic Research

DESCRIPTION: Instrumentation is not currently available for studying phase transitions and other important properties of liquid gun propellents at accurately-known high pressures. Working both with laboratory researchers

and manufacturers of high pressure equipment, the contractor will design, assemble, and test an apparatus for hydraulically pressurizing very small (less than 100 microliter) volumes of liquid propellant in an optical microcell equipped with visible and infrared transmitting windows (minimum aperdture 1 millimeter) to pressures of 200,000 psi, and temperatures from -60 to 60 Centigrade, with no mixing of hydraulic fluid and propellant.

A86-145. TITLE: RESEARCH IN CAD-E FOR EXPLOSIVE WAREHEAD

CATEGORY: Exploratory Development

DESCRIPTION: Currently, a number of continuum mechanics computer codes and analytical models are available which model the formation of fragments, jets, or explosively formed penetrators by explosive warheads. Improved design efficiency would result from the development of software and application of hardware to use these models interactively in a design mode. As a follow-on effort, software to provide design data as either engineering drawings or tapes to drive CAM equipment should be pursued.

A86-146. TITLE: TEMPERATURE DETERMINATION WITHIN A HOT GAS/ATMOSPHERIC MIXTURE

CATEGORY: Exploratory Development

DESCRIPTION: Development of a simulation capability for determining the infrared characteristics of a cloud of hot gas (engine exhaust) mixing with the atmosphere is needed. Conditions such as the temperature and wind speed of the atmosphere and the temperature and velocity of the hot gas would be designated, and the temperature at points within that mix would be calculated.

A86-147. TITLE: ADVANCED PACKAGING FOR ARTILLERY CHARGES

CATEGORY: Exploratory Development

DESCRIPTION: Full exploitation of robotics in emerging artillery weapons requires a minimal number of charge increment types (ideally only one, "universal" increment), minimal charge parasitic weight and volume, and specific propellant packaging characteristics (both to facilitate automated handling and zoning and to assure satisfactory ignition and combustion at all zoning levels). Current combustible case materials, however, require substantial wall thicknesses to meeting handling requirements, seriously limiting our ability to achieve the other desired characteristics, particularly if a large number of these "universal" increments is required in order to provide intermediate velocities to meet all required zoning levels. New combustible and/or consumable materials and packaging concepts need to be developed that provide the low cost, weight, and volume of the old cloth bags with the rigidity and handling characteristics of current combustible cases.

A86-148. TITLE: SURFACE REFLECTION MODELS FOR MODERATE DIELECTRICS

CATEGORY: Research

DESCRIPTION: To develop reflection models for materials having moderate dielectric constants for use in a radar scattering program. The scattering code uses raytracing to determine multiple reflection paths and shadows. The magnitude, phase, and polarization of the backscattered field and reflected field is determined at each intersection point along the ray's path using physical optics. No transmitted ray is calculated, so that the reflection models must be restricted to cases for which the dielectric properties can be incorporated into the reflected ray.

A86-149. TITLE: DISTRIBUTED DATABASE MANAGEMENT SYSTEM

CATEGORY: Engineering Development

DESCRIPTION: There is a pressing need for a flexible database management system (DBMS) in support of a wide variety of projects involving a network of disparate computing systems operating under various versions of the UNIX operating system. The DBMS must support network access of databases stored on distant systems as well as access and update of data maintained on one's local system. Additionally, the DMBS must be readily adapted to future system acquisitions that do not necessarily duplicate existing hardware configurations. Efficient access to databases from applications written in C and other widely-used programming languages as well as direct interactive human access must be provided. The "relational" model must be directly supported and all features generally accepted as usual in the software industry for this style of DBMS should be provided. The emphasis of this project is not so much on database design as on substantial improvement in availability of both data and the DBMS itself in an evolving network context.

A86-150. TITLE: DRAG AND YAW ACCELEROMETER SENSING SYSTEMS

CATEGORY: Engineering Development

DESCRIPTION: Design and develop accelerometer sensing systems for the purpose of making in-flight measurement of yaw motion amplitudes and/or drag deceleration. System must interface with existing IGIR Telemeter Packages. It would be used on a variety of artillery projectiles and, therefore, there may be some constraints on physical size. System or sensors must be able to survive high accelerations that accompany gun-launched projectiles (10-30,000 G's).

A86-151. TITLE: PREDICTION OF PROJECTILE BASE BLEED

CATEGORY: Basic Research

DESCRIPTION: A need exists for the capability to predict the effects of base bleed on projectile aerodynamic performance. Design engineers now are using very simplistic empirical analysis techniques to estimate the performance of projectiles utilizing the base bleed technique for achieving increased range. The required analysis would include effects of mass injection rate, temperature of the injected mass, projectile spin, effective gamma of the injected mass, local pressure in the base region, Mach number, and projectile configuration. The performance parameter of particular interest is the drag.

A86-152. TITLE: LABORATORY RAILGUN BARREL

CATEGORY: Exploratory Development

DESCRIPTION: Design and fabricate a one inch square bore laboratory railgun barrel for use with existing power supply. This device will be used to perform experimental studies of plasma arc armatures which propel projectiles of up to 100 grams to velocities greater that 2.0 kilometers per second. The priority of design considerations shall be:

1. Integrity of device under stress of magnetic forces
2. Utility as a testbed research device
3. Ease of replacement of inner bore surfaces
4. Ease of inserting diagnostic probes for armature diagnostics
5. Ability to accept small material test sections for bore surface studies

A86-153. TITLE: KNOWLEDGE REPRESENTATION USING MENTAL MODELS

CATEGORY: Exploratory Development

DESCRIPTION: In several classes of knowledge-based systems, it is important that the knowledge representation technique closely match that actually employed in human cognition. While there is some empirical evidence that rules, semantic nets/frames, and first order predicate logic can serve this function, recent work by Johnson-Laird and others indicates that an important aspect of human cognition is the formation of mental models that are approximately isomorphic to the situation being considered. Innovations are needed to define mental models as they would be used in knowledge-based systems, and to determine the systems and problem domains for which they are best suited. Candidate systems include message modelling and interpretation, situation assessment, battle order planning and transmission.

A86-154. TITLE: ANGULAR MOTION SENSOR

CATEGORY: Exploratory Development

DESCRIPTION: A sensor to detect the angular motion of the muzzle of a cannon is required. The device would be used in development testing of they dynamic motion of cannon during firing and could form the basis of a continuous muzzle reference system for fielded equipment. The system should be capable of resolving the three vector components of angular motion: pitch, roll, and yaw to a precision of 0.05 milliradian. The system should have a dynamic response of 25 kHz. The system should be sufficiently rugged to withstand the firing environment of the tank cannon.

A86-155. TITLE: PREDICTION OF RADAR CROSS SECTION BASED ON SOLID MODELS

CATEGORY: Research

DESCRIPTION: A requirement for advanced vulnerability analysis is to estimate the radar cross section for postulated, non-existing aircraft. Mathematical models of the postulated vehicles can be generated to aid in these analyses. These models are in reality mathematical constructs called solid models and employ a solid modeling technique known as constructive solid geometry. With this technique a postulated vehicle (or real one, for that matter) can be

modeled including physical attributes such as material type; a variety of physical and mathematical analyses will be applied to the model to yield numerous data, including weight and balance and vulnerable areas. The Army has a requirement to predict the radar cross section for postulated vehicles and needs a technique to quickly compute an estimate of the vehicle's radar cross section based upon the solid model as input.

A86-156. TITLE: HIGH BURNING RATE FORMULATION RESEARCH

CATEGORY: Basic Research

DESCRIPTION: Burning rate promoters offer increased probability for fielding advanced ballistic concepts such as traveling charge.

Boron hydride (B10 and B12) salts, in particular, have shown great effectiveness as burning rate promoters in propellant formulations. Current use of these materials is based on empirical relationships. There exists a great need for gaining further understanding of the details of ingredient functioning.

The research involves formulations work to examine in detail tradeoffs in burning rate and safety properties due to different boron hydride ingredients and various binder, plasticiser and oxidizer species. In addition, new polymers and plasticisers being developed for propellants should be screened for use with the boron hydrides. Finally, the effects of catalysts in promoting the efficiency of boron hydride burning rate additives should be explored. Chemical decomposition studies of ingredient combinations and propellant samples should be conducted to help unravel the chemical details of the mode of action of the B10 and B12 salts.

A86-157. TITLE: FOCAL PLANE MM IMAGERS FOR TEST INSTRUMENTATION

CATEGORY: Exploratory Development

DESCRIPTION: The instrumentation requirement is for an instrument that can be used to measure the MM wave pattern swept out by the MM radar devices on SADARM, ASSAULT BREAKER, and other Fire and Forget Weapons. The requirement for small size, small power and immunity to countermeasures, narrow frequency response, etc. are considerably reduced for a fixed test instrument which is normally operated in a non-hostile environment. The literature has indicated that small array detectors (bolometers) have been assembled using small individual discrete detectors. It is assumed that the technique could be extended using printed circuit and lithographic techniques to generate small arrays such as 8 x 8 and eventually to 32 x 32 which could be used in conjunction with tracking parabolic focusing antennas to allow field measurements on free-falling MM wave devices.

A86-158. TITLE: RADAR BEAM PATH PREDICTION WITH LIMITED NUMBER OF SENSORS

CATEGORY: Exploratory Development

DESCRIPTION: The requirement is for mathematics to aid in the measurement of the MM wave pattern swept out by the MM radar services on SADARM, ASSAULT BREAKER, and other Fire and Forget Weapons. This topic addresses the problem in terms of using the methodology of mathematics to get the most information out of existing (or elsewhere developed) sensors. The mathematics would be designed to use apriori knowledge about the emitter (beam width, scan rate,

power levels, and physical location) and combine this information with the time-amplitude history of the power levels received by the sensors to give an increased accuracy prediction of the actual beam path. For example, a single unaided sensor could only give the time at which a radar beam was nearest the sensor (with a linear scan rate), a mathematically aided sensor could potentially also give the distance to the radar beam when it was nearest.

A86-159. TITLE: PROCESSOR-CONTROLLED WAVEFORM GENERATOR - TO - AMPLIFIER INTERFACE

CATEGORY: Engineering Development

DESCRIPTION: Design, build and test a processor-controlled interface for application between a .1 - 40 Ghz arbitrary waveform generator and a set of n high power amplifiers (HPA) and antenna systems. Functionally, the interface must switch and control RF from the generator to n sets of HPAs/antennas at a microsecond rate. Preamplifier gain and HPA output power must be under control of a MICROVAX I processor. The feedback loop from HPA output must throttle the pre-amp gain to keep the HPAs linear at all times. The final package must be no more than 10 inches high and fit in a 19-inch wide rack.

A86-160. TITLE: TECHNIQUES FOR SMART SENSORS

CATEGORY: Exploratory Development

DESCRIPTION: Future surveillance/reconnanissance sensors will include microprocessors which will automatically detect, recognize, and locate targets. There is a need to determine the testing approach and target types which will best measure the performance of the sensors in terms of probability of detection/recognition and false alarm rates.

A86-161. TITLE: SPECIFYING, TESTING AND EVALUATING C3I SYSTEMS THAT EMPLOY ARTIFICIAL INTELLIGENCE

CATEGORY: Research

DESCRIPTION: Artificial Intelligence (AI) techniques are being employed in the development of some "concept evaluation" models of military C3I systems. As AI comes to be used in Engineering Development Models, an integrated methodology for specifying, testing and evaluating in objective terms the performance of such systems is required. This task should review current and likely future applications of AI in military C3I systems and propose objective measures of performance of such systems which are meaningful to a system user and which are testable.

A86-162. TITLE: PHYSIOLOGICAL MONITORING SYSTEM

CATEGORY: Exploratory Development (MANPRINT)

DESCRIPTION: In testing developmental clothing and protective equipment, it is necessary to monitor the physiological response of soldiers undergoing different activities while wearing or using the prototype equipment. A mobile, wireless system is needed to provide near real-time physiological data on test subjects. The task would be to design a mobile, wireless physiological monitoring system for use in cold regions testing down to temperatures as low as -65 Fahrenheit.

A86-163. TITLE: DETERMINING COMFORT PARAMETERS IN HEATED SPACES

CATEGORY: Exploratory Development (MANPRINT)

DESCRIPTION: Presently, testing of heating and ventilating systems in vehicles and shelters is done in accordance with MIL-STD-1472C. That standard requires that heated spaces that are occupied by personnel on a permanent or semi-permanent basis must be able to maintain an effective temperature (ET) of not less than 41 F (5 C). The standard further requires that the temperature of the air at floor level and at head level should not differ by more than +9 F (+5 C). In much Army testing, these criteria seem to be unnecessary. The ET and temperatures uniformity requirements are very difficult to attain, especially in a cold-soaked armored vehicle such as a tank. Not only does a too strict requirement result in expensive overdesign of the heating system, but it can result in overheating of the crewmembers, which increases their chance for a cold injury. For example, crewmembers wearing the standard vapor barrier VB boct exposed to long periods where their foot temperature is high tend to perspire, wetting their socks. Later exposure to cold may result in cold injury.

The goal of this effort is to experimentally determine comfort parameters, especially with respect to temperatures, for personnel occupying heated spaces when dressed in the cold-dry uniform.

A86-164. TITLE: SUBJECTIVE WORKLOAD ASSESSMENT

CATEGORY: Research

DESCRIPTION: Subjective assessment of workload is usually done with a unique instrument for each application. It would standardize procedures and allow greater comparability of result if a methodology could be identified/created for US Army use in HFE test and evaluation. A methodology, if fairly straight-forward and easy to use and understand, would contribute greatly to the MANPRINT effort by allowing comparisons across systems and individuals.

A86-165. TITLE: MICROCOMPUTER CASCADABILITY AND AUTOMATED MICROCODE GENERATION

CATEGORY: Exploratory Development

DESCRIPTION: Research to date has demonstrated the feasibility and potential of the high-technology concepts of (1) non-von Neuman macro-architecture machine consisting of standardized cascadable microcomputer modules for real-time signal and image processing, and real-time instrumentation control applications requiring computing speed and power not otherwise available in microcomputer systems, and (2) retargetable automated microcode generator to automatically generate microinstructions for application programs from high-level language. These concepts offer significant potential for achieving important economics in the acquisition and utilization of standardized microcomputer-based system.

Exploratory development is now needed to produce cascadable microcomputer module and automated microcode generator prototypes.

A86-166. TITLE: AIR BLAST SHOCK MEASUREMENTS TECHNIQUES

CATEGORY: Engineering Development

DESCRIPTION: The development of accurate, reliable air blast measurement techniques using low-cost instrumentation is required for use in nuclear survivability air blast programs. These programs are extensive and are used to test systems to the effects of the air blast associated with a nuclear weapon. Present instrumentation that is used is expensive and measures air blast overpressures using strain gage or equivalent techniques. It is required that new instrumentation and techniques be developed which measure the air blast effects over large system areas and do it with accuracy and repeatability. This instrumentation should be capable of being used for the measurement of air blast effects for different types of defense system applications.

A86-167. TITLE: EVALUATION OF REMOTE CONTROL FOR TARGET HELICOPTERS

CATEGORY: Exploratory Development

DESCRIPTION: Given existing remote control systems used for command and control of fixed wing aircraft, research and evaluate current techniques. Develop a conceptual system design for fullscale and subscale rotary wing target scenarios through 1992.

A86-168. TITLE: MULTI-SENSORY TRACKING MOUNT CONTROL

CATEGORY: Exploratory Development

DESCRIPTION: A test range instrumentation tracking mount will be equipped with TV, IR, millimeter wave radar, and telemetry tracking sensors. Development of a comprehensive algorithm to use outputs from all of these sensors simultaneously for tracking mount control is planned. Techniques of real time adaptive parallel processing are desired. Algorithms, parallel processing hardware configurations, and software specifications for the final system design are needed.

A86-169. TITLE: MILLIMETER WAVE INSTRUMENTATION RADAR

CATEGORY: Exploratory Development

DESCRIPTION: The tracking of missiles and submunitions near the ground requires the use of an agile, high resolution tracking instrument. Recent developments in millimeter wave technology provide the opportunity to develop such an instrument. Detailed conceptual design of a small lightweight millimeter wave radar is required. Coherent operation is expected with 10 meter range resolution and 0.5 degree angle resolution. A highly mobile, remotely operable system is envisioned. The system should be operable after daily relocation with a high degree of reliability. It is desired to track 0.1 square meter targets to a range of 10KM. Detailed conceptual design is expected to include system theory system description, major component identification, engineering cost estimates, fabrication cost estimates, and system performance estimates.

A86-170. TITLE: IMAGE PROCESSING TECHNIQUES FOR AUTOMATIC VIDEO TRACKING APPLICATIONS

CATEGORY: Exploratory Development

DESCRIPTION: A composite of previously developed video trackers is desired. A great deal of research in the area of automatic video tracking algorithms has been pursued by various government and government sponsored agencies. Several of these algorithms have been successfully implemented at WSMR but the remaining algorithms need to be identified, analyzed, and compiled into a report. Then a set of algorithms and a matching hardware architecture should be recommended for implementation as the next generation of video tracker.

A86-171. TITLE: AIRBORNE VEHICLE ATTITUDE MEASUREMENT

CATEGORY: Basic Research

DESCRIPTION: A method of accurately measuring the attitude angles (pitch, yaw, and roll) of airborne vehicles is required. Priority will be given to methods which do not require equipment on board the vehicle. Measurement accuracy in the neighborhood of + 0.1 degree in each axis is required.

A86-172. TITLE: ARTIFICIAL INTELLIGENCE METHODS IN AUTOMATED VIDEO TAPE READING

CATEGORY: Advanced Development

DESCRIPTION: Existing methods for automated computer reading of data videotape are based on pattern recognition methods and ignore much knowledge about the conditions existing at the time the tests from which the data was collected, are run. Artificial intelligence methods which apply knowledge via expert systems need to be developed in order to achieve maximal system with respect to speed and accuracy.

A86-173. TITLE: IMPROVEMENT OF DYNAPAR SOFTWARE

CATEGORY: Engineering Development

DESCRIPTION: The Army Materiel Test and Evaluation Directorate at White Sands Missile Range uses a Dynaprobe hardware system to collect data on the performance of the digital computer portions of military battlefield automated systems undergoing test. A Dynapar software package is used with the Dynaprobe to reduce the data after test completion. This software package is not compatible with the computers readily available to the test personnel.

The task to be performed consists of:

a. Modify the Dynapar software to run on Digital Equipment Corp. VAX/VMS 11/751 computers, and

b. Improve the modified software to provide an expanded selection of analysis programs and to work interactively with the test personnel during data analysis.

A86-174. TITLE: INCREASE PERFORMANCE (FORCE OUTPUT) OF THE LING 335 VIBRATION EXCITER

CATEGORY: Engineering Development

DESCRIPTION: To redesign the external structural and/or electromagnetic elements of the Ling Model 335 Vibration Exciter such that a continuous peak force of 25,000 pounds is attainable.

RATIONALE: The Ling 335 Vibration Exciters are each capable of producing 20,000 pounds of force with the use of chillers. This is not sufficient force to meet future test requirements. Therefore, it is highly desirable to increase the force capability of these vibration exciters without changing the physical external configuration of the exciters. This is necessary to preclude replacement of the rest of the exciter system.

A86-175. TITLE: PULSED NUCLEAR REACTOR FUEL TEMPERATURE MEASUREMENT DEVELOPMENT

CATEGORY: Engineering Development

DESCRIPTION: The development of techniques and systems necessary for the rapid and accurate measurement of the temperature of the fuel of a pulse nuclear reactor is required. These techniques and procedures will provide for an accurate measurement of the reactor fuel temperatures when the reactor is operated in a pulsed mode. A more accurate measurement capability is required in order to properly evaluate the thermal condition of the reactor core in a pulse, especially the region of the core where the temperature peaks, or reaches a maximum. These techniques will provide for a more accurate assessment of the thermal stresses produced in the reactor core during pulse operation.

A86-176. TITLE: EFFECTIVE TEMPERATURE MATHEMATICAL MODEL

CATEGORY: Research

DESCRIPTION: Currently, effective temperature determination is made using a nomograph based on empirically derived data. It would be extremely useful to be able to determine effective temperature using a mathematical model with consequently greater precision than using the printer nomograph on page 164 of MIL-STD-1472C with its error due to printing anomolies, interpolation, and questimation.

A86-177 TITLE: SELECTIVE SOLVENT FOR DEPLETED URANIUM

CATEGORY: Exploratory Development

DESCRIPTION: Test firing of depleted uranium penetrators against hard targets such as armor plate often results in fragments of uranium being imbedded in the target material. The solution required is a technique/solvent that will selectively remove uranium from steel. The steel will then be available for recycling, and the uranium for recycling or for disposal as low level waste.

A86-178 TITLE: EVALUATION OF VOICE COMMAND SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: There is a requirement to develop a methodology that accurately measures and evaluates pilot voice command systems which are planned for the new generation of Army helicopters. As aircraft become more complex, every effort is being made to reduce pilot workload. Voice command systems are a step in that direction. At the present time, little consideration is being given to procedures to evaluate the system's performance. There is a need to consider various qualitative and quantitative means of measurements as well as to consider variables inherent to such systems; i.e., fluctuations in voice levels caused by stress, etc.

A86-179 TITLE: PILOT WORKLOAD

CATEGORY: Exploratory Development

DESCRIPTION: There is a requirement to develop methodology that accurately measures and quantifies pilot workload. As aircraft become more complex, it is important that workload be considered in aircraft design. At the present time, there is no satisfactory way to quantify workload for pilots. As a result, we must rely on quantitative assessments. Development requires research on techniques to measure pilot workload.

A86-180 TITLE: TOXIC GAS DETECTION IN AIRCRAFT COCKPITS

CATEGORY: Advanced Development

DESCRIPTION: Current gas detection kits are cumbersome and are not suited to an in-flight cockpit environment. In addition, they are limited to interval sampling. Development of a continuous monitoring capability that can be used in a cockpit to detect toxic gases is required. The equipment must be small enough that it does not interfere with the pilot's duties.

A86-181 TITLE: SMALL DROPLET GENERATOR

CATEGORY: Engineering Development

DESCRIPTION: A device is required that will produce droplets having diameters between 40 and 400 micrometers reliably and reproduceably. Liquids of interest include Newtonian and non-Newtonian fluids having viscosities between 1 and 100 centistokes (1000 desired) at 25 degrees C. The device should have a built-in, integral calibration capability.

A86-182 TITLE: RUGGEDIZED GATED VIDEO CAMERA

CATEGORY: Engineering Development

DESCRIPTION: Weapon pointing data for hit probability analysis of stabilized vehicle mounted weapon systems have been obtained with gated video cameras. These cameras in conjunction with a Tracking Error Processor, and digital data acquisition system provide weapon pointing errors proportional to angular elevation and azimuth errors in real time. Since the video camera and lens combination are subjected to considerable shock and vibration in the field environment, (for example, the gun tube of a tank) the contractor shall review the camera systems presently used for this task and develop a camera system which has better resolution and linearity, greater AGC range, and is smaller in size and weight.

A86-183 TITLE: CIM-BUS COMPATIBLE ARRAY PROCESSOR

CATEGORY: Engineering Development

DESCRIPTION: CMOS Industrial Microcomputer (CIM) modules are used in a variety of instrumentation systems. Although many functions are available "off the shelf" a moderate speed array processor is needed to fill several needs. Such an array processor must have local memory (data and program) and be capable of performing arithmetic operations on arrays of data (dot product, vector-scaler product, fast fourier transform (FFT), etc.). The speed requirements can be expressed in terms of a 128 word FFT (floating point data in 20 ms or less.

A86-184 TITLE: INNOVATIVE METHODOLOGIES FOR MAINTENANCE OF SOLDIER HEALTH AND PHYSICAL FITNESS

CATEGORY: Exploratory Development

DESCRIPTION: There is an urgent and continuing requirement to provide the Department of the Army with relevant, concise, accurate, and timely educational information in the areas of personnel health and fitness. Consequently, research support is needed to establish a comprehensive, progressive, and sequential program which will define basic parameters associated with the maintenance of individual health and fitness for senior Army officers. This program will benefit the Army's leaders by increasing their expertise and capabilities for supervising the health and fitness of their organization.

A86-185 TITLE: CORRELATION ALGORITHM DESIGN

CATEGORY: Exploratory Development

DESCRIPTION: Develop an algorithm where all possible points of a digital image are matched to its stereomate. Assume that most y-parallax has been removed and that estimates of x-parralax exist for each point. NXN windows are to be used to develop the discrete correlation functions wherein the measures of similarity is the normalized correlation coefficient. The design must take advantage of all computational overlap sums, sums of squares and sums of cross products when adjacent points are matched and as adjacent lines are matched. The design must provide for a nest of three correlation windows where again computational overlap is exploited and where upon option three discrete correlation functions are developed simultaneously for each match point. The output of the correlator would be new match coordinates on the stereomate as well as relevant data characterizing the match.

A86-186 TITLE: SPATIAL DATA STRUCTURES FOR ROBOTIC VEHICLE ROUTE PLANNING

CATEGORY: Research

DESCRIPTION: There is no known spatial data structure for storing three-dimensional terrain data which algorithms can use to efficiently perform automatic route planning. There is an urgent need to develop an efficient, on-line data format for this work to support emerging requirements of both man-in-the-loop and autonomous robotic vehicle programs. Phase-I of this proposed work will address relatively static, global level route planning from a data base of terrain elevations and descriptors overlayed with tactical intelligence information. Some of the research issues to be addressed include the following: can a hierarchy of resolutions be implemented, for example, reduced resolution for long distance routes (100km) and full resolution for segments of a route (1km); what is the efficiency of operation; and can a data structure be developed which permits scrolling. A new data structure is required because typical route planners (Dijkstra or A* algorithms) require data in graph form (for example, a network of cities and distances between the cities) but terrain data bases are only available in some combination of raster and polygon format. Phase-II work will address more dynamic aspects of route planning such as dynamically updating the route to accommodate unanticipated local deviations. Phase-III work will address such long term research issues as dynamically integrating the terrain data, tactical intelligence, global route, actual path traversal, and navigation sensor data.

A86-187 TITLE: SMART MC&G CONTROL GENERATOR

CATEGORY: Exploratory Development

DESCRIPTION: Consider the situation where preflight knowledge, collection geometry, and sensor characteristics are known and it is required that a set of control entities be developed from a digital data base of MC&G data over a region of interest. The control data will be used in one case in a tactical environment to register digital imagery to the data base for screening purposes. The control data will in a second case, be used to register imagery to the MC&G data base for update and verification functions. Consideration must be given to both applications. Special consideration must be given to the kinds of control which will be discernible on the sensor records which include E/O, SAR, and IR. Special consideration must also be given to the state-of-the-art in vision understanding with respect to extracting corresponding image control features from the imagery. The control types will include point, linear, and a real features. The output of the smart MC&G control generator will MC&G control and associated expected image coordinates. The analysis will define the MC&G data base structure that best suits such an operation. The analysis will also describe limitations imposed on the operations due to less than suitable data base structures.

A86-188 TITLE: AUTOMATED EXTRACTION OF INDUSTRIAL TERRAIN FEATURES FROM DIGITAL RADAR IMAGERY

CATEGORY: Exploratory Development

DESCRIPTION: Develop methods and techniques to detect, identify, and classify

automatically industrial terrain features such as petrol, oil, liquid (POL) storage facilities, pier/dock facilities, transformer years, hangers, and industrial plants from digital radar imagery. The approach should include but not be limited to computer vision techniques, knowledge engineering techniques including expert systems, and the utilization of descriptor sets for the characterization of industrial features on SAR imagery. Digitized SAR image material will be furnished by the government. Personnel and facilities of the prospective contractor must be cleared at least up to the classification level secret by the designated security elements of the Department of Defense.

A86-189 TITLE: LARGE FORMAT HIGH RESOLUTION CARTOGRAPHIC MULTICOLOR PRINTER

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists to develop a capability to rapidly produce hard copy full color cartagraphic products directly from digital feature data. The development of a "Large Format (44" x 60") High Resolution Cartographic Multicolor Printer" is needed. This system should be based on ink jet technology, designed to image color separation input files using the process color printing technique. A capability to rapidly produce high resolution products and high quality screens on a rugged, markable media is essential. A minimum visual resolution of 800 dpi. is needed to meet mapping requirements. Plot time for a full foramt, full color image should not exceed 20 minutes. Map images, including color, text, and line art must meet rigorous accuracy and repeatability requirements to support production mapping.

A86-190 TITLE: ELECTRONIC MAP SYSTEM

CATEGORY: Research

DESCRIPTION: An Electronic Map System will consist of an electronically readable map and a map reading device. The electronically readable map will be a traditional map with an embedded or bonded material from which coordinate information may be read. The map reader will be a portable, self-contained unit for automatically reading the coordinate information of the grid and converting the information to latitude/longitude or UTM coordinates. The map reader will also have the computational power to calculate the distance between points, direction between points, and the estimated position of points using intersection/resection or ranging. The system will lightweight and easy to carry.

A86-191 TITLE: PORTABLE POLARIZED MICROSCOPE TECHNIQUE FOR ASBESTOS IDENTIFICATION

CATEGORY: Basic Research

DESCRIPTION: The Toxic Substances Control Act (TOSCA) prohibits the use of asbestos in new buildings and requires that old buildings such as schools be inspected for asbestos. Inspection and analysis for asbestos is quite costly and requires considerable turn around time. The proposed concept would consist of developing a simplified, portable, compact phase contrast and polarized light microscope (PC/PLM).

The simplified PC/PLM microscope will enable field technicians to be trained in a short time and then to analyze for asbestos according to straightforward and rapid methods. The methods will follow suggestions made by various authors in the literature, i.e., Webber, Pupons, and Flesner, and thus rely on precedent. By means of standardization and calibration techniques the acceptability of the testing procedures thus formulated will be assured and their capability with EPA and OSHA methods guaranteed. The method will utilize comparisons of actual samples with photographs and/or photomicrographs to quantitatively and qualitatively analyze for asbestos.

A86-192 TITLE: HYBRID SENSORS FOR CONTINUOUS AIR QUALITY MONITORING

CATEGORY: Basic Research

DESCRIPTION: The objective of this work unit is to identify new sensor technologies for use in continuous air monitoring/surveillance systems. Special emphasis should be placed on hybrid sensors which combine selection of the specific species of interest, concentration measurement, and analog to digital conversion of the concentration signal, all on a single integrated circuit. Species of particular interest are CO, CO2; H2, H2O, H2S, Hcn; CH3, non-methane hydrocarbons, total hydrocarbons; sulfur oxides; nitrogen oxides, 02, o3, oxidants; and particulates, both less than 10 micron and greater than 10 micron mean diameter. Technologies such as semipermiable membranes and catalytic conversion before detection should be explored. Digital concentration input should be 12- or 14-bit concentration, temperature and humidity corrected, to be directly interfaced to commercially available 8086- or 80286-based micro-computers via IEEE-448 or RS-232. Software concentration range control is desirable.

A86-193 TITLE: TECHNOLOGIES FOR DECONTAMINATION OF EFFLUENT AIRSTREAMS FROM STRIPPING TOWERS

CATEGORY: Basic Research

DESCRIPTION: The disposal of waste volatile solvents in landfills and leakage from underground storage tanks has lead to widespread contamination of groundwater in industrialized areas. The volatile solvents are often removed by air stripping, however, this can result in merely converting a water pollution problem into an air pollution problem. The purpose of this study will to identify existing technologies and/or develop new technologies which could be retrofitted onto air stripping towers to trap and/or detoxify volatile contaminants. New process configurations should also be considered which take advantage of the economic aspect of air stripping while avoiding the undesirable emission of air pollutant.

The research should consider all technologies currently used for detoxification or removal of air polutants, detail the effect of the concentration ranges experienced in stripping towers on the effectiveness of the detoxification and/or removal process, examine the effects of other process variables which will be dictated by the stripping operation (e.g., high humidity, temperature fluctuations, variable flowrates, etc.) and evaluate the economical and technical feasibility of retrofitting these technologies onto existing towers. In addition, new technologies for detoxification/removal should be identified, and process stream modifications investigated.

All residuals which could be generated by each process must be identified, and the cost and/or hazards of disposal must be tabulated. The effect of shock loads and intermittent operation must also be addressed.

A86-194. TITLE: GRAPHICS AND DATABASE INTERFACE

CATEGORY: Basic Research

DESCRIPTION: Microcomputer database management systems (DBMS) are being used to manage data about installation facilities and construction projects. Computer aided drafting (CAD) utilities are also available to develop graphic display of installation maps or building drawings. This proposal reflects the need to develop microcomputer software capable of producing graphic display of database information. Utilities to retrieve stored data and display the results on a map or drawing are needed. Query capabilities to the database from the drawing is also required. Limiting criteria for the database selection needs to be entered from the keyboard and from the drawing. Users should be able to take advantage of a display window to identify the space applicable to the query. Outlining an area on the screen to be included in the search of the database can be combined with selection criteria from the keyboard to utilize DBMS utilities such as data form editing and report generation. R:base 5000 DBMS will be used to store data, create screen forms, and develop reports from existing Army applications. Graphics standards such as GKS should be observed. Programs should be user friendly and allow an application developer to create and execute menu driven functions.

A86-195 TITLE: COMMUNICATION DEVICES FOR FIELD TRAINING UNITS

CATEGORY: Basic Research

DESCRIPTION: Training range automation programs will be able to generate safety fan overlay and safety data that must be communicated to units firing from a remote training area. Communication devices need to be developed that will allow the safety overlay and safety chart to be transmitted by a modem/ radio combination to a field unit. These devices should interface with a microcomputer to transmit data to a suitcase size receiving unit that can accept and print charts and graphs. The receiving unit should be a battery powered, small, lightweight device utilizing readily available technology and hardware. It should be capable of accepting keyboard input to transmit firing location data to the safety officer. Once the firing location is transmitted to the range office, safety overlay and safety chart calculations will automatically be done and the results will be sent back to the firing unit so a paper copy can be printed. Portable or laptop computers with lightweight printers are suggested for development. These portable devices will then be checked out from the range control office prior to a unit starting a training exercise. While some methods do exist to accomplish this task, the cost of this equipment is prohibitive. The objective of this proposal is to minimize the system costs and remain useful to users with little or no training.

A86-196 TITLE: STRUCTURAL FOAMS

CATEGORY: Basic Research

DESCRIPTION: High strength, high stiffness, low density structural foams. The objective is to develop a structural foam with a 2 to 5 pound per cubic foot density, modulus of <1,000 psi, and a potential cost less than 3 dollars per pound.

A86-197 TITLE: ROOFING SYSTEMS

CATEGORY: Basic Research

DESCRIPTION: Single component roof structural desk system. A roofing/ structural deck system than can be layed on structural joints such that one system provides structural decking, insulation, and a water proof membrane for flat roof systems.

A86-198 TITLE: LOW COST ELECTROMAGNETIC SHIELDING

CATEGORY: Basic Research

DESCRIPTION: The objectives of this research effort are to determine new design concepts for low cost electromagnetic shielding, to determine levels of shielding obtainable, and to make life cycle comparisons between the various alternatives.

As the automation of military command, control, communications and intelligence systems continues to expand, the need for shielding of the facilities to house these systems also expands. Most shielding designs currently in use are relatively expensive and often involve welded seam sheet steel. New construction design and methodologies to reduce shielding costs of such facilities are needed.

The electromagnetic shielding of a facility involves the complete enclosing of the volume to be protected within a continuous metal enclosure. The metal enclosure may be free standing, attached to structural walls, integrated into existing walls, or somehow sprayed onto structural walls. The requirements include:

1. Investigate construction methods and determine promising approaches to the shielding problem. Some designs with promise include:

    a. Copper sheets with soldered seams.
    b. Galvanized steel sheets with seams joined by nailing.
    c. Galvanized steel sheets with soldered seams.
    d. Sandwiched seams for various metals using furring strips for support and attachment.
    e. Mesh (metal) reinforcement in concrete.
    f. Silver soldered aluminum sheet.
    g. Pop rivetted aluminum sheet.
    h. Other approaches as determined.

2. Fabricate sample portions of models of facilities and attach shielding while developing optimal installation efficiency.

3. Determine material and labor costs.

4. Determine shielding levels obtainable.

5. Predict shielding performance versus time.

A86-199 TITLE: MICRO-CLEANING CF COAL AT INDUSTRIAL SCALE BOILER PLANTS

CATEGORY: Basic Research

DESCRIPTION: Micro-cleaning is defined here to mean the removal of sulfur and ahs from the coal matrix on the microscopic level by pulverizing the coal prior to cleaning. The proposed system would consist of a group of equipment that could take run of the mine high ash and high sulfur-coal and refine it to a relatively low (about 1 percent) sulfur content and low (about 6 percent) ash content. This process must consider both organic and inorganic sulfur removal. The procedure should be designed so that it can be adequately handled by a technician at a typical industrial scale boiler plant. The process should crush the coal and clean it, using micro-cleaning technologies, just prior to firing in a pulverized coal burner, slagging combustor or similar fine coal combustion technology. Ideally, the process will not increase the coal cost per ton to more than $50 (excluding the transportation). The process rate should be in the 1 to 15 tons per hour capacity range.

A86-200 TITLE: ACCEPTANCE TEST CONCEPTS FOR MECHANICAL SYSTEMS

CATEGORY: Basic Research

DESCRIPTION: Current procedures for acceptance testing mechanical systems in new Army construction are inadequate and do not insure that the systems are correctly installed and function in an energy efficient manner. The purpose of this work would be to investigate current measurement technology and develop a mechanical system acceptance test procedure using this technology which could be used to insure that new Army mechanical systems operate properly. The acceptance test procedure would have to be usable within the normal Army construction process and should clearly indicate the energy efficiency of the new mechanical system. The initial acceptance test would be limited to building air distribution systems including controls, coils, and fans. Chillers and boilers and their related components would not be included.

A86-201 TITLE: PAVEMENT ICE DETECTOR SYSTEM

CATEGORY: Exploratory Development

DESCRIPTION: A device is needed to detect the presence of ice on a paved surface. This device should be sufficiently sensitive to determine whenever the paved surface has accumulated ice to the point of becoming a hazard; for instance on highways or on an airport runway. The device should be capable of detecting ice on the pavement itself; not a device that detects ice accumulation on itself and by inference is therefore detecting ice formation on the paved surface.

A86-202 TITLE: MINI-COMPUTER VERSIONS OF TABS-2 PROGRAMS

CATEGORY: Exploratory Development

DESCRIPTION: The TABS-2 system of numerical flow and sediment transport models are widely used by the Corps of Engineers on mainframe computer. Some of the programs have been modified to run on mini-computer. There is a need

to have the entire system of about 40 programs made operational and efficient on various mini-computer systems.

A86-203 TITLE: EROSION RESISTANT MATERIAL FOR DIKE PROTECTION

CATEGORY: Exploratory Development

DESCRIPTION: Training dikes in rivers and estuaries constrain flow so as to minimize navigation channel shoaling and cross currents. These dikes are subject to damage by erosion of the sediment at the instream end and erosion of the bank at the land end. There is a need for an inexpensive method/ material that can be applied to the scour zones when traditional materials (e.g., rip-rap) is either too expensive or inadequate.

A86-204 TITLE: VECTORIZED VERSIONS OF TABS-3

CATEGORY: Advanced Development

DESCRIPTION: The TABS-3 system of numerical three-dimensional flow and sediment transport models are being used by the Corps of Engineers to solve sedimentation and water quality problems in waterways. The models use substantial amounts of processor time on super computers such as the CRAY 1 and the CYBER 205. Explicit vectorization of these programs to take full advantage of the super computer architecture will result in substantial cost savings to the Corps.

A86-205 TITLE: VIDEODISC TECHNOLOGY APPLICATIONS TO MASTER PLANNING AND BUILDING DESIGN

CATEGORY: Exploratory Development

DESCRIPTION: Videodisc technology offers attractive low cost mass storage medium for photographs, maps, and design drawings. Development of a prototype system is needed to demonstrate how this technology can assist Army master planners and building designers. Also, there is a need to develop video image manipulation techniques which facilitate end-user changes to video image data such as master plan data stored in Videodisc.

A86-206 TITLE: SYNCHRONOUS VIDEO RECORDER

CATEGORY: Exploratory Development

DESCRIPTION: Develop a video recorder capable of changing speed of recording with ability to synchronize with vehicle speed to maintain a constant number of frames for a given traveled distance.

A86-207 TITLE: DEVELOPMENT OF SPECIAL PURPOSE FINITE ELEMENT SYSTEM FOR MASS CONCRETE THERMAL ANALYSIS

CATEGORY: Exploratory Development

DESCRIPTION: Develop special purpose finite element method program(s) capable of 2-and 3-dimensional, non-linear, time-stepping analysis for computing temperature distributions and resulting thermal stresses and strains in mass concrete structures during and after construction. The program(s) must be

capable of simulating incremental (staged) construction and initiation and propagation of cracking. The program(s) also must be capable of handling internal heat generation; heat exchange by convection, conduction, and radiation; all practical boundary restraint conditions; and age and temperature dependent material properties. The program(s) must also account for creep of concrete.

A86-208 TITLE: DEVELOPMENT OF AN ULTRASONIC PULSE ECHO SYSTEM FOR EVALUATION OF CONCRETE

CATEGORY: Exploratory Development

DESCRIPTION: Billions of dollars are presently being considered as needed to repair the nation's infrastructure. Also, the repair of locks and dams will be expensive. No ultrasonic pulse echo system is commercially available for evaluating concrete like other materials. Eight years of research by Ohio State University, three years of research by the Army Corps of Engineers, and work by others have shown that a system is feasible. A non-destructive device is urgently needed to assess the condition of concrete in various structures.

A86-209 TITLE: SUBUNIT VACCINES FOR MILITARY-IMPORTANT DISEASES

CATEGORY: Exploratory to Advanced Development

DESCRIPTION: Subunit vaccines are those composed of key portions of killed microorganisms. The aim of this effort is to rid the killed microorganism of undesirable components by utilizing the techniques of microbial engineering and identifying just those parts of an organism that are able to produce immunity without side effects and to utilize genetic engineering to produce these purified antigens in large quantities.

A86-210 TITLE: DIAGNOSIS OF NATURAL AND INDUCED DISEASES OF MILITARY IMPORTANCE

CATEGORY: Exploratory to Advanced Development

DESCRIPTION: This effort is designed to provide state-of-the-art technology to develop a system for rapid identification and diagnosis of agents or diseases acquired naturally or by exposure to biological weapons. The system will provide for rapid identification of agents/diseases through examination of clinical specimens such as blood, urine, spinal fluid, and throat washings. The system should be extremely sensitive using very specific reagents such as monoclonal antibodies prepared through hybridoma technology. Methods utilizing the latest in biotechnology techniques should be utilized, such as labeled molecular probes for the identification and analysis of microbes or their products.

A86-211 TITLE: IMMUNOASSAY FOR T-2 TETRAOL

CATEGORY: Exploratory Development

DESCRIPTION: T-2 tetraol is a principal urinary metabolite of T-2 in mammalian systems. An assay effective in sensitively measuring T-2 tetraol in urine is needed to screen for prior exposure to T-2. Production of a sensitive immunoassay is desired.

A86-212 TITLE: VACCINE DELIVERY SYSTEMS

CATEGORY: Exploratory Development

DESCRIPTION: A requirement exists for controlled-release systems, carriers, and/or adjuvants compatible with vaccines or subunit vaccines for high-hazard agents of specific interest to the Army. Additionally, a need also exists for new methods of immunization and/or mucosal immunity to these high-hazard agents.

A86-213 TITLE: NOVEL AGENTS FOR CHEMOTHERAPY AND PROPHYLAXIS OF MULTIDRUG RESISTANT STRAINS OF PLASMODIUM FALCIPARUM

CATEGORY: Basic Research

DESCRIPTION: Stains of Plasmodium falciparum which have become resistant to standard antimalarial drugs are increasing in prevalence and threaten to compromise efforts to control this disease. Thus, a requirement exists to discover antimalarial agents which do nor share structural similarities to drugs which are currently in use. Such novel compounds may possess biological mechanisms of action which are unique and thus limit the likelihood that cross-resistance to existing drugs will render them ineffective. Structural classes other than the 4-aminoquinolines, and the amino alcohols should be emphasized.

A86-214 TITLE: PHYSIOLOGIC STABILIZATION AFTER TRAUMA

CATEGORY: Basic Research

DESCRIPTION: A general requirement exists to provide improved field care after traumatic injury when evacuation is delayed. The overall aim of this research and development is to provide treatment under adverse conditions that maximized salvageability and recovery once definite care becomes available. Contemplated efforts cover a wide technological spectrum from state-of-the-art applications designed to improve and simplify first aid and resuscitative methods on the field to basic scientific investigations designed to explore unusual and innovative technical means for temporarily suspending or stabilizing pathophysiologic processes after traumatic injury.

A86-215 TITLE: BLOOD BAGS

CATEGORY: Advanced Development/Non-Systems

DESCRIPTION: A requirement exists to develop rugged, plastic bags that can be stored with a preservative for ten years. The bags must be tolerant to wide temperature fluctuations within a 24-hour period.

A86-216 TITLE: BLOOD PRESERVATIVES

CATEGORY: Basic Research

DESCRIPTION: A requirement exists to develop a new blood preservative that allows red cells to be stored up to 56 days while maintaining at least 80 percent of their original 2,3 diphosphoglycerate.

A86-217 TITLE: BLOOD SUBSTITUTE

CATEGORY: Basic Research

DESCRIPTION: A requirement exists for a safe, efficacious emergency blood substitute for human use when whole blood is unavailable. Any proposed substitute should provide acceptable volume expansion as well as tissue oxygenation delivery capacity without requiring oxygen enriched breathing mixtures. Prolonged room temperature storage of the dehydrated material is desirable for logistic purposes.

A86-218 TITLE: LYOPHILIZED PROTEINS IN PLASTIC BAGS

CATEGORY: Basic Research

DESCRIPTION: A requirement exists to develop a techniques to fill sterile plastic bags with a sterile protein solution followed by lyophilization of the protein for long-term storage.

A86-219 TITLE: HUMAN CORE TEMPERATURE MEASUREMENT DEVICE

CATEGORY: Exploratory Development--Advanced Development/Non-Systems

DESCRIPTION: A requirement exists for a human core temperature measuring device. The device must be non-invasive to the human body (i.e., anal probe) in its operation; however, a device which is ingested and subsequently eliminated from the body will be considered if it meets FDA approval. The device must be capable of transmitting data a minimum of one meter and must be able to meet U.S. Army precision criteria of + or - 0.2 degrees F and accuracy criteria of + or - 0.1 degrees F.

A86-220 TITLE: HYBRIDOMA PRODUCTION

CATEGORY: Advanced Development

DESCRIPTION: A requirement exists to acquire hybridomas secreting antibody to a spectrum of agents of military interest. The objective is to develop a library of monoclonal antibodies and nucleic acid probes against infectious agents of military interest. The monoclonal antibodies secreted by these hybridoma cells will be used in the development and eventual provisioning of the rapid identification/diagnostic system, and in-house laboratories.

A86-221 TITLE: ARTIFICIAL INTELLIGENCE FOR MAINTENANCE TRAINING

CATEGORY: Exploratory Development

DESCRIPTION: The complexity of some Army equipment has increased to the point that the probability of correct fault diagnosis is lower than desired. The training time and cost required to improve the situation using traditional training procedures is impractical. Progress is microcomputer design and artificial intelligence suggest that training devices may be possible which will aid school and on-the-job training (OJT). For instance, Derek Sleeman, Stanford University has developed procedures for discovering the specific errors made by algebra students and has developed programs for "Diagnosis and remediation by intelligent tutoring systems." John Seeley Brown has

accomplished the same for arithmetic. Claire Weinstein at the University of Texas-Austin has developed techniques for modifying defective learning strategies. Application of these and other artificial intelligence techniques may increase school training effectiveness and allow more effective OJT.

The training devices for school environments might train learning strategies and generic skills which have application across may jobs and/or they might be reprogrammable to provide training on a number of specific devices. The OJT trainer and job aid would be easily reprogrammed to adapt to new procedures and modified equipment. The devices might also complete parts requisition forms and maintenance logs automatically, as well as maintain personnel performance records.

A86-222 TITLE: RESEARCH IN SIMULATOR/DEVICE MIX METHODOLOGIES

CATEGORY: Exploratory Development

DESCRIPTION: As technology expands in the area of simulation for training, the Army must determine the most effective and least costly methods of mixing devices to support training in operational units. A methodology for clustering critical tasks and sequencing the skill acquisition process across part and full task trainers would be extremely useful. Techniques are needed for examining existing and proposed simulators for their unique "niche" in the overall unit training program.

A86-223 TITLE: MEASUREMENT AND MODELS OF EMPLOYMENT DECISION MAKING

CATEGORY: Exploratory Development

DESCRIPTION: Each year the Army must enlist and reenlist thousands of soldiers. In order to recruit and retain high performing soldiers, it is important to be able to understand, measure, and model the variables considered by individuals in making their decisions to join the Army or reenlist. These variables are also important in terms of the decision to enroll and continue in ROTC and to make a career as an officer in the Army.

A86-224 TITLE: RESEARCH IN PROJECTING MANPOWER AND SKILL LEVEL REQUIREMENTS EARLY IN WEAPON SYSTEM DEVELOPMENT

CATEGORY: Exploratory Development

DESCRIPTION: Historically, the system acquisition process has been driven by cost, adherence to schedule, and hardware/software performance. Recently, increased emphasis has been given to early identification of the human resources needed to operate and maintain the new systems. Accurate estimates of the number of individuals and the skills they must possess provide a basis for (a) comparisons with estimated future supply; (b) identification of system changes to reduce operator and maintainer requirements; and (c) selection among competing systems. Innovative techniques which can be used to generate quantitative and qualitative estimates of operator and maintainer requirements on the basis of information available during concept development are needed. Procedures for estimating ability requirements are especially desired.

A86-225 TITLE: RESEARCH ON COGNITIVE PROCESSES IN DECISIONMAKING UNDER UNCERTAINTY TIME STRESS

CATEGORY: Exploratory Development

DESCRIPTION: Commanders, intelligence analysts, and others are often required to make decisions under conditions of uncertainty and severe time stress. Uncertainties may be associated with missing, incomplete or ambiguous information, or with future outcomes that are unknown. Research is needed to (1) better understand the cognitive processes (e.g., memory, judgement, or problem-solving) of the decisionmaker under such conditions, and (2) suggest approaches for supporting the cognitive processes so that the overall quality and timeliness of decisions made under uncertainty and time stress are enhanced.

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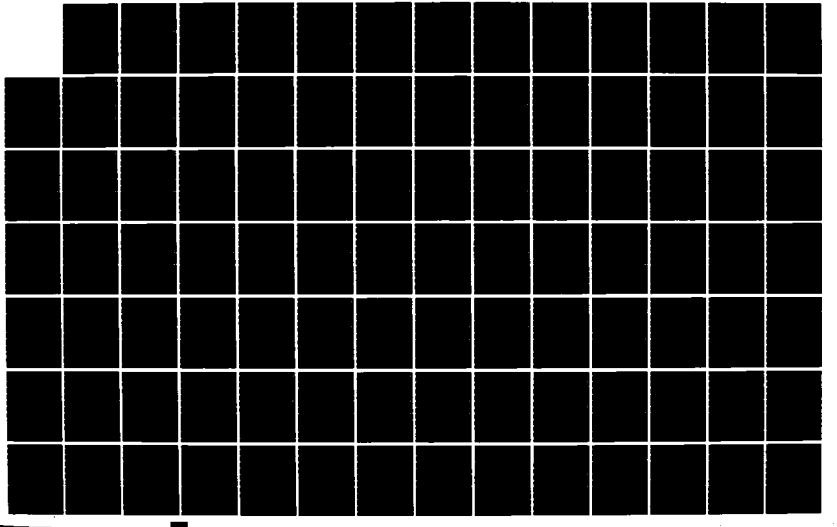
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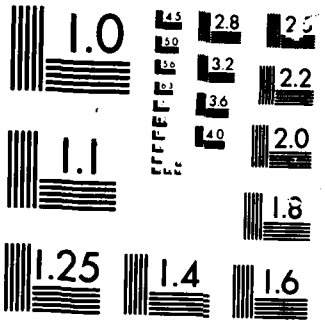
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Topics #N86-155 through #N86-158

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Topic #N86-159

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Topics #N86-160 through #N86-162

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Topics #N86-163 through #N86-164

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Topics #N86-165 through #N86-170

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Topic #N86-171

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Topics #N86-172 through #N86-174

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Arlington, VA

N86-1. TITLE: Acoustic Measurement Techniques

CATEGORY: Research

DESCRIPTION: Sophisticated sensing techniques and materials with specific properties including reliability, and more accurate, reliable, and versatile acoustic techniques for sensing and measuring parameters of interest to the Navy will provide options and improvements in instrumentation for sensing operational parameters and for characterization and reliability assurance of naval materials. The interest is in exploiting the power of acoustic measurement techniques, especially those that are only now possible with rapid advances in other technologies and in computing power. There is a need for basic research that will develop innovations in acoustic methods for measurement of parameters of fluids and solids and advance the state-of-the-art in acoustic measurement instrumentation. The interests are to conceive and demonstrate proof-of-principle for innovations in acoustic measurement methods and to implement some of them in ways that will find applications. These range from the experimental validation of existing theoretical results to the putting together of several proven techniques heretofore not used in combination. The applications include nondestructive evaluation, transducer calibration and characterization, materials research, measurement of radiated noise and other sound fields, and sensing of environmental parameters.

N86-2. TITLE: Chemical Intelligence for Automated Systems

CATEGORY: Research

DESCRIPTION: Requirements exist for the development of chemical sensing and measurement capabilities in areas that include drugs of abuse, chemical defense, contamination control and cabin atmosphere monitoring, optimization and control of specific chemical processes, and chemical intelligence for automated systems, e.g., robots used to monitor and control materials processing for device fabrication. Concepts related to the development of fast, "smart" chemical microsensors and miniaturized instrumentation for detection and analysis are being sought. Particular emphasis will be given to fiber-optic based systems. Research emphasizing new sensing phenomena, new device concepts and materials, methods for enhancing sensitivity and selectivity of response to particular chemical species, and information enhancement of chemical measurements are examples of research areas of interest.

N86-3. TITLE: Generation of High Voltage Subnanosecond Pulses

CATEGORY: Exploratory Development

DESCRIPTION: Commercially available subnanosecond electrical pulsers suffer from two limitations: low voltage levels and/or considerable pulse-to-pulse jitter. A pulser which overcomes these limitations would open up new avenues of research in diverse areas, especially high resolution radar and radar target identification via natural resonance extraction. One promising approach is through the use of a picosecond mode-locked laser to control a semiconductor switch in a high voltage line.

Topic #N86-175

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Topics #N86-176 through #N86-177

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Topics #N86-178 through #N86-181

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Topics #N86-182 through #N86-190

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Building 2, Room 101
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The objective of this work would be to demonstrate a working laboratory model of an electrical pulser delivering 1 kV pulses with widths of 100 ps or less at repetition rates of about 500 Hz; the pulse-to-pulse jitter would have to be no more than a few picoseconds. The later phases of the effort would involve manufacturing a prototype that would demonstrate sufficient stability and reliability for commercial applications.

N86-4. TITLE: Oriented Protein Monolayers/Multilayers on Metallic Surfaces

CATEGORY: Exploratory Development

DESCRIPTION: The Langmuir Blodgett technique has been used to transfer surface films of amphipathic lipids at air/water interfaces to solid surfaces. There is a need for an extension of this technique that would enable the transfer of protein films to solid (metallic) surfaces and preserve their structures. The proteins of greatest interest are those capable of transferring electrons (e.g., redox enzymes) to and from the metal.

N86-5. TITLE: High Temperature Adhesive Systems

CATEGORY: Research

DESCRIPTION: The joining of composites to composites, composites to metals, and metals to metals by adhesive bonding is currently limited to use temperatures well below the glass transition temperature of the adhesive. High temperature adhesive systems are lacking for use temperatures above approximately 350°F.

The objective of this research is to develop new classes of adhesives through the use of preceramic or inorganic precursor materials. A preferred adhesive is one that can form a bonded system under low temperature forming procedures, yet will maintain integrity under cold-dry and hot-wet use conditions. A further objective of this research is to develop adherend surface preparation procedures that will form stable adherend/adhesive interfaces.

N86-6. TITLE: NDE of Adhesive Bonds

CATEGORY: Research

DESCRIPTION: The use of adhesive bonding to join structural materials is limited by the lack of inspection techniques to determine whether the adherend surface has been properly prepared, whether the adherend surface has been degraded after surface preparation techniques but before bonding, whether a durable bond has been formed, and whether a bond that has been exposed to use conditions has maintained its integrity.

The objective of this research is to develop innovative noninvasive inspection techniques that can make these determinations.

N86-7. TITLE: Extensible Databases

CATEGORY: Research

DESCRIPTION: Research and development in the database management systems

area has traditionally concentrated on supporting business applications. Recently the design of database systems capable of supporting non-traditional application areas such as CAD/CAM and VLSI, scientific and statistical applications, expert database systems, and image/voice processing has emerged as an important direction of database systems research. These new applications differ from more conventional applications (e.g., transaction processing, record keeping) in a number of critical aspects, including data modeling requirements, processing functionality, concurrency control, recovery, access methods, and storage structures. A number of groups are attempting to meet the demands of these new applications by either building interfaces on top of existing relational database systems or by trying to extend the functionality of such systems. These approaches may appear promising, but are not likely to provide acceptable performance. Research is needed which will lead to design methods for database management systems that are flexible enough to permit extensions to operations such as data modeling, query processing, access methods, storage structures, concurrency control and recovery.

N86-8. TITLE: Fundamentals of Solid State Batteries

CATEGORY: Research

DESCRIPTIONS: A number of solid electrolytes, including polymer-based systems, exist which have ionic conductivities sufficiently high for use in solid state batteries. Investigations of solid state electrochemical cells and their electrochemical behavior are required before solid state batteries can be developed. Emphasis should be given to systems involving polymer/based electroloytes which are capable of practical charge/discharge rates at or near room temperature. Issues which need to be addressed include materials compatibility, electronode-electrolyte interface formation and interfacial composition, impedance, and electrical behavior. Kinetic investigations are needed to establish the factors determining rates and to identify approaches to catalysis in solid state systems. Included in the scope of this work are cycling studies of prototype cells to determine the effects of charge/discharge on cell behavior, stability and electrochemical performance.

N86-9. TITLE: Systemic Grammar and Instruction Dialogue

CATEGORY: Research

DESCRIPTION: The task is to produce a comprehensive formal theory of instructional dialogue within the framework of systemic grammar. The theoretical analysis must be sufficiently general to encompass both human-human and human-computer instructional dialogue. It must be sufficiently formal to support the principled design and implementation of natural language interfaces for intelligent tutoring systems. The work should make contact with on-going psychological and artificial intelligent research on learning and knowledge representation in one or more of the following domains: mechanics, hydraulics, electricity, probability, algebra, navigation, or computer programming. The end-product of the research effort will be a demonstration version of an intelligent training system in one of these technical areas, incorporating a theory-based natural language instructional dialogue capability.

N86-10. TITLE: Representation of Transient Auditory Events

CATEGORY: Research

DESCRIPTION: Acoustic transients of 100 ms or less within noisy backgrounds provide distinctive cues for the identification of an underwater event or sound source that are more salient than the analysis of steady-state emissions within those backgrounds. However, further research is needed to determine alternate ways to represent those events in either visual or auditory displays. The formats that are advanced would be consistent with the decision rules employed by human operators in the classification of sound sources and long-term memory for those events. The understanding of human performance has been formalized with information-processing models that are applicable over a limited range of brief sounds but those models need to be re-evaluated and, as necessary, to be revised to account for many more categories of underwater events. Recent advances in data base design, faster algorithms, and audio-video technologies should be exploited in the investigation of this problem area. An interdisciplinary approach that utilized concepts from engineering psychology, computer science, and signal processing should be given strong consideration.

N86-11. TITLE: Ocean Optical Property Measurements

CATEGORY: Research

DESCRIPTION: Develop a capability for the measurement of ocean optical attenuation and scattering. Current systems are not capable of separating the two energy loss mechanisms. The ideal measurement device would be capable of rapid, in-situ independent measurement of both attenuation and scattering. It should be capable of operating at depth (to 1000m), and have broad bandwidth (300-800 nm). The objective is to develop a precision tool useful for science measurements that can be adapted to use in survey systems. The information derived from these data is essential for development of oceanic biology behavior models, an understanding of the distribution of dissolved and particulate matter, and development of undersea communication techniques.

N86-12. TITLE: Foliage Penetration Radar

CATEGORY: Advanced Development

DESCRIPTION: The Marine Corps Required Operational Capability Intelligence (ROC INT) 1.05 of 17 May 1976 *Lightweight Foliage-Penetration Battlefield* Surveillance Device (FOLPEN BSD) states the requirement for a man-packed (30 lbs) radar with the ability to detect moving personnel and vehicles through 300 meters of light to heavy foliage, and 1500 meters in open terrain. It is desired that advanced development models of this system be developed to test in the Fleet Marine Force.

N86-13. TITLE: Waxless, Reduced Length Military Snow Ski

CATEGORY: Engineering Development

DESCRIPTION: The current snow ski in the Marine Corps inventory requires

waxing and is approximately 205cm in length. The advantage to this ski is the ability to wax to meet existing snow conditions and an increased downhill speed. There are some appreciable drawbacks to this ski, among them the increased logistical burden of maintaining a variety of different waxes, the time and skill required to wax the ski, and the supervision necessary to ensure all Marines in the unit wax to the same standard. A waxless, reduced length ski would be lighter, eliminate the work associated with waxing a ski, and the shorter length would make it easier for the Marine to learn how to ski, turn, sidestep, and climb. This is extremely advantageous given the weight a military skier is required to carry. A waxless, reduced length ski should have a grip surface that's durable, quiet, maintenance free, and provide an adequate amount of grip under all snow conditions. It should also incorporate the metal edges that the current ski has as well as comparable flotation. The length should be between 140-180cm and the ski should be compatible with the vapor barrier boot currently in use by the Marine Corps.

N86-14. TITLE: Solid State Laser

CATEGORY: Research

DESCRIPTION: Development and demonstration of a solid state laser capable of producing light in the equivalent frequency region of the cooper vapour lasers are required. This effort would be basic research because no such device has been demonstrated to date. A demonstration of the technical feasibility is needed prior to attempts at packaging for military applications.

N86-15. TITLE: Amphibious Task Force Simulator/Decoy

CATEGORY: Research/Exploratory Development

DESCRIPTION: Threat forces have the ability to track an amphibious task force (ATF) from embarkation to the final assault phase on the beach. One method of deception which could enhance survivability of the ATF would be a simulator which visually, sonically, and electronically reproduces it in false areas of the ocean. Research is required to see if the simulator is technology feasible.

N86-16. TITLE: Hardware Failures vs. Software Malfunctions, Computing Reliability and Maintainability Data

CATEGORY: Management and Support

DESCRIPTION: Traditional methods of computing reliability, availability and maintainability (RAM) are hardware oriented. Current Command Control systems are complex mixes of hardware and software. Hardware can fail and be repaired. Software does not fail. It either works or does not. It cannot be repaired or corrected in the same manner as hardware. Current methods of RAM computation consider software malfunctions the same as hardware failures thereby distorting RAM data. A method of RAM development that differentiates between hardware failures and software malfunctions is required. Consideration must be given to a method in which repeated occurrences of the same software malfunction are computed in RAM and whether

or not the malfunction is minor or impedes system functional performance.

N86-17. TITLE: Infrared Camouflage of Command and Control Equipment

CATEGORY: Exploratory Development

DESCRIPTION: Current Marine Air Command and Control System (MACCS) facilities rely on lightweight camouflage system nets to provide a degree of infrared concealment. However, MACCS radars, Command and Control vans and numerous associated tactical generators are very vulnerable to sophisticated Forward Looking Infrared (FLIR) detection systems and IR weapons. Exploratory development is needed to design and test IR reflective paint, better concealment coverings or nets, generator concealment means, and IR decoy systems to emulate the MACCS. Prototype devices should be low cost and sufficiently developed for field testing with actual command and control systems, radars, and generator equipment. Any innovative IR suppression means that is technically feasible and available should be identified.

N86-18. TITLE: Portable Decontamination System

CATEGORY: Advanced Development

DESCRIPTION: A need exists for the development of an advanced portable decontamination system for use by Marine Corps Battalions. The system must be independent of external power, be capable of supplying 10gpm of 110°F water for showers or supporting up to four spray wands, with each wand having an output of 1.5gpm of 250°F water at 1000 psi. The total system weight is not to exceed 400 pounds and be comprised of not more than six components or kits; while each of the components or kits is not to exceed 100 pounds. The system must be capable of operating on diesel fuel. The objective of the Phase I effort would be to demonstrate the technical feasibility of this proposed portable decontamination system by designing and fabricating a prototype system.

N86-19. TITLE: Integrating Directed Energy Weapons into the Marine Corps (1995-2015)

CATEGORY: Exploratory Development

DESCRIPTION: One factor has remained unchanged since the beginning of warfare: killing, destroying and defeating an enemy by the utilization of physical weapons. Today we stand on the threshold of a revolutionary change: killing, destroying, and defeating an enemy by the utilization of energy weapons. The recognition of this revolution and the timely seizure of the initiative in embracing, adapting and employing these new weapons are critical to the survival of the Marine Corps as a capable, cost-effective force in readiness.

The objectives of this effort are to:

(a) determine the feasibility applying directed energy weapon technology in the replacement or augmentation of physical destructive devices. Propose specific applications;

(b) conduct cost analysis to determine the life cycle costs for the employment of directed energy weapons proposed in paragraph (1) compared to conventional weapons; and

(c) develop a plan for integrating the weapons recommended in (1) and (2) into existing Marine Corps plans and programs.

N86-20. TITLE: Amphibious Task Force Camouflage

CATEGORY: Research/Exploratory Development

DESCRIPTION: The Amphibious Task Force (ATF) is detectable by threat forces from embarkation to the final assault. To enhance survivability of the ATF, new and revolutionary means of cover are required. The cover must be visual, sonic and electronic.

N86-21. TITLE: Surviving the Enemy's Use of Directed Energy Weapons (1995-2015)

CATEGORY: Exploratory Development

DESCRIPTION: One factor has remained unchanged since the beginning of warfare: being attacked, assaulted and confronted by the physical weapons of an enemy force. Today, we stand on the threshold of a revolutionary change: being attacked, assaulted, and confronted by the directed energy weapons of an enemy force. The recognition of this revolution and the timely seizure of the initiative in protecting ourselves from, defending against, and countering the directed energy weapons of an enemy force are critical to the survival of the Marine Corps as a capable, survivable force-in-readiness.

The objectives of this effort are to:

(a) determine the feasibility of protecting ourselves from, defending against, and countering directed energy weapons. Propose specific alternative applications;

(b) conduct cost analysis to determine the life cycle costs for the specific alternative applications in (1); a

(c) develop a plan for integrating th applications chosen from (1) and (2) into existing Marine Corps plans and programs.

N86-22. TITLE: Optical Fiber Sensor for Chemical Agent Detection and Identification

CATEGORY: Advanced Development

DESCRIPTION: A need exists for the development of an advanced detection system to provide Marine Corps infantry units with a remote chemical agent detection system which is manportable. The system should incorporate two or more filters or optical discriminators to provide discrimination of chemical agents by infrared absorption/emission characteristics. The objective of the Phase I effort would be to develop and explore the technology of optical fiber sensors for use as a filtered infrared chemical warfare agent detector.

N86-23. TITLE: Develop Method for Rapid Assessment of Expeditionary Airfield

CATEGORY: Research

DESCRIPTION: Airfields located in a Marine Corps areas of action may be conventional paved construction (captured or occupied), or may be constructed from AM-2 matting (Aluminum Landing Matting). Marine aviation elements deploying to these fields must be equipped with an airfield damage repair capability which meets the specific airfield requirement. The ability to rapidly (within one hour, post attack) assess the battle damage and evaluate where minimum repairs can be made to successfully reestablish air operations is paramount. The method established must be suitable for the expeditionary environment and adaptable to existing weapon systems (either air or ground).

N86-24. TITLE: Compatible Lighting for Night Vision Goggles (NVG's) for Landing Craft

CATEGORY: Engineering Development Management and Support

DESCRIPTION: The Cockpit Illumination of Driver Instructions will blind the NVG's in use by anyone in the cockpit. Aircraft cockpit lighting has been successfully filtered with blue/green covers and indirect illumination. This approach should be applied to the LCAC internal cockpit lighting design and external navigation lights to accommodate the use of NVG's by the Pilot/Driver/Navigator.

N86-25. TITLE: Single Broadband Tactical Manpack Radio

CATEGORY: Research

DESCRIPTION: Design/develop one radio to handle the entire tactical bandwidth (2mHz-3 GHz) and which possesses the capability to choose from multiple modulation schemes. Additionally, the radio should possess a single, standard generic communications security device to ensure inter/intraoperability in the security arena. Finally, it should be reemphasized that the technology to fulfill these requirements is here today. Hopefully, future technology developments will provide weight and size reductions that could also include the super high frequency (SHF) bandwidth (3gHz-30gHz) in a manpackable form and could expand the bandwidth of the proposed radio even further. The impact of such development would be threefold: (1) Improve inter/ intraservice operability; (2) Provide a capability for graceful communications degradation in combat; (3) Reduce maintenance cost and complexity.

At present, infantry line (i.e., combat) units tactical radio nets operate within three distinct portions of the frequency spectrum and utilize a variety of radios. With advancing technology, specifically very large scale integrated (VLSI) chips, great reductions in size and weight for HF, VHF, and UHF radios can be achieved. This is evidenced by the quantum size and weight improvements in the AN/PRC-104 versus it predecessor, the AN/PRC-47. Unfortunately, with present technology, the expansion of Manpack radios into the SHF and higher portions of the frequency spectrum, is constrained by the relatively large size of the crossed field oscillators (e.g., magnetrons, reflex klystrons, etc.) required to produce these frequencies. However, much larger bandwidths in a radio could, nevertheless, be achieved. This could increase the frequency range of an individual radio to include the HF, VHF, and UHF portions of the spectrum through modern advances in broadband linear amplifiers. The combination of VLSI size/weight reductions and broadband amplifier spectrum expansion in a

single manpackable radio offers a tempting alternative to present battlefield communications.

N86-26. TITLE: Aerostat, Blimp, RPV/Airborne Early Warning for USMC

CATEGORY: Research

DESCRIPTION: Currently the Marine Corps has no organic airborne early warning (AEW) capability. Three alternatives to a manned AEW aircraft are: aerostats, blimps, and remotely piloted vehicles (RPV's). An in-depth research analysis of the capability, cost, feasibility, manpower impact, and risk of each of these alternatives is required. Analysis should consider all logistics aspects of the three alternatives. Affordability within the Navy procurement budget (blimps) and the Marine Corps procurement budget (aerostats and RPV;s) should be addressed. A recommended AEW system, if any, should be submitted.

N86-27. TITLE: Variable Speed Compatible Refueling Drogue for Air Refueling

CATEGORY: Engineering Development

DESCRIPTION: At present, the mission of refueling both fixed wing and helicopter aircraft cannot be accomplished without air equipment change to the refueling pods. This is due to the design of the high speed drogue that will not support the weight of the refueling hose at the lower speeds required for helicopter refueling. The challenge is to develop a drogue that will support the 80' refueling hose at airspeeds between 105 KIAS and 250 KIAS.

N86-28. TITLE: Multi-Static Radar (Passive) Applicability for Small Radar Cross

CATEGORY:

DESCRIPTION: Research is required in the area of multi-static radar receiver applicability for detection and correlation of small radar cross section aircraft. The study should determine the feasibility and affordability of using multi-static radar technology to reacquire and track small radar cross section targets that may be undetectable by conventional radars.

N86-29. TITLE: Research for Mobile Electronic Warfare Support System (MEWSS) Enhancement

CATEGORY: Research

DESCRIPTION: The Mobile Electronic Warfare Support System is to be modular, self-contained, electronic warfare system installed in a Light Armored Vehicle. An enhanced system is envisioned that will be capable of detecting, locating, and degrading enemy command, control, and communication (C^3) systems operating in a frequency range beyond the current system capabilities. The prototype, partial-capability system, is only capable of performing jamming and DF operations in the frequency range of the currently used RACAL RJ3100 jammer, and WatkinsJohnson AN/PRD-10 DF (direction finding)

system. The research is to explore available and anticipated systems that will meet the requirements of an enhanced system.

N86-30. TITLE: High Speed Digitizer

CATEGORY: Exploratory Development

DESCRIPTION: In connection with ongoing USMC technology, development of electro-optics for land mine detection and survey, the need for a very high speed and high-repetition rate digitizer has been identified. The requirement is for a device capable of digitizing (to at least eight-bit accuracy) a signal occurring at a rate of 15KHz lasting on the order of 200 nanoseconds, with the digitization sampling the signal at least every nanosecond over the entire 200 nanosecond period. Higher accuracy levels would be of value as would a longer sampling window.

N86-31. TITLE: Electronic Beam Scanning for Command, Control, Communications Countermeasures (C^3CM) Applications

CATEGORY: Exploratory Development

DESCRIPTION: In the future Battle Group, more effective applications ofC^3CM will be required to optimize the capabilities of Navy combatant platforms. Innovative approaches utilizing new technology are needed to provide software and hardware to efficiently control electronically scanned, agile beam antennas. Specific improvements desired include reduction in weight, complexity, and cost. These technologies have potential applications in many of the Navy ESM, EW, and C^3CM programs. Currently these techniques are used primarily in only the most expensive projects.

N86-32. TITLE: Enhanced HF Propagation Prediction

CATEGORY: Exploratory Development

DESCRIPTION: High Frequency radio propagation between two points is predicted with sufficient speed and accuracy by the MINIMUF 3.1 algorithm for many applications. However, when problems requiring arrays of Maximum Usable Frequencies are run on small processors such personal computers, the compute time for the MINIMUF algorithm limits the breadth of computations and displays that can be accommodated. An innovative hardware/software approach to provide very fast execution of the MINIMUF algorithm thus unloading this specialized task from the host processor is needed. Once unloaded, the host processor can be programmed using conventional software to manipulate large MUF arrays in new and more meaningful ways to support Naval use of HF propagation with relatively inexpensive personal computer type hardware.
As a goal, execution of each point pair should occur in one millisecond or less. One approach that suggests itself is to build a dedicated peripheral card for an IBM type personal computer using a machine language coded microprocessor. However, different innovative approaches might yield significant advantages over this. Information on the MINIMUF 3.1 algorithm is available from:

U.S. Department of Commerce
National Technical Information Service

5285 Port Royal Road
Springfield, VA 22161
Telephone (703) 487-4650
Request document AD A066-256, "The MINIMUF 3.5, Improved Version of MINIMUF-3, A Simplified HF MUF Prediction Algorithm". The cost is $7.00 pulse $3.00 for handling.

N86-33. TITLE: Fiber Optics Based Local Area Network

CATEGORY: Research

DESCRIPTION: This effort is to provide a conceptual design of a fiber optics based local area network (LAN) which will distribute radar video to remote control indicators (RCIs). The LAN will also be used to provide control for RCIs as well as track file information. The task is (1) to develop the LAN protocol for this application and determine its performance for various numbers of RCIs, (2) to conceptually design the fiber optics network, including optical switching, cabling, connectors, environment and interface electronics and (3) to assess the impact of the LAN on current Identification Friend or Foe (IFF) shipboard systems.

N86-34. TITLE: Lightweight Broadband Shipboard High Frequency Antenna

CATEGORY: Exploratory Development

DESCRIPTION: Examine concepts for a broadband high frequency (2-30 megahertz) naval shipboard transmit and receive antenna for use with frequency agile communications systems. The antenna must meet severe environments of shock, vibration, salt spray, ice and stack gas. Lightweight, low takeoff angle, omni-directional pattern and high efficiency are desirable characteristics. A voltage standing wave radio (VSWR) of less than 3 to 1 is necessary across the band with a transmit power of approximately 1 kilowatt peak envelope power.

N86-35. TITLE: Manufacturing Cost Analysis - Gallium Arsenide Monolithic Microwave Integrated Circuits

CATEGORY: Exploratory Development

DESCRIPTION: Perform a cost analysis of various manufacturing techniques for gallium arsenide monolithic microwave integrated circuits (GaAs MMICs) designed for military systems. The analysis should project probable innovative batch fabrication techniques to be used to manufacture hybrid circuits vs. the totally monolithic approach. Custom and standard designs should be compared and the cost impact of computer-aided manufacturing or other innovative fabrication techniques should be assessed. The cost analysis should also include factors such as packaging, testing, performance and reliability. A report is to be prepared which summarizes the results of this analysis. The report will be used in planning future GaAs MMIC development programs.

N86-36. TITLE: Naval Countermeasure Controller

CATEGORY: Exploratory Development

DESCRIPTION: U.S. Naval Electronic Countermeasure assets for protecting the fleet from anti-ship missiles have expanded considerably in recent years. Laboratory ECM engagement simulations have demonstrated that considerable enhancement of Battle Group survivability can be achieved by coordinating the usage of these assets, which are spatially distributed on ships, aircraft, remote operated airborne platforms and on decoys launched from aircraft and ships. EW systems are needed as control mechanisms that can execute these coordinated ECM tactics in the real-time of naval battles. Coordination of data from radar, ESM and other sensors (including off-board), and knowledge of platform locations must be intelligently and automatically utilized to achieve predictable effectiveness. Knowledge of currently deployed ECM controllers, relevant data and communications link capabilities, Naval weaponry and operating procedures is required.

N86-37. TITLE: Power Converter, 110VAC to 8 VDC

CATEGORY: Engineering Development

DESCRIPTION: The use of lithium batteries in the AN/PSC-2 Digital Communications Terminal (DCT) aboard ship is discouraged because of an unacceptable hazard to personnel.

A power converter is required to convert standard shipboard 115VAC input power to 8 VDC output power to drive the AN/PSC-2 DCT. A converter that can be accommodated in the battery well of the DCT is desirable and must be hazard-free to the DCT operator.

N86-38. TITLE: Remote Under Ice, Ice Thickness Measurement

CATEGORY: Exploratory Development

DESCRIPTION: An urgent need exists today for a capability to remotely measure the thickness of ice as accurately as possible (minimum accuracy of ± 10%) over eighty percent of the Arctic region. The principal area of interest is the Polar Cap, Barents and Kara Seas regions. The measurement would be: (1) made from an underwater platform without restricting its movement except for perhaps slowing its speed; (2) accurate to within plus or minus ten percent (± 10%), (3) made in near real time. The results would be printed on a permanent paper medium as well as visually displayed. Internally housed equipment should be lightweight and consume not more than one standard rack of electronic equipment. Present ice thickness measurement techniques principally use Microwave, Synthetic Aperature Radar or Sonar. Sonar is the least desirable technique to be employed in ice thickness measurement.

The objective of this task is to develop a technique for remotely measuring Arctic ice thickness from a submerged moving platform while imposing minimum restrictions on the platforms movement. The technique would meet the requirements stated above. As a minimum, the work under this task would consist of literature search, development of ice measurement technique, in depth analysis of measurement technique, and assessment of feasibility/risk analysis.

N86-39. TITLE: Satellite Surveillance and Countermeasure

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative approaches and new technologies in the areas of Satellite Surveillance Countermeasures and defense. Technologies encompassed include, but are not limited to microwave electronics, electro-optical, space electronics, and multisensor correlative processing. Applications range from satellite shipboard sensor and countermeasure systems to support Naval objectives in world wide ocean surveillance and targeting.

N86-40. TITLE: Signal Processing: Broadband Cross-correlation Technique Development

CATEGORY: Exploratory Development

DESCRIPTION: Narrow band spectral analysis forms an important part of Signal Processing techniques for the detection of targets/objects that may be imbedded in various types of noise backgrounds. However, the spectra emitted by many objectives is broad-band in nature and requires a different signal processing approach to maximize probability of detection for a fixed probability of false alarm. In high signal-to- noise environments the detection performance of an autocorrelator and cross correlator are about the same. In low signal-to-noise environments, the detection performance of the crosscorrelator is superior to the autocorrelator. The results of this research will be applicable to the detection of both radar and sonar targets which emit few/no discrete tonals but whose emission is primarily broad band energy.

The objective is to extend the theory of signal detection to the case where the signal to be detected has an unknown random parameter, namely doppler, whose apriori probability density is unknown and the background noise is additive, white and gaussian (AWGN). Apply this theory and other relevant theory to the development of an adaptive broadband crosscorrelation receiver or matched filter receiver. Utilizing real world or simulated data, analyze the detection performance of this receiver (measures of goodness may be taken to be the detection index, processing gain, etc.). Develop the optimum and suboptimum receiver structures for the signal and noise regimes mentioned above, using real world or simulated data, compare the detection performance of the optimum and sub-optimum receivers; develop receiver operating characteristic curves (ROC's) for the broadband cross-correlator/matched filter, the optimum receiver (if different from cross-correlator) and the sub-optimum receiver. Examine the "learning features" of the broadband correlator receiver and relate these to the receiver memory requirement.

N86-41. TITLE: Solid State Radar Transmitter Amplifier Modules

CATEGORY: Exploratory Development

DESCRIPTION: Define a five-year development plan for solid state radar transmitter amplifier modules. The plan is to be based on the study of present and planned S-band radar systems. At frequencies of L-band (1-2 GHz) and below, solid state modules have been successfully used in phase array radar transmitters. At X-band (8-10 GHz), the performance and cost goals for solid state modules are well defined. At S-band (3-4 GHz), there is a lack of definitive performance and cost goals. Under this task,

existing and planned radar systems are to be studied with a view toward defining common sets of solid state transmitter amplifier modules which could be used in a variety of systems. The study should take into consideration microwave tube approaches as well as competing solid state approaches such as bipolar transistors and field effect transistors. A report is to be prepared which summarizes the study results and outlines a five-year solid state transmitter amplifier module development program with projected cost estimates for such a program.

N86-42. TITLE: Submarine Antenna Mast Design

CATEGORY: Engineering Development

DESCRIPTION: Develop a faired mast for submarine mast-mounted antennas that would exhibit the required strength yet be producible by standard production methods. The faired mast must meet the hydrodynamic and strength requirements of MIL-A-23836 and the TRIDENT and SSN21 ship specifications.

N86-43. TITLE: Submarine Erectable Whip Antenna for Towed Buoys

CATEGORY: Advanced Development

DESCRIPTION: The submarine's communication buoy has an erectable ship antenna which protrudes from sea surface when in raised position and allows buoy to transmit and receive at HF/UHF. A new design concept is needed to improve reception/transmission and reliability while in operating environment.

N86-44. TITLE: Tailoring Contract Data Requirements

CATEGORY: Research

DESCRIPTION: This research shall support the DOD "Streamlining Initiative" of the SPAWAR Specification Control Advocate.

The Contract Data Requirement List (DD Form 1423) is the formal tool to list all data required by a government agency from a contractor in any specific acquisition project. The entries in this list are dictated by the engineering aspects for each acquisition project and the requirements for data must comply with wide ranging and diverse aspects such as testing, reproducibility, scheduling and other technical process related activities. The form provides little freedom of "how to express" the data requirement, and it can be observed that high and low cost positions for data manipulations are described with identical brevity.

Investigate the possibility of restructuring the details of the DD Form 1423 to promote tailoring. Establish systematic guidelines relating the entries of the DD Form 1423 (e.g., block 16) to cost and value relationships. Develop trade-off criteria for data ordered correlating the benefits/value to the cost to develop, produce, and deliver the data product.

N86-45. TITLE: Technological Upgrade of Air Traffic Control and Identification System

CATEGORY: Advanced Development

DESCRIPTION: Feasibility studies that explore technological advances are needed in order to upgrade the operational performance of existing shipboard and shorebased TACAN, IFF and air traffic control systems. Proposals are solicited that address innovative concepts for signal collection, distribution and processing, with emphasis on potential high pay-off in advanced development. Investigation should include potential uses of materials (composites, ceramics, etc.), components (detectors, sensors, waveguides, etc.), and technologies (local area networks, fiber optics, etc.). Purpose is to establish a foundation for accelerated upgrade of operational performance of existing and planned systems with respect to parameters, such as sensitivity, interference, immunity, survivability, and reliability.

N86-46. TITLE: Logistics of Anticipated Technology Innovation in Electronic Systems and Device Design

CATEGORY: Exploratory Development

DESCRIPTION: The electronic system and device technologies are advancing at a rapid rage. These technologies are being driven by non-military applications such as the cellular phone and, in many cases, by foreign industry. To exploit this advancing technology and to refocus the driving application to military designs, new concepts and new techniques of logistics, modernization and system design are required. The Navy's lengthy pipeline required to phase in new technologies must be shortened significantly. A new dynamic approach to this problem is required. This effort will be to investigate the logistics of anticipated technology innovation in electronic system and device design and develop an approach that will shorten the modernization pipeline. Among those programs that are considered critical at this time are high power bipolar and silicon field effect transistors for RF power amplifiers, L band and above.

N86-47. TITLE: Threshold Corrosion Fatigue of Welded Shipbuilding Steels

CATEGORY: Exploratory Development

DESCRIPTION: The use of fracture mechanics fatigue crack growth analyses requires fundamental information about how materials behave in the low crack growth rate, and threshold regime, while in a marine environment. The threshold stress intensity parameter is typically employed to characterize or define that state of stress below which fatigue crack growth rate is zero or undetectably small. The fatigue behavior in this regime is analogous to that in the endurance limit region of the S-N diagram. The threshold stress intensity parameters are difficult to obtain even in air, because of the required sensitivity for the measurement instrumentation. The data-gathering difficulty is compounded in the case of corrosion fatigue because accurate crack measurements for long-term periods in seawater are required. Therefore, a significant effort must be expended to facilitate development of methods to determine low crack growth rate and threshold data in seawater.

Once an appropriate experimental technique is developed, it is anticipated that various fatigue crack growth variables, such as temperature and level of cathodic polarization could be explored. Such data should also be

obtained for different shipbuilding steels. The weld and heat-affected zone also ultimately should be characterized.

The objectives of this effort are to determine the threshold stress intensity parameter for corrosion fatigue and crack growth rates as the threshold is approached. This would be accomplished by:

(a) developing a test technique appropriate for determining the threshold stress intensity parameter and corrosion fatigue crack growth rate within the long-life regime in seawater and for variables of interest (temperature, level of cathodic protection, etc.).

(b) demonstrating validity of the technique by obtaining limited threshold data for the base metal of a representative Navy steel at two levels of cathodic protection and two temperatures, nominally 20 and 4°C.

In accomplishing the above two objectives, the project should ensure that accelerated test procedures are considered, and that relative accuracy of different crack length measurement techniques and differences between substitute electrolytes are quantified.

N86-48. TITLE: Remote EM Sensor Technology

CATEGORY: Exploratory Development

DESCRIPTION: Develop sensor, signal processing and telemetry technology applicable to EM sensors that can be covertly deployed from a submarine platform. Compact EM sensors are desired covering the VLF millimeter, infrared and visible EM spectrum. Various aspects of fiber optic technology may be employed to provide optical remote processing and telemetry. Affordability must be a prime consideration.

N86-49. TITLE: Advanced Propulsion Concepts

CATEGORY: Exploratory Development

DESCRIPTION: Develop concepts for advanced propulsion system for nuclear submarines with increased power density over existing systems. A synergistic combination of power plant, transmission and propulsor are desired to allow increased speed and/or power with less weight and volume. Such a propulsion system must either be inherently quiet or be capable of quieting with existing technology.

N86-50. TITLE: Assessment of Fiber Reinforced Plastics for Combatant Submarine Structures

CATEGORY: Exploratory Development

DESCRIPTION: Perform a feasibility study to determine the applicability of fiber reinforced plastic composite materials for combatant submarine structures, such as the pressure hull, high pressure gas flasks, weapon stowage structure, control surfaces, bed plates, pipe hangers and non-built-in tanks. The study should assess the capability of industry to develop the structures, potential reduction of life cycle costs, weight savings that can be achieved and the associated technical risks for development.

N86-51. TITLE: Miniaturized Magnetic Sensors

CATEGORY: Advanced Development/Exploratory Development

DESCRIPTION: Show feasibility for developing a miniaturized orthogonal magnetic sensor, capable of detecting field changes of 1 nanotesla while operating in a field environment of 20 oersteds. Sensor elements shall be not more than 10 cm^3 in volume (not including electronics). The sensor shall operate at normal room temperature with a stability and drift of 1 nanotesla per hour. Measurement of alternating fields (AC) in the 60 Hz and lower region is also desirable.

(Note: Proposals that closely match these specifications will be considered.)

N86-52. TITLE: Anti-fouling Materials or Techniques for Sound Transparent Sonar Domes

CATEGORY: Exploratory Development

DESCRIPTION: Develop new anti-fouling materials or techniques to prevent marine growth on submarines and surface craft without requiring special handling for personnel protection during installation and removal.

N86-53. TITLE: Evidential Reasoning Algorithms for Shipboard Decision Aids

CATEGORY: Exploratory Development

DESCRIPTION: AI-based decision aids will play an increasing role in assisting ship commanding officers and unit commanders to perform various complex tasks (e.g, planning allocation of C^3 countermeasures, monitoring enemy and friendly ship movements, predicting hostile responses, evaluating proposed courses of action, etc.) Application of AI-based reasoning derived from gradual accumulation of evidence is a critical function in such activities, but is currently supported by a largely ad hoc mixture of techniques derived from statistical analysis.

The contractor will first examine the theoretical bases for these techniques and identify appropriate conditions for application of each technique. The contractor will then analyze the nature of the decision tasks with particular attention to the conditions identified. Finally, the contractor will describe how the techniques can: (1) best be utilized in application to command-level decisions that are often characterized by sparse data, inconsistencies, and disparate decision goals, and (2) be integrated in practical terms into planned combat support systems.

N86-54. TITLE: Data Fusion Technology

CATEGORY: Exploratory Development

DESCRIPTION: Planned improvements in shipboard data processing capabilities (digital data buses, distributed processors, etc.) will signifi-

cantly enhance the ability of ship commanding officers to manipulate large amounts of data. The utility of these improvements will be much diminished, however, if the data cannot be readily transformed into information for use in making decisions critical to mission accomplishment (e.g., decreasing ship vulnerability, increasing weapon effectiveness).

The contractor will investigate the feasibility of practical database interfaces that use advanced techniques to interpret requests for such information, autonomously develop calls to the appropriate databases, and assemble the results in decision-oriented format. The databases to be considered will be of diverse form and content, and located both on-board ship and at remote sites. The contractor will also describe how these semi-intelligent interfaces can be made compatible with planned combat systems elements, and the information displays associated with these elements.

N86-55. TITLE: Improved Thermal and Mechanical Properties of Missile Structures Through Use of Graphite Fiber Reinforcement

CATEGORY: Exploratory Development

DESCRIPTION: The graphite fiber is the most versatile reinforcement known. With PAN precursor, tensile strengths up to 1.2 msi will be available in FY1986 and with pitch precursor, modulus up to 140 msi will be available. The fabrication technology is now to incorporate these fibers into metal carbon or polymer matrices. The objective of this program is to determine the limits on specific strength and specific modulus that can be obtained in matrices that are applicable to advanced Navy missile systems. This program will identify the fabrication technology needed to combine specific strength (generally required at low temperature) and specific modulus (generally required at high temperature) into a single composite through the use of different types of fibers in a single matrix. This approach will lead to a composite technology that can be tailored to the needs of future Navy Missile Systems. Demonstrations of high specific strength and specific modulus in a single composite will be accomplished in Phase I. Fabrication and processing methods will be developed under the Phase II follow-on program.

N86-56. TITLE: Joining of Thermally Mis-Matched Components for High Velocity Missiles

CATEGORY: Exploratory Development

DESCRIPTION: High velocity missiles (Mach 4-7) require low thermal expansion ceramics for radomes, IR domes, and fuzing windows. The primary missile structure, however, will be a high thermal expansion material such as a superalloy. A transition material is required for dome to structure joints that is a hybrid composite with a graded thermal expansion compatible with the ceramic at the interface and compatible with the superalloy at the opposite interface. Graphite fiber reinforced aluminum or copper (depending on temperature capability required) can provide the required properties. Graphite reinforced metals will be graded by fiber thermal expansion (variable from highly positive to moderately negative) and fiber modules to be thermally and mechanically compatible with ceramic domes. Available

products in graphite reinforced Al and Cu will be surveyed and evaluated with respect to thermal and mechanical properties, reproducibility and cost. Directions for future development will be carefully considered and recommendations will be made for a Phase II development program.

N86-57. TITLE: High Performance Large Diameter Composite Tubes

CATEGORY: Exploratory Development

DESCRIPTION: This project involves use of hot filamentary winding techniques to produce large diameter, lightweight metal matrix composite tubes for missile and space applications. Structural integrity will be determined and mechanical property tests conducted to verify efficiency of fiber and metal property translation in the structure. Consideration will also be given to cost and versatility of fabrication.

N86-58. TITLE: Development of Ceramic Reinforcement Materials for Metal Matrix Composites

CATEGORY: Exploratory Development

DESCRIPTION: This Phase I program will demonstrate production of a discontinuously reinforced metal system, with isotropic characteristics, from commercial mat materials (of the reinforcing medium). Presently, discontinuously reinforced metal materials are produced via a process including a mechanical mixing step to combine and randomly orient the constituents. This project will utilize open-pore mat materials such as Al_2O_3 and graphite. The matrix metal is applied via a fluid dip process to initially coat the mat. Subsequent bonding or densification steps would be similar to present composite fabrication techniques (viz., diffusion bonding, braze bonding, H.I.P.). The initial mat characteristics create skeletal forms to allow inexpensive handling and ease of coating without need for mechanical mixing. Plate forms of two reinforcements will be fabricated for test. This process offers versatility beyond any present composite processing system. Since availability of many ceramic, graphitic, metal, and/or organic mat and foam products exists, the unique characteristics in these materials can be utilized. The matrix system could be a variety of graded metals, ceramic metals, or glasses. By judicious selection, material characteristics such as low x-ray absorption, excellent wear resistance, or directional conductivity can be combined with enhanced mechanical characteristics.

N86-59. TITLE: Develop Predictive Methods for Assessing Munition Sympathetic Detonation

CATEGORY: Advanced Development

DESCRIPTION: Develop computer programs and methods for assessing the susceptability of munitions to sympathetic detonation. Acquire and tabulate existing data on Navy munitions sensitivity and develop mathematical models to predict energy transfer to the explosive loads of the munitions and to predict the resulting reactions. Energy transfer occurs from a combination of blast and high speed multiple fragment impact. Also use the models to identify the most useful existing small-scale explosives sensitivity

characterization tests. Suggest new tests if the need is indicated. Provide a catalogue of already existing and newly created computer code developed to facilitate usage by the Navy Insensitive Munitions Community.

N86-60. TITLE: Predictive Methods for Assessing Munitions Sensitivity

CATEGORY: Exploratory Development

DESCRIPTION: Develop computer programs and methods to predict the sensitivity of munitions to unplanned stimuli such as heat, shock, and bullet and fragment impact. Acquire and tabulate available energetic materials sensitivity data, develop computer models to predict unwanted reactions, and provide a catalogue on the computer program(s) developed to facilitate usage by the Navy Insensitive Munitions community.

N86-61. TITLE: Artificial Intelligence Signal Processing

CATEGORY: Exploratory Development

DESCRIPTION: Develop artificial intelligence signal processing and information management systems to enhance combat system performance. Such systems should aid target detection, localization and classification. Artificial intelligence systems may either be general, i.e., capable of being utilized in a wide variety of combat systems, or specific, i.e., tailored to specific systems(s).

N86-62. TITLE: Insensitive Munitions Slow Cookoff Protection Concepts

CATEGORY: Exploratory Development

DESCRIPTION: The U.S. Navy has a program to develop insensitive munitions. The goal is to have all ordnance react no more violently than burning when subjected to the stimulus (among several) of a slow cookoff test. This is a low heating rate test whereby the ordnance item is preconditioned to 130 deg F then gradually heated at the rate of 6 F deg/hr until unit reaction occurs. Solid rocket motors, missile warheads, and bombs are the ordnance items usually tested, sometimes individually and sometimes in combination. Reactions are typically explosions or detonations even when the same units only burn when heated rapidly in a large fuel fire.

Innovative concepts are sought for developing methods to reduce the reaction violence of ordnance subjected to the slow cookoff test. Acceptable approaches include new propellants and explosives formulations, special internal or external liners/insulators, modified or new case designs and case materials, and active or passive add-on devices. Concepts may apply to only one or to all types of ordnance items. Of equal interest are concepts which can be backfit to existing ordnance and concepts which are only practical for new production units. Approaches should add little or no weight or aerodynamic drag to the munitions. There can be no loss in propulsion performance of rocket motors or lethality of warheads and bombs.

N86-63. TITLE: Non-Superconducting Sensors

CATEGORY: Exploratory Development

DESCRIPTION: Develop sensors that are non-superconducting to measure low varying electromagnetic fields in the frequency range of 1-100 Hz. Directional sensitivity of 10^{-12} tesla, is desired. Stability under varying ocean temperatures is required.

N86-64. TITLE: Computer Aided Logistics Modeling

CATEGORY: Research

DESCRIPTION: Computer Aided Logistics Support requires restructuring of the communication principles between involved organizations. They must work now in a complimentary fashion, highly in parallel. An appropriate mix (or composition) of communication factors (such as voice, text, picture, sketch, model, or binary code) which will not be misunderstood or misinterpreted (i.e., what was said and what was heard) are to be addressed along with addressing and resolving the recognition problems (e.g., incorrect recognition or failure to recognize).

N86-65. TITLE: Non-Contact Ranging System for Collision Avoidance

CATEGORY: Exploratory Development

DESCRIPTION: The increasing number of projected robotic applications involving mobility have highlighted the need for a small modular and inexpensive short range non-contact ranging system to provide for collision avoidance. A multitude of such sensors will be required for a moving platform in order to provide sufficient environmental awareness with regard to object location in order to preclude impacts while in transit. In addition, such sensors will assist in the acquisition of data on terrain traversibility. While some research is being done in the area and there exist various types of non-contact ranging devices, none are really practical for employment in this scenario. Existing ultrasonic ranging systems are simple and economical, but have numerous drawbacks which make them unsuitable in reality, arising from errors associated with temperature dependence, diverging beam patterns, and specular reflection from target surfaces. Also, laser based ranging systems suffer from inherent system complexity and expense, although overcoming some of the problems associated with acoustical ranging units. Simple near infrared proximity sensors, while low in cost, offer no precise range information, but just a binary indication of target vs. no target. It is desireable to develop for this application a modular unit capable of simple interface to an intelligence system in sufficient quantity so as to provide accurate range and bearing information in all directions, thereby allowing the mobile robotic system to model its environment with sufficient accuracy so as to avoid contact with surroundings while traversing the area. The units must therefore be small in physical size, relatively inexpensive, and have low power consumption, providing output in a timely and practical fashion so as to achieve the stated objective.

N86-66. TITLE: Expert/Rule Based System for Weld Process Control

CATEGORY: Exploratory Development

DESCRIPTION: Welding is an extremely labor intensive operation in the

manufacture and repair of ships and shipboard equipment. The weld process itself if often viewed as an art rather than a material science. Subsequently, the quality of welds produced by manual methods varies widely and is extremely operator dependent, necessitating large investments in training and certification overhead. To enhance productivity while at the same time improving resultant weld quality an repeatability, robotic welding systems are being developed for application in Navy scenarios. The lack of volume and the unstructured environments associated with such precludes the adaptation of conventional industrial welding robots as are successfully employed in the automotive industry. Off-line programming techniques as well as three dimensional seam tracking capabilities are being developed by funded Navy programs to address this problem. There remains, however, the issue of adaptive control of the weld process itself, and NAVSEA funded development efforts in this area have taken the form of a knowledge based system to initially set and continuously adjust weld parameters based on sensor feedback and a comprehensive rule base describing the weld process itself and the interrelationship of the various weld parameters. The development of a practical model of the weld process and the generation of the appropriate rules for such a rule base are needed near term developments.

N86-67. TITLE: Hand Held/Portable Data Terminals

CATEGORY: Advanced Development

DESCRIPTION: NISTARS controls all material at the Naval Supply Centers, with material movement in the automated NISTARS building processed via fixed data terminals by the warehouse worker. This detailed control reduces processing mistakes, allows supervisors to monitor individual training requirements and gives electronic proof of material movement leading to increased accountability and inventory accuracy. Material in the non-mechanized buildings, although under NISTARS control, is processed using physical documents, and is still fraught with the problems inherent to a paper intensive system. A hand held processing device could download information to the non-mechanized worker on the floor or in a vehicle similar to what is being done in the mechanized warehouse, and provide step by step instructions for processing material. This device would interact directly with the NISTARS central controller to provide "on-line" information on warehouse refusals, quantity changes, unit of issue changes, etc., thereby increasing control by reducing lapsed time between the event and its record in the data base.

N86-68. TITLE: Reduction in Repairables Leadtime R&D Request

CATEGORY: Exploratory Development

DESCRIPTION: Both repair turnaround times and procurement leadtime for repairables have continued to increase. Additions to either repair turnaround time or procurement leadtime require increased inventory investment. Additionally, fleet readiness is often adversely impacted because of these lengthening times. R&D efforts need to focus on delineating the key variables of repair turnaround time and procurement lead time. The various actions that can be taken to shorten these times by inventory managers and procurement specialists then need to be defined. Finally, a program must be

developed to guide inventory managers/procurement specialists through the decision process.

N86-69. TITLE: Procurement and Inventory Manager Interface R&D Request

CATEGORY: Exploratory Development

DESCRIPTION: This effort will center around contracts awarded via negotiations. Often in the negotiation process, alternative prices and quantities are offered to the government official from the commercial company. The government official does not have the expertise to determine if the alternative prices are reasonable and if increased quantities are in the best interest of the government based upon various factors (e.g., obsolescence, current asset position, etc.,). A "real time" system needs to be developed so that the procurement expert can communicate with the inventory manager so that such factors as learning curves, fixed versus variable costs, risk of long supply, and budget constraints are taken into consideration.

N86-70. TITLE: Emulation of Nonavailable Microcircuits

CATEGORY: Engineering Development

DESCRIPTION: Emulation of nonavailable microcircuits is required to supply DOD system managers with microcircuit parts no longer in production. Industry can view this as a multi-faceted task including emulation of obsolete processes, designs or fabrication techniques. The goal of the task is to produce quantities of microcircuits with a minimum of non-recurring engineering. A typical example is the emulation of nonavailable TTL microcircuit with CMOS technology.

N86-71. TITLE: Innovative Garment Assembly Technique

CATEGORY: Exploratory Development

DESCRIPTION: There is a need to develop new methods of garment assembly techniques, which would decrease the number of skilled technicians currently needed for operating conventional sewing equipment. This exploratory development would be in the area of automatic seam sealing or the formation of a garment as a one-piece suit. This new equipment would have to be able to be operated by unskilled personnel and produce a garment of equal or better quality than conventional sewing techniques at a lower cost to the Navy.

N86-72. TITLE: Durable Polymeric Treatments for Imparting Flame Retardancy to Synthetic (Polyester, Nylon) - Rich Cotton Blend Fabrics

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has a need for a durable (50 launderings, minimum flame retardant (FR) treatment that can be effectively applied to synthetic (polyester or nylon) rich cotton blended fabrics. The finish should be capable of being applied with conventional equipment and should have no significant adverse effect on any of the fabric's other functional characteristics. The Government will supply materials to the contractor for

finishing and evaluation.

N86-73. TITLE: Development of Non-Flammable Oxidized Polyacrylonitrile Fabrics

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has a need for durable, non-flammable materials that could be fabricated into protective garments for use aboard ship. The technology used to manufacture oxidized polyacrylonitrile fiber (OPF) needs to be investigated to determine whether it is possible to produce yarns with sufficient strength and reduced fibrillation tendencies so as to provide fabrics suitable for manufacture into protective clothing. The Navy is interested in evaluating four to ten ounce per square yard OPF materials that would possess sufficient strength (80 pounds minimum break strength and 5 pounds minimum tear strength) and abrasion resistance (1000 cycles minimum Taber abrasion), and be dimensionally stable (3% warp and filling, maximum, when laundered at 140F).

N86-74. TITLE: Industrial Robotics for Printing Facilities

CATEGORY: Advanced Development

DESCRIPTION: Binding operations in the Navy Publications and Printing Service (NPPS) system cost the Navy $15.8 million annually and require approximately 340 manyears. Much of the work being done is manual, highly repetitive, labor intensive, and requires little training. Examples are loading and unloading paper to and from automated duplicators, stitching, drilling, hand collating, affixing address labels, packing, and wrapping.

An overview of bindery operations within the system suggests that approximately 50% of stitching, drilling, and packaging and 10% of sundry labor can be accomplished through robotics. This would provide savings of $2.54 million annually, representing approximately 55 manyears of effort. Development of this technology in bindery operations provides an inroad to development in other areas of the printing plants and other functions within Navy activities.

Engineering development of a robotic system capable of accomplishing one or more of the above tasks is desired.

N86-75. TITLE: Word Processing/Data Processing Integration

CATEGORY: Exploratory Development

DESCRIPTION: Investigation of the feasibility of integrating existing Tandem work processing software with existing Tandem transaction processing software to support a major procurement application to be exported throughout the Navy Field Contracting System. Deliverables would include an assessment of the possibility of accomplishing a description of alternative approaches including pros and cons, and alternate methods using non-Tandem word processing software.

N86-76. TITLE: On-board Manufacture of Expendable Fuel Tanks

CATEGORY: Engineering Development

DESCRIPTION: An FY-85 SBIR project is being supported for exploratory development of drop tanks that can be easily stored on aircraft carriers in a disassembled state. An alternative to this approach would be an engineering development project that pursues manufacture on board from (1) a plastic-type material that can be molded and (2) a kit of parts that would complement the manufacture (i.e, piping, lugs, etc.). Since the storage problem is for the tank, itself, CVs could store the raw material in any number of sizes/shapes and manufacture upon need.

N86-77. TITLE: Fuel Storage Tank Water Bottom Detection System

CATEGORY: Exploratory Development

DESCRIPTION: To reduce tank bottom corrosion and prevent potential fuel contamination, all fuel storage tanks must periodically have water drained from the bottom of the tank. Determining the presence of water at the bottom of a tank is a time consuming and labor intensive process. If a system were available to remotely monitor the occurrence of water bottom, time and monetary resources presently expended to manually perform this task could be substantially reduced. This R&D effort would determine whether a suitable remote water bottom detection system is available. The project would be divided into two phases. During the first phase, a literature review would be conducted to determine whether feasible systems to detect water bottoms currently exist or can be developed. This phase would include technical evaluation of the reliability, accuracy and maintainability of existing equipment and a recommendation for future testing. In the second phase, monitoring systems would be developed/modified and field tested to determine their accuracy, reliability and economic payback.

N86-78. TITLE: Expert System for Retail Inventory Management

CATEGORY: Exploratory Development

DESCRIPTION: Retail inventory management is extremely labor intensive today. The responsiveness of the supply is impaired because of inefficiencies inherent in our present system. The various elements of retail inventory management (e.g., item establishment, dues maintenance, record maintenance, exception processing) are all exercises in information processing. Because so many decisions are made today off-line, the utilization of our computer system is much lower than it should be. Data review structures are needed that can be used by retail item managers. They should lead to a common level of expertise that can be programmed into an expert system similar to the analysis being currently conducted at the wholesale level.

N86-79. TITLE: Development of a Medical Dictionary and Training Materials for the Navy Outpatient Medical Information System (NOMIS)

CATEGORY: Advanced Development

DESCRIPTION: A Navy Outpatient Medical Information System (NOMIS) will

be developed to collect, process, and display medical data for use in Navy outpatient clinics. A systems analysis must be conducted at representative clinics to determine information requirements of the clinics and to develop specifications for systems design. A comprehensive dictionary of data elements must be defined to standardize the outpatient medical record. Training material must be produced to support user needs. Concepts and plans are solicited for a study effort that would lead to development of a prototype data management system that is flexible, interactive and incorporates extensive user-assistance capabilities.

N86-80. TITLE: Facilitation of Measurements of Specific Absorption Rates

CATEGORY: Exploratory Development

DESCRIPTION: A system is needed to facilitate the outdoor measurement of average radio frequency (RF) and microwave energy absorption (specific absorption rage, SAR) in a full-size man model. Currently, arduous, manual methods are employed in twin-well calorimetric procedures to measure average SAR. These procedures are time consuming and labor intensive. This effort involves the development and testing of mechanical handling and weather protection systems for the twin-calorimeter SAR measurement system. The resulting apparatus will be used with the man-model recently developed at the Naval Aerospace Medical Research Laboratory (NAMRL). The purpose of the weather protection system is to provide a thermally equivalent environment for both calorimeters and for both man models outdoors with the absence of direct sunlight and rain. The success of the twin-well method relies on the thermal homogeneity of the models and the calorimeters. The mechanical handling system provides a rapid means of removing the models from the nonmetallic supports and inserting them into the gradient-layer calorimeters.

The effort will include assembly of all the apparatus at NAMRL and testing with the government-supplied large gradient-layer calorimeters. The tests will include 48-hour tests with the calorimeters loaded with water at the same temperature to measure how closely the output voltages track each other. Similar tests will be conducted for the water loads set at a specified difference in temperature. Finally a comparison test will be conducted in which one run will manual manipulation of the models, and a second run will use the developed handling apparatus. A final report describing all experimental results and providing specifications for all apparatus will be required.

N86-81. TITLE: Instrument for Photometric Determination of Surface Roughness

CATEGORY: Engineering Development

DESCRIPTION: Navy dental treatment has sizeably increased delivery of resin bonded appliances in order to provide fixed prosthetic services within the constraints of military operations. Failures observed in some of these prostheses have been noted at the bonding resin and metal interface. This may be due to insufficient development of undercut roughness during laboratory etching of the metallic surface. The current method

of assessing etch quality in dental prosthetic laboratories uses light microscopy. Light microscopy has recently been shown to be unable to distinguish properly-etched from etched-but-less-retentive metal surfaces. Biangular reflection measurements of etched metal surfaces, on the other hand, have shown very good correlation (r=.99) with surface area/volume measurements and subsequent bond strength studies. Navy dental laboratories need a reflection photometry instrument, durable enough for field use, which can be used for reliable quality control of etching procedures on metallic frameworks of fixed dental prostheses.

N86-82. TITLE: Molecular Structures for Avionics and Aviation Materials

CATEGORY: Exploratory Development

DESCRIPTION: Recent advances in biology (genetic engineering, hybridoma, immobilization of enzymes), chemistry (thin films and surface modification) and physics (electrical conduction by charge density waves) suggest possibilities for the manufacture and control of molecular structures of great diversity, complexity and miniaturization.

The purpose of this program is to obtain relevant research and development on molecular structures of great diversity, complexity and miniaturization.

The purpose of this program is to obtain relevant research and development on molecular structures for Avioics and Aviation Materials. The R&D is expected to create and demonstrate an understanding of the opportunities and limitations in the building of molecular structures for use in computers, sensors and electronic/optical/magnetic devices. The program also addresses the novel use of biopolymer dynamics in particular: electron handling, exciton, tunneling, Rydberg state and semiconductor behavior. It is also recognized that multi-dimensional material matrices and associated structural and functional properties are of interest.

N86-83. TITLE: Fault Tolerant Systems: Design and Evaluation Algorithms

CATEGORY: Research

DESCRIPTION: Develop reliability algorithms for the design and evaluation of parallel processors and networks of computers. The algorithms should be computationally efficient while representing system component dependencies of both hardware and software failures. The algorithms should be capable of representing the logical/physical activities of thousands of nodes. Present reliability modeling techniques are incapable of appropriate representations of fault coverage parameters, (e.g., latent, intermittent/transient, software and hardware faults). The intent is to develop methods which will be applied, mission-critical functions such as aircraft flight control. Approaches are sought which evolve tractable model structures with increasing problem complexity (number of components, dependent relationships as an initial step toward possible realizable numerical implementation to be demonstrated.

N86-84. TITLE: Correlation of Flight Maneuvers with Mission Flight Purpose Codes

CATEGORY: Research

DESCRIPTION: Flight maneuver data of fleet aircraft operations are currently obtained from counting accelerometers that record cummulative load factor exceedances. These data to not account for gross weight or mission loading configurations. Operational flights are performed in accordance with designated flight purpose codes that generally identify mission loading. A correlation of these loadings with accelerometer data for the relevant flight will provide a basis for incorporating flight purpose code reporting into the Structural Assessment of Fatigue Effects (SAFE) program reporting criteria.

N86-85. TITLE: Fatigue Enhancements of Lugs

CATEGORY: Research

DESCRIPTION: Structural lug assemblies, either bushed or not, have historically been prone to premature fatigue failures. The purpose of this effort is to develop procedures and tooling for fatigue enhancement of lug assemblies. The emphasis will be on developing techniques that are easily implemented, for both new production and rework efforts. Fatigue and crack growth tests will be used to ascertain the effectivity of developed methodolgies, used simulated lug geometrics, under constant amplitude and variable amplitude loading conditions.

N86-86. TITLE: Lightweight Sealed Parachute and Harness Assembly

CATEGORY: Advanced Development

DESCRIPTION: Explore potential concepts for development of a lightweight environmentally sealed parachute and harness assembly to replace NB-8 and similar non-ejection set type parachutes. These types of parachutes represent over 75% of the Navy inventory and require significant annual expenditures for repacking at 210 day intervals. These parachutes are also relatively heavy which results in additional costs related to fuel consumption and loss of payload capability. The first phase of this effort is to explore potential concepts of a system meeting the following requirements: (1) minimum repack cycle of five years; (2) environmentally sealed parachute; (3) quick-donningharness; (4) total weight of parachute and harness less than 17 pounds; (5) vertical descent rate less than 24 ft./sec. with a 265 pound suspended mass; (6) ability to open parachute up to 150 knots and (7) ability for the parachute to glide upon command. This first phase should also define specific requirements for the subsequent engineering development phase.

N86-87. TITLE: Aircraft Velocity Measurements During Carrier Takeoffs and Landing

CATEGORY: Exploratory Development

DESCRIPTION: The actual velocity vectors of aircraft being catapulted

from aircraft carriers, and engaging speeds on touchdown and arrestment by recovery systems are critical measurements. This task calls for investigations of available systems that can independently and accurately measure the speed of the aircraft as it disengages from the catapult shuttle, and the speed and sink rate (vertical velocity) as the aircraft touches down and engages the arresting gear. The proposed system should be maintainable, reliable and compatible with the shipboard environment.

N86-88. TITLE: Evaluation of Avionic Equipment Re-racking for the E-2C Aircraft

CATEGORY: Engineering Development

DESCRIPTION: Reliability of the avionics installed in the E-2 depends in part on the environment to which it is subjected. The equipment rack must provide isolation from shock and vibration, protection for wiring and connectors and efficient cooling airflow.

The investigation of improved racking methods will involve the development of prototype racking for high failure, low reliability Weapon System Replaceable Assemblies (WRAs) and the demonstration of their effect in improving system overall performance based on installation of their effect in improving system overall performance based on installation in a test aircraft. Follow-on testing would involve deployment of a test rack in an E-2C aircraft squadron and evaluation of the performance based on reported maintenance data.

N86-89. TITLE: Utilization of New Acoustic Processing Equipment

CATEGORY: Engineering Development

DESCRIPTION: New high speed acoustic processing equipment is being developed to support Navy requirements. Utilization of this equipment in VP aircraft will provide significantly enhanced mission performance. To take advantage of this equipment's capabilities, the equipment must be configured and packaged so that it conforms to a particular platform's mission requirements and physical constraints.

Studies are required which define UYS-2 configurations that satisfy the P-3C mission requirements, are amenable to the P-3C's physical environment, and are compatible with system architecture.

N86-90. TITLE: Sensor Data Organization, Storage and Recall

CATEGORY: Exploratory Development

DESCRIPTION: Intensive and extensive amounts of data will be acquired and processed by various acoustic and non-acoustic sensor systems in VP aircraft. To assure that maximum use of these data can be made to adequately support mission planning, operations and analyses, the data must be organized and stored in a rapid fashion that supports its rapid recall for continued use to support VP operations, and post mission analyses and mission planning at ground facilities. Studies are required to identify data organization, storage and recall methodologies and technologies that

will support VP operations, mission planning and analysis. The methodologies and technologies identified must be consistent with the P-3C's operational environment, sensor systems, methods of operation, and be applicable to the post mission analyses and mission planning environment.

N86-91. TITLE: Missile Batteries

CATEGORY: Research

DESCRIPTION: Developments in the field of conductive polymers have advanced to the point where they should be reviewed for application to lightweight, high reliability, high capacity batteries for missile systems.

N86-92. TITLE: Mathematical Simulation of Battery System By Use of Battery Analogs

CATEGORY: Research

DESCRIPTION: Perform literature search relating to silver oxide/zinc battery modeling for review of mathematical simulation. Develop (n) mathematical relations with (n) unknowns for generalized solution from program equations set. Finally, verify simulated model with available battery test data.

Results:

- Definition of design parameters
- Parameters for meaningful correlation
- Mathematical equation sets.

N86-93. TITLE: Hydroxyl Ion Mass Transfer and Balance

CATEGORY: Research

DESCRIPTION: Experimentally determine the mass balance deficiencies in silver oxide/zinc battery systems by making detailed calculation of the hydroxyl (OH) mass transfer and balance.

N86-94. TITLE: Computer Keyboard Innovations

CATEGORY: Research

DESCRIPTION: The productivity advantages of keyboard arrangement other than the standard QWERTY are well known but unfortunately remain unpopular because of the large base of traditional typewriter users. The effectiveness of operators using innovative key arrangements for "word processing" activities while engaged in tasks primarily related to computer aided engineering jobs such as design, simulation and technical documentation need to be reviewed to determine if a significant gain in productivity would justify an extensive training/retraining effort. Zero experience, "hunt'n'-pecks", and expert typists would be included and assessed as candidates for this training.

N86-95. TITLE: Reliability/Maintainability Prediction and Assessment Techniques for Automated Test Equipment

CATEGORY: Engineering Development

DESCRIPTION: The proliferation of Automated Test Equipment (ATE) in today's testing and production environment is made possible by advancement in the integrated circuit technology. Memory and logic devices with high capabilities and speed can now be produced at a very low cost. This allows the development of smart instruments capable of self-control (i.e., determine 10% and 90% points internally on rise time/fall time measurements), self-correcting (i.e., subtract offset), self-calibration, and self-diagnostics.

The complexity of the instrument lowers its reliability and makes it more difficult to maintain. Reliability predictions using parts count and stress analysis are tools that are used in the prediction. The goal of this project would be to develop a model for reliability prediction and assessing payback for reliability improvement in today's evolving ATE technology.

N86-96. TITLE: Real Time Software Requirement Development

CATEGORY: Engineering Development

DESCRIPTION: Review current real time Automated System Requirements Development Tools and produce a top-level System Requirements Development Tool Specification incorporating the best features. This top-level specification should describe a state-of-the-art software Requirements Development System, which provides:

- User friendliness
- Input and output query capability, so designer and sponsor can check for consistent and properly engineered systems development
- Documentation capability of MILSTND 1679A, in hard copy
- Description of how the testing of the system requirements would be automated in the Requirements Development Tool

N86-97. TITLE: Diagnostic Test Methodology

CATEGORY: Engineering Development

DESCRIPTION: Investigate and report on the best automated approaches to develop a methodology for thorough diagnostic testing. Consider both equipment and system level diagnostics for large, real time systems.

N86-98. TITLE: Automated Librarian for Computer Software Source Code

CATEGORY: Engineering Development

DESCRIPTION: Develop System Requirements for an Automated Librarian to maintain computer software source code. The Automated Librarian concept must consider, at a minimum, data base security, user friendliness of systems, and automatic backup features.

N86-99. TITLE: Software Performance Model to Token Pass Media Access Strategy

CATEGORY: Advanced Development

DESCRIPTION: Broadband Local Area Network (LAN) technology is being applied to various communications needs. The prototype LAN uses a token pass protocol to support digital communications over a Cable Television (CATV) backbone. Under this project, a performance model may be developed for the token pass protocol. The model will permit specific features of the token pass protocol to be studied in detail. The result will be a tool for verification and tuning of protocol implementation.

N86-100. TITLE: Robust Linear Multi-variable Feedback Design Methods (Application to Robotics)

CATEGORY: Advanced Development

DESCRIPTION: Any realistic analysis technique must take into account the imprecise nature of mathematical models for physical systems, and any design method inspired by it must incorporate adequate robustness guarantees. Several robustness issues should be investigated in the context of Multivariable Systems. The project can be divided into three major components. The first deals with robustness questions in Linear Multivariable Systems when plant uncertainties are structured and appear as parameters in the plant description. Specific topics that could be considered are pole assignment, observers, regulation, asymptotic tracking and transfer function shaping. The aim is to develop the theory as well as accompanying design techniques. Even though this work deals specifically with linear systems, its impact is not limited to such systems as in many occasions a linear model adequately describes the operation of a nonlinear system about some operating point. The second component considers the case when plant uncertainties are unstructured and appear as multiplicative perturbations on the transfer function of the plant. Emphasis can be placed on robust stability and robust sensitivity reduction. Such uncertainties can occur because of unmodeled dynamics, time delays, diffusion processes, etc., and may also be used to represent perturbation effects that, in fact, are not at all uncertain, such as nonlinear elements (provided they are given "conic sector" interpretations). A goal of the entire project would be to incorporate the above mentioned robustness requirements into the development of comprehensive multivariable feedback design methods. The third component considers the application of the methods discussed above to a number of robotic manipulator systems with the intent being to evaluate their performance.

N86-101. TITLE: The Use of Robotics in Automatic Factory Assembly

CATEGORY: Advanced Development

DESCRIPTION: The application of robotics in other industries has already shown improvements in quality control, time and cost savings, and reliability. Future applications of robotics to guidance manufacturing processes should have equivalent benefits.

N86-102. TITLE: Evaluation of Functions Represented by Grid Points

CATEGORY: Exploratory Development

DESCRIPTION: A future guidance system might have to derive gravity from a set of values stored on a three dimensional grid of points around the trajectory. The optimum approach requires a tradeoff between the interpolation function, the number and regularity of the gird points, the computer filing system, speed, and memory. Another guidance application would be the derivation of a map in map matching guidance. What is desired is a generalized algorithm and associated techniques which would allow specialization of the algorithm for a particular application to yield an efficient computer program.

N86-103. TITLE: Methodology for Measuring Data Coverage

CATEGORY: Research

DESCRIPTION: The object of this research is to develop a method of measuring the effectiveness of test cases developed for large real time software systems. The main area of concern is how well the test cases cover allowable data utilization. Specific areas of concern involve the testing of data tolerance, data stress testing and iterative conversion testing.

Proposals which address only areas of currently well defined methodologies such as type conversion testing, etc. will not be accepted.

Proposals should be written so as to address the task as a two part effort:

1) the development of a methodology and
2) the implementation of a prototype.

N86-104. TITLE: THLL Based Symbolic Debug Facility on the VAX

CATEGORY: Exploratory Development

DESCRIPTION: The objective is to develop a symbolic debug facility on the VAX that allows the user to specify debug operations in terms of the symbols and line numbers of the source listing of a THLL program. THLL is the TRIDENT Higher Level Lanugage which is used for TRIDENT Fire Control program development and for systems programming on the VAX. Such a symbolic debug facility requires an interface between the THLL compiler and the VAX Symbolic Debug System. The capabilities of a symbolic debug facility for THLL should be similar to those provided for FORTRAN on the VAX.

N86-105. TITLE: Distributed System Architecture for Real Time Embedded Computer Systems

CATEGORY: Exploratory Development

DESCRIPTION: There has been a definite trend in real time embedded computer systems toward distributed processing. Distributed System architectures are being used in embedded real time applications which are both control and computational intensive. The expanding problem domain and the development of powerful militarized microprocessors assure more distributed processing in the future.

There are numerous issues that need to be resolved before such architectures can be used to their best advantage. Among these issues are connectivity, strucutre and capabilities of the operating system, applications software layout, communication protocols, synchronization of concurrent processes, fault tolerance, decentralized control, performance, connection of standard as well as unique (application dependent peripherals devices, adding additional processors, and others.

The goal of this research is to identify a system architecture (hardware and software) that facilitates software development and permits the system to be incrementally enhanced (hardware and software) at minimal cost.

N86-106. TITLE: High-Interaction, Transient MHD Modeling

CATEGORY: Research

DESCRIPTION: A need exists for the understanding of high-interaction transient magnetohydrodynamics. For MHD devices to fill the requirements for lightweight, high power-density, electric generators, they must move toward higher interacting parameters and have rapid start/stop capabilities. The high-interaction processes have not been studied due to complexity of the physics. In recent years, extensive modeling has become possible due to the advancements of computers. However, most modeling has been restricted to time-averaged quantities. In this effort transient, high-interaction modeling will be achieved through the inclusion of spatially and temporally nonuniform flow and swirl effects, including freestream and boundary layer turbulence and their time constants.

N86-107. TITLE: Computer Model to Optimize Geometric Decomposition to Shorelines

CATEGORY: Exploratory Development

DESCRIPTION: Present vulnerability methodology utilizes a shotline approach to determine penetrator capability. This shotline data is a decomposition of 3-D geometric description data. The decomposition involves laying a fixed grid over the geometry and assessing the composition under each grid cell. The accuracy of this method improves as the grid size is decreased, however, this increases total solution time. In fact, there exists some set of irregular shaped/sized grid elements that would comprise the minimum set needed to accurately decompose the geometry. This task would provide methods of determining this minimum set, and produce FORTRAN code to imple-

ment the optimal solution.

N86-108. TITLE: Algorithm for Correcting Errors in the Correlation Function Caused by Hetrodyned Signals

CATEGORY: Research

DESCRIPTION: When two detrodyned signals are correlated they produce an undesired "roping" in the correlation function that does not appear when basebanded signals are correlated. The root of the problem is the lack of a phase rotation correction for the cross- spectrum. An algorithm is needed to remove the roping for both the auto-correlation and cross-correlation functions. The algorithm could be based on any of the following concepts: a modified inverse fast fourier transform, modifications to the cross-power spectrum before applying a standard inverse fast fourier transform, or modifications to the correlation function itself to remove the "roping". Other methods should be documented and analyzed for effectiveness and computational load for implementation on a computer. The best method shall be coded in standard FORTRAN 77 and tested.

N86-109. TITLE: Hindered Aliphatic Amine Synthesis

CATEGORY: Research

DESCRIPTION: There is a need to synthesize a homologus series of hindered aliphatic diamines of the type:

$H_2NC(R)_2(CH_2)_x(R)_2CHN_2$ where x-2 and R=ethyl, proply, butyl and t-butyl for use in curing agents for epoxy resins. These compounds are of interest because the sterically hindered amine groups have large reaction rate ratios (k_1/K_2) which lead to cross-linked resins with unique mechanical properties. These compounds must be pure (99+%), thoroughly characterized by GC, MS, NMR, IR and elemental analysis. It is necessary that a sufficient quantity (-250 grams) of each compound be prepared on order for the Navy to be able to evaluate the mechanical properties of the cured resins.

N86-110. TITLE: Improved Carbon=Epoxy Adhesive

CATEGORY: Exploratory Development

DESCRIPTION: Develop an adhesive system (1 or 2 component) for carbon-epoxy composites with the following properties: 1) Tg 120 C; 2) pot life 1 hr. after mixing; 3) gelation below 90 C at heating rates between 1 and 10 C/min. ; 4) full strength achieved after 20 minutes at no higher than 150 C; 5) lap shear strengths between 4,000 and 5,000 psi at room temperature; and 6) for a one component system shelf life that should be at least 1 yr. at room temperature.

N86-111. TITLE: Toughening of Discontinuously Reinforced Composites via Matrix Alloy Design

CATEGORY: Exploratory Development

DESCRIPTION: Hitherto, all metal matrix composites reinforced with continuous or discontinuous ceramic reinforcements invariably contain popular and readily availabe alloys. Thus, for SiC/Al system with particulate or whisker SiC, 6XXX, 2XXX, 7XXX, and 5XXX series Al alloys are used as matrices. As far as toughness or elongation is concerned, a wide variation exists in these unreinforced alloys themselves depending upon processing history. Toughness of SiC/Al composites with 2XXX, 5XXX, 6XXX and 7XXX Al alloy matrices is much lower than their unreinforced counterparts. This is, of course, expected but there is a definite indication that the tougher the matrix, the tougher the composite, given that other factors remain constant.

The objective of this effort is to develop Al alloy matrices with compositions which may differ radically from contemporary alloy compositions. One may differ radically from contemporary alloy compositions. One may consider using only high purity alloying ingredients with extrmely low levels of Fe and Si or, conversely, addition of elements which alter the stacking fault energy. Elements which affect or reduce matrix thermal expansion may possibly enhance composite toughness simply by lowering the dislocation density which in turn could benefit fracture toughness. Any of the above approaches, or others, may be investigated to improve the toughness of discontinuously reinforced composites via matrix modification.

N86-112. TITLE: Behavior of Metal Matrix Composites at Cryogenic Temperatures

CATEGORY: Exploratory Development

DESCRIPTION: Metal matrix composites are candidates for use as structural materials on satellites and spacecraft. The task is to develop a data base reflecting the thermomechanical characteristics of these composites at very low temperatures typical of orbital and deep space conditions.

N86-113. TITLE: Corrosion Behavior of Metal Matrix Composites in Hostile Environments

CATEGORY: Research

DESCRIPTION: MMC's are materials with varied interfaces that need protection, and an understanding is required as to how much corrosion does occur and is initiated at these interfaces.

N86-114. TITLE: Preparation and Development of Advanced Battery Catalysts

CATEGORY: Research

DESCRIPTION: Dramatic improvements in both the performance and reduced safety hazards can occur in state-of-the-art high energy lithium batteries by employing specific organo metallic catalysts, including a 100% increase in cell capacity, increased rate capability, high voltages with much less heat development (improved safety). The catalyst enables cells that become anode-limited under some conditions (unsafe mode) to retain their Li-limited safer design feature.

Proposals are sought to evaluate potential catalysts and to establish an understanding of the principles of the fundamental electrocatalysis processes that occur using selected catalysts in state-of-the-art power sources.

N86-115. TITLE: Improved Design and Construction of a Measurement System for Monitoring the Changes in the Coefficients of Thermal Expansion of Metal-Matrix Composite Thin-Walled Tubings

CATEGORY: Advanced Development

DESCRIPTION: The linear coefficient of thermal expansion along the symmetry axis of metal-matrix composite tubes can be as low as - x 10^{-6} per degree C. Along the circumferential direction, this coefficient is an order of magnitude higher. An optical apparatus that allows remote, continuous monitoring of the coefficient of thermal expansion in a vacuum chamber in the temperature range of +190 C is needed for the testing of tubes having lengths ranging from 0.5 to 6 feet, diameters ranging from 0.5 to 3 inches, wall thickness ranging from 0.02 to 0.10 inches. The successful proposal must demonstrate the physical principles underlying the design and operation of the apparatus. Considerations for the supporting of the specimens in the vacuum chamber and for the relevant sources of errors in the entire measurement system are necessary.

N86-116. TITLE: Adhesive Bond Evaluation

CATEGORY: Research

DESCRIPTION: Nondestructive testing of adhesive joints is a problem which has plagued the nondestructive testing community for decades. Currently practiced ultrasonic techniques can often determine whether a bond has occurred, but the prediction of bond strength relies heavily on assumptions which are often unfounded. The reliability of such strength predictions might possibly be improved by a combination of an applied mechanical stress in conjunction with a nondestructive measurement. Development of practical means for both applying stresses and evaluating their effects on bond interfaces may provide a reliable means of assessing bond performance under actual loading.

N86-117. TITLE: Laser Cladding Research for High Temperature Coating

CATEGORY: Research

DESCRIPTION: There are a significant number of hardware systems within the Navy that require high temperature coatings. Missile components such as ram inlet ducts (3000 F) and missile exhaust combustors (5000 F) for high mach number (mach 5-7), Wide Area Defense Missiles (WADM) now in development, missile launch rails exposed to hotter and longer burning missiles requiring higher temperature materials and coatings, and turbine engine components are examples of such hardware systems. Coatings for the systems require a high degree of integrity to survive the combined environments of mechanical wear, high temperature, erosion and corrosion. Laser cladding offers the potential for providing coatings with extended capabilities and unique properties to meet the above challenges and, therefore, a suitable area for

research by laser contractors.

N86-118. TITLE: Fabrication Methodology for Advanced Ceramic Armor Materials

CATEGORY: Exploratory Development

DESCRIPTION: There exists a need to develop manufacturing procedures which will reduce final ceramic materials costs while maintaining or improving the ballistic protection of the ultimate armor system. The physical geometry of the ceramics shall be plates ranging from 3" x 3" x 0.1" to 6" x 6" x 0.5". The desired ceramic plates will have properties similar to boron carbide and/or titanium carbide, but the final ceramic plate cost shall be less than or equal to plates made from alumina. Changes of silicon carbide whiskers as reinforcement materials, are desired and shall be considered as options. The product shall be a technical report documenting material properties and manufacturing methodology. Specific recommendation for ceramic systems and associated projected manufacturing costs and availability shall be included in the final report.

N86-119. TITLE: Real-Time, 3-D Computer Vision

CATEGORY: Exploratory Development

DESCRIPTION: Investigation of passive machine vision concepts for use in robot, Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM), and other military applications that will provide range and classification of objects in three dimensional space in real time (video frame rates).

N86-120. TITLE: Advanced General Purpose Controller

CATEGORY: Exploratory Development

DESCRIPTION: Develop a software/hardware architecture for an advanced, compact, microprocessor based multipurpose controller for real time sensory understanding and adaptive control of weapons, robots, automation, and other Navy control applications. The concept should employ a highly distributed, hierarchical architecture to enhance performance and flexibility.

Investigations should include software design methodologies, interface designs, protocols, bus architectures, microprocessor selection, computer languages, packaging and other design parameters.

N86-121. TITLE: High Density Power Sources for Robots

CATEGORY: Exploratory Development

DESCRIPTION: One of the major barriers to continuous autonomous operation of mobile robots is performance of available power sources. Lightweight, long-term stable power sources, which tolerate environmental extremes (e.g. high/low temperature, humidity, shock), are required for the operation of robot control electronics. In addition, bursts of power for mobility, heavy lifting, and other mechanical functions are often required.

High density power sources that can provide these capabilities over long periods of time with minimal maintenance are of great interest.

Advanced power systems, including hybrid concepts that integrate available power sources, should be investigated to meet the needs for long-term, low-level robotic operation with surge capabilities for high-power demands.

N86-122. TITLE: Mobile Robot Development

CATEGORY: Exploratory Development

DESCRIPTION: Navy mobile robot and remote control systems have requirements to navigate an area and to collect and integrate sensor data.

Studies leading to concept development are needed to consider the following for various types of operational environments (outdoors, indoors, shipboard):

(a) mobility
(b) autonomous navigation
(c) scene mapping and memory
(d) sensors and sensor integration for navigation, data collection, decision making, and communication

N86-123. TITLE: Phase Diagram Determination of High Temperature Ceramic Systems

CATEGORY: Research

DESCRIPTION: Advanced air-breathing propulsion systems, such as ramjet and turbine engines, can demonstrate significant performance improvement over current systems through operation at higher temperatures. Higher operating temperatures, and thus performance, are primarily limited by materials capabilities. Carbon/carbon composites show good potential for propulsion system applications due to high-temperature strength, but must be protected from oxidation. The use of ceramic compounds, applied as coatings or forming the matrix of carbon/ceramic composites, offer considerable potential in developing oxidation-resistant material systems.

A need exists for the determination of phase relationships of ceramic compounds having potential for providing oxidation resistance for carbon/-carbon or carbon/ceramic composites at approximately 5000 F. The binary systems hafnium carbide/tantalum carbide, hafnium diboride/tantalum carbide should be examined. The binary oxide systems hafnium dioxide/tantalum pentoxide and zirconium dioxide/tantalum pentoxide and the ternary systems hafnium dioxide/tantalum pentoxide/boron oxide (B203) and zirconium dioxide/tantalum pentoxide/boron oxide (B203) should also be examined to determine phases present. A particularly important output of this work is to determine the minimum temperature at which liquid phases are present.

N86-124. TITLE: Production of High Strength Hafnium Carbide Fiber

CATEGORY: Exploratory Development

DESCRIPTION: Advanced air-breathing propulsion systems, such as ramjet and turbine engines, can demonstrate significant performance improvement over current systems through operation at higher temperatures. Higher operating temperatures, and thus performance, are primarily limited by materials capabilities. Carbon/carbon composites show good potential for propulsion system applications due to high temperature strength, but must be protected from oxidation.

Novel concepts exist for oxidation protection of carbon/carbon composite materials involving the use of alternative oxidation resistant ceramic fibers. Oxidation resistant materials at use temperatures of 5000 F suggest the use of hafnium carbide fiber, which is currently not being produced. The production of hafnium carbide fiber is desired with the specific goal of improving strength properties above the state-of-the-art low strength ceramic fibers produced (i.e., zirconia) for insulation purposes.

N86-125 TITLE: Erosion Resistant Radome Materials

CATEGORY: Exploratory Development

DESCRIPTION: A need exists to develop composites of $NbAlO_4$ and $HfSiO_4$ mixed with SiO_2 and BN for radome applications. Both SiO_2 and $HfSiO_4$ have high densities relative to their respective dielectric constants. The high relative densities should yield good erosion resistance. If these two primary compounds are individually mixed with the proper amounts of silica and boron nitride, the results could be radome composites that exhibit good erosion resistance along with good structural and dielectric properties. High purity, fine grain precursor materials will be required. Mixtures will be cold formed and sintered at atmospheric pressure. Materials will be provided for mechanical, impact and dielectric testing. An initial total of six composite variations will be required.

N86-126. TITLE: Improved Underwater Warheads

CATEGORY: Exploratory Development

DESCRIPTION: Due to the major efforts to harden enemy submarines an urgent Navy need is to develop more lethal warheads for underwater mechanisms. This topic involves development of innovative warhead concepts that take advantage of all available damage mechanisms i.e., bulk shock, directed energy, secondary effects, etc. These concepts should include metallurgy and explosive material improvements as well as advanced design techniques. The effort will include the analysis necessary to develop the warhead designs and provide performance estimates and sub-scale test designs of the most promising concepts for lab and field testing by NSWC.

N86-127. TITLE: X-Ray Fluorographic Screen or Converter

CATEGORY: Exploratory Development

DESCRIPTION: Develop a fluorographic screen or converter optimized for Real Time Dynamic Radiography. This technique is utilized to observe internal component behavior of a solid propellant rocket during static firing. There are three energy ranges of interest listed in order of priority: 1) 50 KeV, 2) 9 MeV - 15 MeV, and 3) 20 MeV - 30 MeV. Respond to any or all catagories in which you feel you have an expertise. Improvements desired over currently available products are: a) efficiency, b) brightness, c) resolution, d) contrast and e) spatial frequency.

N86-128. TITLE: Solid Propellant Characterization

CATEGORY: Exploratory Development

DESCRIPTION: Develop tools and/or techniques to nondestructively detect and characterize (to a depth of .125 - .250 inch) crystalline solids in an elastomeric binder. Solids of particular interest are aluminum, ammonium perchlorate, and HMX/RDX in sizes of 1 - 100 microns and a composite solids loading of 60 - 90 volume percent. Characterization includes detection of agglomeration, particle size distribution and particle size changes.

N86-129. TITLE: Photodeposition of Metal for Multilayer Printed Circuit Boards

CATEGORY: Exploratory Development

DESCRIPTION: Devise a method of photodeposition of metals useful in printed circuits and hybrid circuits to meet the following requirements: 1) Metal runs no wider than .002 inch, 2) Spaces between run no wider than .002 inch, 3) Demonstrate ability to fabricate multiple layers of metal runs (3 or more) on or in dielectric materials suitable for electronics applications, and 4) Must function in a military environment (-55 to 125 C) without degradation (i.e. shorts, opens, delamination, etc.).

N86-130. TITLE: Fiber Optic Light Source

CATEGORY: Advanced Development

DESCRIPTION: This work is needed to develop a light source for a fiber optic system to be used to verify the "safe" or "armed" condition of a rocket motor arm-fire device of a safety-arming device under dark or very low light conditions.

The light source will be used to illuminate either a white letter "S" on a green background or a white letter "A" on a red background so that the "safe" or "armed" condition of the rotor located deep inside the safety-arming device or arm-fire device can be verified visually by simply viewing the end of the fiber optic bundle. The light source must not require any external energy source and must be contained within a volumetric envelope of a cylinder with a diameter of 0.25 inches and a height of 0.2 inche. The light source must supply light for a minimum of 15 years, the lifetime of the safety-arming device or arm-fire device. The "safe" or "armed" position must be capable of being observed without giving away the position of our forces to the enemy.

N86-131. TITLE: Compact Cryogenic Cooler

CATEGORY: Advanced Development

DESCRIPTION: Design and fabricate prototype cryogenic cooler with the following characteristics; 1) cool to 20K (or lower) a silicon integrated circuit producing no more than 0.75W heat; 2) maintain temperature uniformity of 0.01K across a thin silicon device 15mm on a side; 3) cryogenic unit volume less than 16cm^3 with nominal dimensions of 2.54 x 5 x 0.5cm (excluding power lines, high pressure lines, etc.). Design must include Dewer with optical window to view the silicon integrated circuit. The cooler must function reliably after being cycled 400 times. Cooler and power source must provide 5 minutes cooling at 20K following a cool-down period of no longer than 20 seconds.

Small cryogenic coolers are used aboard some tactical missiles. There is a continuing need for more efficient cryogenic coolers capable of reaching temperatures lower than 77K. Missile applications require rapid cool-down times and provisions for maintaining good temperature uniformity across the item being cooled, Therefore, size, efficiency, low temperatures, and speed are important parameters for new cooler designs.

N86-132. TITLE: On Tool Z - Direction Reinforcement Techniques for Composite Laminates

CATEGORY: Exploratory Development

DESCRIPTION: Composite materials are highly susceptible to damage due to interply delamination. Reinforcement in the through ply direction (Z - direction) substantially reduces this damage. Z - direction reinforcement is not used widely in industry because no technique exists to reinforce laminates after they are laid up on the mold tooling.

This effort should develop tools and techniques to reinforce woven or unidirectional composite materials in the Z - direction while the laminate is on a female tool. This could include developing stitching techniques where access to the laminate is available from one side only. The tool the laminate will be on must be a standard metal or composite tool. The Z - direction reinforcement technique shall not harm the tooling. The techniques developed will be suitable for production manufacturing environment.

N86-133 TITLE: Improved Switching Concept for S-A Devices

CATEGORY: Advanced Development

DESCRIPTION: In "out-of-line" explosive train type Safe-Arm devices, key elements of the explosive train circuitry are electrically switched in/out to provide interruption to current flow for safety and provide continuity for armed functions. Normal missile environments (vibration, temperature, shock, etc.) produce unacceptable conditions on the contacts of the rotor switch fingers and printed circuit pattern in present S-A devices. These range from small out-of-spec resistances to open circuits.

The objective of this work is to develop an alternate means of communi-

cating between circuitry used for safety and that used for initiation of the explosive train without violating the basic safety requirements of MIL STD-1316. The use of LED's, fiber-optics or other innovative devices is encouraged. Types of signals used vary from DC to 10KHz. Voltage available is nominally $+24\pm4$ VDC. Current requirements vary from several milliamps to one amp depending on circuit function. Impedance of switching concepts should be less than 0.02 ohms. Normal missile environments, space, safety, signal power requirements, and compatibility with existing fuze design and fabrication methods shall be taken into consideration. Power interruption and circuit protection are requirements since these switching systems provide signal and power to fuze circuitry in the explosive train of warhead S-A devices.

N86-134. TITLE: Fuze Contract Sensing Transducer

CATEGORY: Advanced Development

DESCRIPTION: This device is needed to detect acoustic emissions or other phenomena that result when plastic deformation occurs in a missile skin. It must be less than $0.1in^3$ in volume and operate accurately from -65 F to +165 F. It would be highly desirable for the device to function properly when the outer missile skin reaches temperatures up to 600 F. It must provide a TTL high level output when any degree of plastic deformation occurs and not provide an output due to any level of vibration that does not cause plastic deformation. For example, vibrations due to operation of the missile's rocket motor, control system or aerodynamic buffeting, hail or rain should not be detected by the transducer. It should operate on 24VDC to 32VDC unregulated at less than 50 ma.

N86-135. TITLE: PROM Programming Methodology

CATEGORY: Advanced Development

DESCRIPTION: The method of shorted junction fuse of programming a PROM (i.e., the characteristics of the programming pulse (amplitude, ramp, how many, etc.)) affects the reliability of the blown fusedlink or shorted junction fuse. New technology PROMS such as Titanium-Tungsten of shorted junction have not been studied from the viewpoint of military programmability. This study should determine what factors affect the reliability of the blown or shorted junction and what their values should be in order to guarantee a reliable program bit. This should include determination of the value of burn-in after programming in improving part reliability.

N86-136. TITLE: MOSFET Testing

CATEGORY: Management and Support

DESCRIPTION: A review of the burn-in and life testing requirements of MIL-S-19500 is needed to determine if changes could be made to enhance reliability assurance and/or reduce cost. This would require:

1) a comprehensive study of the present requirements,
2) collection of technical data,
3) analysis of statistical sampling requirements, and

4) a specific recommendation.

N86-137. TITLE: Investigate Alternatives to Ceramic Substrates for Interconnection of Leadless Chip Carriers and Other S.M.D.s

CATEGORY: Exploratory Development

DESCRIPTION: The advent of surface mount device has caused a change in interconnect board technology, The most common method of mounting surface mount devices is ceramic substrates. Ceramics continues to suffer from manufacturability and stress sensitivity problems, despite excellent packaging density and thermal characteristics. In addition, ceramic is not compatible with pinned devices such as pin-grid arrays and pinned chip carriers. Although new board technologies are arising, improvements in packaging density and thermal properties need to be investigated.

N86-138. TITLE: Investigate New Field Repair and Removal Methods for S.M.D.s

CATEGORY: Exploratory Development

DESCRIPTION: Surface mount devices and high pin count devices have not been in use long enough for adequate repair techniques to develop. The complexity of this technology makes old repair methods inadequate, but also makes the cost of individual boards too high not to repair. New techniques of detaching and remounting devices as well as earlier repaired construction techniques, such as sockets need to be investigated.

N86-139. TITLE: Custom/Semi-custom Integrated Circuits

CATEGORY: Engineering Development

DESCRIPTION: The use of custom/semi-custom integrated circuits (IC's) in military systems is increasing. This increase is creating the need for studies in design using CAD/CAM software, applications studies, packaging, timing and functional verification, continuing availability, and testability. The use of custom/semi-custom IC's in special applications can result in higher reliability, lower power consumption, and lower system costs.

N86-140. TITLE: Simulation Software

CATEGORY: Engineering Development

DESCRIPTION: Design verification and test program development for new components requires the use of simulation software. Software packages are capable of simulation for timing verification as well as functional verification. Models for complex parts are obtained from gate level logic diagrams and/or functional descriptions. The expected work includes modeling and simulation of some of the most complex components available.

N86-141. TITLE: Electrostatic Discharge (ESD) Component Field vs. Contract Susceptibility

CATEGORY: Engineering Development

DESCRIPTION: ESD component susceptability is based on voltage contact using the Human Body Model (HBM) test circuit for establishing limits. The current ESD Classification (DOD-STD-1686) imply an equivalency between voltage contact and field voltage susceptibility.

N86-142. TITLE: Very High-Speed Integrated Circuits

CATEGORY: Engineering Development

DESCRIPTION: Research and development work to date in the field of Very High-Speed Integrated Circuits (VHSIC) indicates significant promise for the use of devices in special applications where extreme compactness, minimal power consumption, and high reliability are required.

The expected work would consist of applied studies in the area of VHSIC technology for use in airborne missile systems at S-band and L-band for applications in telemetry and navigational transmitters and translators.

N86-143. TITLE: Polymide Quartz Multilayer Board

CATEGORY: Advanced Development

DESCRIPTION: Ceramic integrated circuit packages have a thermal mismatch when mounted on the standard epoxy fiberglass multilayer board. If a polymide quartz multilayer board could be developed, it would provide a much closer thermal expansion match with the ceramic package. This would result in improved reliability and longer life for the electronic package.

N86-144. TITLE: The Physics of Metal Matrix Composites

CATEGORY: Exploratory Development

DESCRIPTION: The use of metal matrix composites in advanced missiles and guidance systems in particular is at the introductory level at this point in time. If a concentrated development program were undertaken to improve our understanding of the physical properties of these materials, their application in areas where strength, stability, and low weight are of critical importance could be made more quickly and without unexpected risk.

N86-145: TITLE: Passive Variable Thermal Resistance Techniques

CATEGORY: Advanced Development

DESCRIPTION: Thermal stability and the absence of large thermal gradients are key design elements in maintaining accuracy through improved stability of critical alignments and also aids in improved performance of the inertial components.

A technique whereby the thermal resistance across a heat flow path can vary as a function of the heat flux present would result in improved thermal stability in critical areas. In particular, the development of a compact passive variable thermal resistance device would represent a unique advance

in thermal design.

N86-146. TITLE: LSI Circuit Evaluation with Eletrcon Beams

CATEGORY: Research

DESCRIPTION: Conduct an assessment of the differences and the significance of the differences between photon and electron beam excitation of LSI circuits. The following electrical parameter (magnitude and time varying response) must be considered in the study: V_{OH} V_{OL} I_{cc}. In addition the thermomechanical response shall also be considered.

N86-147: TITLE: Dielectric Conductivity Effects Under the Influence of Ionizing Dose Rates

CATEGORY: Research

DESCRIPTION: Determine the effects on dielectric conductivity of common electronics materials over a large does rate regime. Consider the effects of varying spectral content in the impinging X-ray fluence.

N86-148: TITLE: Near Net Shape Titanium Tanks

CATEGORY: Advanced Development

DESCRIPTION: Titanium propellant tank segments are currently machined from forgings and welded together. Investigation of processes that could produce hemispheres close to finish dimensions are required. Possibilities include superplastic forming, hot isostatic pressing, and shear spinning. The goal is to produce tanks at substantially lower cost.

N86-149: TITLE: Direct Attachment of IC's to PCB's

CATEGORY: Advanced Development

DESCRIPTION: Integrated circuit (IC) chips are currently mounted in ceramic or plastic packages, which are in turn mounted on printed circuit boards (PCB's). Lower cost and improved performance could be realized, particularly for very large scale integrated circuits (VLSIC's) if the chips would be mounted directly on the PCB. Techniques need to be developed for chip attachment, interconnection from the chip to the PCB, heat management, and environmental protection.

N86-150. TITLE: Expert Systems for Manufacturing Planning

CATEGORY: Research

DESCRIPTION: The manufacturing planning function is basically a manual operation that relies on the experience and skill of the individual planner. The best planners are those who have many years of experience and are thoroughly knowledgeable of the materials and manufacturing processes involved. The purpose of this research is to investigate the capture of the knowledge base of experienced planners, and the incorporation of this knowledge into an "Intelligent Planning Assistant", or expert system for the

planning process.

N86-151. TITLE: Expert System for Insuring Design for Testability Features in VLSI Designs

CATEGORY: Research/Advanced Development

DESCRIPTION: VLSI designers are being faced with increasingly complex functional requirements. The density of the designs is in the range of 1,000 to 100,000 gates per chip.

This degree of complexity increases the risk of designs that vary from being difficult to test, to untestable.

Efforts should be directed toward approaches that minimally interfere with designers' options, while requiring the testability questions to be addressed concurrently with the functional design. A "VLSI Design Assistant" would be used by the designer to make the design both functional and testably acceptable.

The "assistant" would provide the tools necessary to accomplish such designs. It is suggested that a particular technology - such as configurable gate arrays - be chosen at a test vehicle.

N86-152. TITLE: Thermal Insulating Coating

CATEGORY: Basic Research

DESCRIPTION: Formulation of state-of-the-art coatings to insulate weapons from aviation fuel fires in accordance with these parameters:

1. maximum film thickness of 60 mils
2. maximum backside temperature of 500 degrees F after 5 minutes
3. minimum heat flux of 10 BTU/ft^2 - sec.

N86-153. TITLE: Chemical Vapor Deposition Coatings for High Temperature Materials

CATEGORY: Basic Research

DESCRIPTION: Carbon/carbon and other temperature composite materials, for use in gas turbine engines, require environmental protection from oxidation and other forms of gas corrosion attack.

Chemical vapor deposition coating technology provides a capability to uniformly coat complex ship parts. Therefore the development of specific chemical vapor deposition technology for the protection of high temperature composite systems should be addressed. Of particular interest is the use of such coating for raising operating temperature, increasing operating time at temperature and increasing the number of thermal cycles which can be achieved in engines.

N86-154. TITLE: A Miniature Expendable Zoom Lens for Remotely Piloted Vehicle (RPV)

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has a need for a small lightweight low cost zoom lens that can be controlled remotely. This lens will be used with commercially available CCD TV cameras with an 8.8mm x 8.8mm format. Typical requirements call for a focal length that varies from 12mm to 30mm, an aperture of f/4, a total length less than 60mm. Concepts, materials and process that will provide performance compatible with CCD array resolution and lightest possible weight and lowest unit cost are sought.

N86-155. TITLE: Advanced Acoustic Array Development

CATEGORY: Exploratory Development

DESCRIPTION: A need exists for the identification of accoustic noise sources originating from many locations on moving undersea submersibles. With the radiating sources identified, noise quieting techniques may then be applied to lower the source levels.

The problem is to develop a narrow beamwidth sonar system/line array capable of spatially resolving noise sources to a minimum of three to five feet at a standoff distance of 100 feet. Design constraints would be to 1) minimize main lobe beamwidths, 2) minimize transducer self-noise, 3) have comparable acoustic sensitivity and response to piezo-ceramic hydrophones, and 4) the capability to operate at significant depths of fresh or ocean-water. Also required would be the establishment of suitable signal processing techiques which would allow broadside beam-forming of array elements as well as the individual element output over a broad frequency range.

N86-156. TITLE: Direct Measurement of Free Surface Mechanical Shear Waves in a Noisy Environment

CATEGORY: Exploratory Development

DESCRIPTION: It is required to employ a sensor to measure the tangential components of motion of the free surfaces of vibrating structures at frequencies of 10-30 kHz. The measurements are made inside moving vehicles which subject the sensor to a vibration environment that can mask the desired data with extraneous noise. A demonstration of feasibility would consist of a sensor capable of measuring the desired data while mounted on a platform that was excited by mechanical vibrations in the frequency bands of interest.

N86-157. TITLE: Using a Quadaxial Cable to Feed VHF/UHF Mast Mounted Antennas

CATEGORY: Exploratory Development

DESCRIPTION: Shipboard (and especially submarine) antenna design is often driven by the extremely limited space available for location of the antenna radiator. As a result, antennas designed for different frequen-

cy bands (not operating as an array) are often stacked end-to-end in colinear arrangements on a single shipmast. In addition to the usual problem of isolation between antennas, is the quandry of bringing the coaxial transmission line feed for the upper antenna past the lower antenna without the cable becoming a serious parasite to the lower antenna(s). As an alternative to the parasitic feed cable arrangement, certain antenna designs do allow passage of a feed cable through the vertical antenna/mast axis. However, the bandwidth of such antenna designs is reduced because of the necessity of using frequency dependent (tuned) distributed rf networks to isolate antennas attached to a common mast.

The objective of this task is to design a three port, coaxial transmission line device that would accept two (2) coaxial transmission line inputs (with individual VHF/UHF bands) and combine the cables into a single, quadaxial output (with individual VHF/UHF bands) for feeding stacked antennas. The outer two conductors (outer coax) split off first to feed the lower antenna (e.g., the VHF band), while the inner coax continues up the mast to feed an additional antenna (remaining UHF band).

N86-158. TITLE: Anisotropic Compliant Layers For Turbulent Boundary Layer Control and Flow Noise Reduction

CATEGORY: Exploratory Development

DESCRIPTION: In 1960 experimental results of up to 25 dB reduction in turbulent boundary layer (TBL) wall pressure fluctuations were reported for flow over a compliant layer. The layer, which was similar to coatings evaluated for drag reduction by Kramer, was of anisotropic composite construction. Limited efforts in the past have been unsuccessful in explaining the 1960 experimental results. Recently research has sought to determine compliant surface potential for delay of transition and drag reduction. However, this effort has been largely confined to consideration of isotropic layers and has not addressed at all the question of TBL noise reduction. A combined analytical and experimental approach to determine the TBL noise reduction potential of anisotropic compliant surfaces is needed. The modeling should be capable of handling layers similar to those investigated by Kramer. The experimental approach is to be complementary to the modeling. Experiments must address factors such as accurate determination of material properties of anisotropic layers in addition to measurement of pertinent flow parameters and surface deformation characteristics. The desired end result will allow calculation and experimental validation of the wavevector - frequency spectrum of the pressure fluctuations on and within an anisotropic compliant layer subjected to turbulent flow.

N86-159. TITLE: Pressure Wave Generation

CATEGORY: Research

DESCRIPTION: It is well known that pressure waves generated by a passing ship can be sensed by appropriate transducers and used to satisfy requirements of mine logic. The goal of minesweeping is to artificially generate ship-like influence fields to cause premature detonation of the mine. Methods are sought for generating large ship-like pressure signatures using towed devices which could be deployed by naval mine countermeasures vessels.

N86-160. TITLE. Quantitative Assessment of Water Contamination of Hydraulic Fluids

CATEGORY: Exploratory Development

DESCRIPTION: A simple method of quantitatively determining the amount of water in hydraulic oils is required. The method must be applicable to hydraulic oils conforming to: MIL-F-17111, MIL-H-5606, MIL-H-83282, and MIL-H-46170 and should be capable of determining the quantity of water down to 100PPM± (parts per million). The method shall be operable by field personnel at the organizational level with a minimum amount of training and shall be capable of performing the analysis at the aircraft or support equipment without major facility requirements. The test should be performed within 10 to 15 minutes.

N86-161. TITLE: Power Plant and Storage System for an Electromagnetic Aircraft Launcher

CATEGORY: Exploratory Development

DESCRIPTION: There is a need for an Electric Power Generating and Storage System to be developed for use on naval aircraft carriers.

Specifications:	
Storage Capacity:	100 Mw
Production Rate:	70 Mw in 45 sec
Discharge Rate:	70 Mw in 3 sec
Weight:	Less than 165,000 lbs
Volume:	Less than 4,000 cu ft

Must be compatible with a shipboard environment.

Provide analysis and formulate recommendations for possible generating and storage systems and naval use.

N86-162. TITLE: Enhanced CV/CVN Fixed Wing Aircraft Centerline Approach System

CATEGORY: Exploratory Development

DESCRIPTION: A recent Fleet survey funded under PE62241N: Proj WF41-460 disclosed the need for significant improvements in the CV/CVN centerline optical landing suite. A review of accident records shows a fourfold incidence rate at night relative to day operations.

PHASE I: Devise/analyze a conceptual CV/CVN centerline optical system(s) displaying aircraft line-up position and the rate of deviation from/towards the centerline position for fixed wing aircraft in the carrier approach/landing pattern. The system shall incorporate a positive "on course" indication to the pilot for both day and night time operations. Examine the engineering and human factor elements for positioning the data display at the existing Fresnel Lens Optical Landing System or at a separate location. Assess system feasibility; effectiveness at night; in fog, rain, and other adverse weather; performance with respect to range; system reliability, maintainability, supportability, and affordability. Provide a development plan for (possible) Fleet introduction.

PHASE II: Design/fabricate breadboard hardware to ascertain concept feasibility and acceptance.

N86-163. Title: Low Cost Power Divider for Electronic Warfare Application

CATEGORY: Advanced Development or Engineering Development

DESCRIPTION: Threat environment generators are used widely in the Electronic Warfare business to simulate threats for systems testing of ECM/ESM systems. The following project is high-risk, but potentially high-payoff due to its high utility and lowering of test costs.

Design a power divider for application in broad bandwidth threat environment generators used in EW simulation laboratories for design, test, evaluation and integration of EW systems and software. The task involves design of a low-cost two-way power divider that operates over the 0.5 to 4.0 GHz range with greater than 20 db isolation between ports.

N86-164. TITLE: High Power RF Switch

CATEGORY: Exploratory Development of Advanced Development

DESCRIPTION: Presently, many high-power radio-frequency switch devices are constructed in wavequide or stripline configurations using packaged PIN diodes. The switches often have limited bandwidth, power capability, slow switching time, driver interface problems and large weight or volume. An application exists which requires a high-power, single pole-double-throw (hot) radio-frequency switch (500 watts CW) which can be switched at rates of at least 125 KHz. The device should be small (less than 300 cu. in), easily integrated with other functions, light-weight (under 10 lbs.), have an integrated switch driver (TTL controlled), wide frequency bandwidth (at least 500 MHz) and be reasonably reproducible. The device should also meet MIL-E-5400 environmental specifications.

This project is relatively high-risk, since no known manufacturer has designed such a device. It has high-potential use in a variety of RF countermeasures systems, and would be a significant state-of-the-art improvement for EW countermeasures systems.

N86-165. TITLE: Research in the Application of Training Technology for Attrition Reduction in Hazardous Field Training Environments

CATEGORY: Engineering Development

DESCRIPTION: The shortage of qualified Explosive Ordnance Disposal personnel is a continuing problem affecting the combat effectiveness and operational readiness of Navy units. In FY 84, the Naval School, Explosive Ordnance Disposal Basic Course suffered an overall 37 percent attrition, 44 percent setback rate, and a 52 percent Surface Basic setback rate, at a dollar cost of over $2.5M (plus salaries). These training attrition problems are compounded by the requirement for second class certification, a requirement which significantly decreases the quota fill rate for those entering the Explosive Ordnance Disposal School. Recently, the Army has successfully tested a hand-held training device in the field. The results

demonstrated a dramatic decrease in training attrition coupled with increased performance. Research in the application of the hand-held technology and other computer aided instruction (CAI) techniques to the Navy explosive ordnance disposal training problems may decrease the rate of attrition and incidence of accidental injury both at the explosive ordnance disposal school and at the prerequisite diver training program.

N86-166. TITLE: Expert Systems for Training Analysis and Design

CATEGORY: Research

DESCRIPTION: The training analysis and design process is a lengthy process requiring the development of a large data base of information which is used to produce follow-on documentation. The purpose of this research is to investigate the applicability of expert systems technology to the training analysis and design process.

Efforts should be directed toward approaches for developing intelligent software programs which will provide automation of time-consuming processes and products.

N86-167. TITLE: Digital Representation of Solid Objects

CATEGORY: Exploratory Development

DESCRIPTION: Develop a method for acquiring x,y,z postion data for each pixel on a 512 x 512 resolution photographic display of a three-dimensional object. The objective of this task is to devise and construct a system which measures both position and intensity for a region of a solid object corresponding to the area subtended by a single pixel on an orthographic projection of the object. The system may employ either pressure sensing (e.g. probes), electro-optical, or accoustic techniques.

N86-168. TITLE: Target Acquisition Trainer for Strike Aircrew

CATEGORY: Advanced Development

DESCRIPTION: One of the greatest difficulties in air-to-ground bombing is the location and identification of targets from altitude. Most bombing errors occur from a misidentification or localization of the target. Previous psychological studies have indicated that pilots who have more practice both in actual combat and in a training environment are much better at acquiring ground targets than those pilots with limited experience. Thus, it appears that air-to-ground visual acquisition can at least partly be learned. There is an ongoing requirement to provide enhancements to actual flight training for pilots through the use of simulators and part-task trainers.

The initial need in this area is to determine the state-of-the-art video recording, display, and mini- or microcomputer capabilities that can be utilized to train target detection and classification from various altitudes under various environmental conditions. The system is required to display scenes videotaped or filmed from aircraft that can be integrated into a stand-alone computer system. The computer system would provide

diagnostic feedback regarding the identification and the classification of various targets. The system should also be flexible enough to be utilized as a trainer for the instruction of point-to-point aerial navigation.

N86-169. TITLE: Estimating Training System Resource Expenditure for Broad Categories of Training

CATEGORY: Advanced Development

DESCRIPTION: Training system cost estimating methods follow traditional guidelines and, if applied properly, provide high confidence results. However, there are alternate methods which can be applied, some of which have been used effectively within the Department of Defense. The methodology suggested for development is based upon fully describing categories of training and then estimating resource expenditure per unit of training time for each category. Models could be developed which estimate non-dollar resources required for facilities, technical training equipment and devices, curriculum development, training staff, materials, supplies and training plant overhead. The models developed for this approach should be adaptable for microcomputer application and should be usable for evaluating alternative training approaches.

N86-170. TITLE: Embedded Training for Airborne Anti-Submarine Warfare

CATEGORY: Advanced Development

DESCRIPTION: The increasing sophistication of equipment requires not only training and practice in the classroom but on-the-job training while deployed for many months at sea or at forward bases. At present, the training of Naval aircrew utilizes relatively few training sites capable of providing simulation training of the equipment available for various airborne ASW sensor stations. To maintain a high level of proficiency during the periods between major training events at centralized facilities, a system capable of providing simulation training at deployed sites is needed.

The initial need in this area is to determine the state-of-theart approach to onboard training for the sensor station of the P3-C ASW aircraft. The system must (1) be embedded within the tactical computer system, (2) set up various ASW secenarios that can be simulated with their actual onboard equipment, and (3) provide diagnostic feedback as to the aircrew's operation of the equipment against the simulated threat(s).

N86-171. TITLE: Computer-Based Manpower Management Education Software

CATEGORY: Exploratory Development

DESCRIPTION: Job tours of Navy manpower managers usually last only two years. This approximates the amount of time needed on the job to become accomplished in using the "tools of the trade"--manpower management models. A "manpower systems simulator" is needed to replace many aspects of on-the-job training, which is both slow and inefficient as a means of transferring information. The objective of this work is to design computer graphic simulators of manpower management systems. The purpose is to facilitate

managerial acquisition of knowledge on the fundamental behavior of personnel systems and the models used in managing those systems. The simulations will take the form of "management games" which employ management decision scenarios to drive mathematical models of manpower systems. Interactive feedback mechanisms are then used to simulate the management problem environment of manpower planners. A collateral but important aspect of this effort is the evaluation of artificial intelligence software and Symbolics hardware/software in the development of management games.

N86-172. TITLE: Approximation to the Combination of Complex RF Signal Sources

CATEGORY: Exploratory Development

DESCRIPTION: The requirement to combine a number of signal sources in a radar simulation of detection and acquisition of cruise missile targets has severe impact on computer resources. The addition of various signal returns to the radar requires the use of complex arithmetics algorithm in order to take into consideration the signal's gain and phase.

An approximation to this arithmetics process which would speed the simulation run time would be very desirable. This approximation must take into account the gain and phase of each signal in the combination process to some demonstrated degree of accuracy under stated conditions and assumptions.

N86-173. TITLE: RF Seeker Automatic Ship Target Classification for Cruise Missiles

CATEGORY: Exploratory Development

DESCRIPTION: Ship target classification and selection are important operational capabilities for cruise missiles, since potential ship targets significantly outnumber our missiles. Ideally, ship targets need to be classified and then the "high valued" ship target selected for attack by the missile system.

The automatic ship target classification system development should include the fundamental system concept, RF seeker considerations, feature extraction and selection processing techniques, and classification algorithms. Ship target selection should be described and included in the classification subsystem. Also. the expected tactical performance payoffs for cruise missile applications should be considered.

N86-174. TITLE: Programmable Real Time Holographic Image Modulators for Cruise Missile Application

CATEGORY: Exploratory Development

DESCRIPTION: Investigate the potential for implementing image processors using programmable holgraphic techniques to process, in real time, images generated by terminal guidance imaging seekers. Develop a system architecture assuming a raster scanned array input and a state of the art framing rate. Address the feasibility of implementing a "missile sized" processor

and the potential for demonstrating a prototype design for Phase II.

Consider in the above effort the response time implications at missile speeds and the resolution/response time trade-offs to achieve accurate targeting.

N86-175. TITLE: Synthetic Line Hardware

CATEGORY: Exploratory Development

DESCRIPTION: Synthetic lines are widely used in marine applications because they are lightweight, corrosion-resistant, easy to handle and have a relatively high strength-weight ratio. They are found on Navy vessels as mooring lines, lifting lines, guys, stays and tow lines to name a few uses. Deficiencies in the current applications are in part caused by deficiencies in associated hardware (terminations, linkages, etc.). These deficiencies also limit the potential of synthetic line for a wider range of Navy applications. The current techniques and hardware used with synthetic lines were adapted from wire rope technology. As a result, the associated hardware is heavy and is usually the weak link in the line system because the differences in mechanical properties between steel wires and synthetic fibers have not been adequately addressed. Handling this hardware, which can weigh over 300 pounds is both difficult and hazardous. In addition, corrosion of metallic end fittings is a major problem.

N86-176. TITLE: Metallurgical Modelling of Microshrinkage

CATEGORY: Exploratory Development

DESCRIPTION: AS turbine engine contractors turn to castings as a solution to the high cost of engine parts, there is concern for microshrinkage in these parts. Microshrinkage continues to be the number one problem with castings in the field. There is a strong need to understand how it occurs and what its three-dimensional characteristics are. Hipping is being used to seal microshrinkage. However, commercial hippers report that they occasionally have unexplained failures to close internal microshrinkage. The situation is not tolerable as greater reliance is placed on castings and the assumption that the ideal properties exist in manufactured parts of a critical nature. Such structures include impellers, blisks (integrally bladed disk), frames, fan blades and cases. A method is therefore needed to model the physical morphology of microshrinkage and how it forms during the solidification process. This knowledge can then be used to develop processes that will eliminate the presence of microshrinkage in critical Navy aircraft propulsion components. This will increase safety and aircraft readiness.

N86-177. TITLE: Gas Turbine Augmentor Acoustic Characterization

CATEGORY: Exploratory Development

DESCRIPTION: Naval gas turbine augmentors currently experience operability and durability problems associated with acoustic resonance (i.e. screech and rumble). Very little is know other than empirical correlations - these correlations have been inadequate in addressing current problems, and future

configurations will be a more severe environment regarding resonance. The proposed program would analytically and/or experimentally characterize acoustic resonances in a reactive environment (i.e. burning) in an attempt to develop and design acoustically insensitive augmentor components.

N86-178. TITLE: Tools for Acoustic Transducer Development

CATEGORY: Exploratory Development

DESCRIPTION: The further improvement of the reliability and performance of underwater acoustic transducers requires the development and use of some design tools that are not available. Some of the problems can be overcome by the development of computer-aided engineering models and measurement techniques related to various non-piezoelectric materials in longitudinal vibrator transducers. For example, a DUMILOAD was developed for a relatively new Navy fleet transducer that was so critically dependent upon the parameters of one material that the unit was unsatisfactory for its intended purpose. The use of suitable models with correctly-measured parameters would rectify the problems that influence the reliability, life-cycle cost, and general development of improved Navy transducers. This task involves the improvement of existing techniques for the development and improvement of transducers of the longitudinal vibrator type. The computer-aided engineering tools developed must relate specifically to the improvement of design considerations for non-piezoelectric, non-metallic, compliant materials used within the structure forming the basic vibrator or the DUMILOAD thereof. Since these techniques will be used by the Government to evaluate proposals, this requirement for models and techniques needs to be furnished by an independent organization, not associated with the development of such sources by private industry.

N86-179. TITLE: Applications Software Synthesizers

CATEGORY: Research/Exploratory Development

DESCRIPTION: The need with regard to software is the ability to produce software for large complex systems that is robust, reliable, and easy to change.

In the past, a special system called an "Applications Software Generator" has been used to assist the applications programmer to integrate existing application software program parts with new program parts. This approach facilitates change of software, and reduces the probability of programming errors through the reuse of existing program parts. This approach has been successful in a limited way at the programming language level; however, it fails to address the aspects of the software development process which give rise to the software errors that are most difficult and costly to fix, the successive refinement which translates the applications knowledge into programming knowledge. This effort will extend these ideas into the applications domain through the development of applications software synthesis technology.

This technology will (1) permit and support the semiautomatic derivation and rederivation of the implementations for applications computer programs from the formal specification of the software at the level, in the

terms and from the perspective of, the applications domain, and (2) provide for the rapid generation of automated synthesizers for particular applications.

The work will explore unique combinations of AI, knowledge-based approaches and modern software engineering technology.

N86-180. TITLE: Systematic Software Design and Generation

CATEGORY: Research/Exploratory Development

DESCRIPTION: This technical problem involves the development of design constructs and components to rapidly build software systems. The objective is to develop an approach for low-cost rapid generation of software design and components for families of systems coupled with automatic transformation techniques for building systems. This requires (1) development of a technique for defining and specifying reusable components for the software engineering environment; (2) development of a method (with supporting tools) for defining and specifying an environment using pre-defined components; (3) expansion of (2) so that the environment specification becomes the environment family specification (which contains every member of a certain class of environments) and the method includes a technique for generating the design of any particular family member; (4) development of approaches for building environments from a variety of pre-existing components; (5) development of specialized strategies for doing quality assurance on environments within a given family; and (6) build a small support system (e.g, microprocessor based system).

N86-181: TITLE: Masked Technology for Ion Beam Lithography

CATEGORY: Advanced Development

DESCRIPTION: The pacing technical problem in masked ion beam lithography is the fabrication of the all-silicon crystalline thin membrane (2-micrometer thick) 1.25 x 1.25 cm^2 within a 50mm or 75mm diameter silicon wafer.

A systematic approach to the development, evaluation and optimization of a technique (equipment and process) for the deposition of a defect-free, heavily boron-doped (2 x $10^{20}/cm^3$) epitaxiallygrown layer (2-micrometer thick) on a _110_ single-crystal silicon n-type substrate.

This effort is in support of the Navy "Masked Ion Beam Lithography" system development for a high-throughput, production-compatible micropattern replication technique of VLSI/VHSI circuit with 500-nanometer (and smaller) design rules.

N86-182. TITLE: Smoke Control Aboard Ship

CATEGORY: Exploratory Development

DESCRIPTION: In order to evaluate and improve systems and procedures for smoke control aboard ship, safe and effective techniques and equipment for conducting smoke movements tests are needed. This involves defining realistic performing, safe smoke simulants and equipment to measure visibil-

ity (correlates with human vision) and concentration. The smoke simulants and measurement procedure must be convenient, portable and have minimum impact on personnel and ship equipment. Assembly and packaging of existing technologies into a new system and procedures is acceptable.

N86-183. TITLE: Wake Measurements in Propeller Rotating Coordinate System

CATEGORY: Exploratory Development

DESCRIPTION: Under some circumstances the unsteady flow experienced by a rotating propeller blade is not easily described by measurements made in the fixed coordinate system. Methods are required to experimentally measure the flow field through a propeller as viewed from the propeller rotating coordinate system. Measurements are the time dependent velocity at several positions along the propeller span for propellers of diameter approximately one foot and rotational speed of 6000 rpm operated in air at 100 ft/sec. The frequency response should be up 3000 Hz.

N86-184. TITLE: Automatic Inflation Device for Life Preservers

CATEGORY: Engineering Development

DESCRIPTION: Automatic inflation devices for life preservers are available, but they are expensive and can only be reused after rearming by the manufacturer. The Navy needs an inexpensive, reliable automatic inflation device for life perservers but with a manual override. Rearming needs to be accomplished by Fleet personnel. The engineering development should focus on a mechanical device as opposed to a squib fired device. Units must be humidity and corrosion resistant and compatible with existing manifolds and carbon dioxide units in the Fleet.

N86-185. TITLE: Constant Tension Spooling Device for Wire Rope and Cables

CATEGORY: Engineering Development

DESCRIPTION: Constant tension spooling devices for wire rope and electromechanical cables are required at shore and tender based IMA's. Such equipment provides smooth transfer of wire rope and cable from shipping spools onto the ship as well as aiding in distributing constructional stretch throughout the whole cable length.

Specifically, a constant tension spooling device is desirable which is simple, compact and light crane portable. It should be self powered, capable of handling ropes and cables within a diameter range of 1/4 - 3/4 inch and have a spooling tension capacity of 500 - 10,000 lbs.

Techniques that may be considered include electric, pneumatic and hydraulic driven reeling systems, either separately or in combinations.

N86-186. TITLE: Non-Destructive Test Equipment for Stainless Steel Corrugated Core Spot-welded Sandwich Panels

CATEGORY: Exploratory Development

DESCRIPTION: The David Taylor Naval Ship R&D Center has been involved in the test and evaluation of stainless steel corrugated core spot-welded sandwich panels for naval deckhouse applications. This R&D has led to the use of corrugated core panels on naval combatants. There is a need to develop suitable NDT inspection tools to ensure adequate spot weld integrity of stainless steel corrugated core spot-welded sandwich panels for shipboard use. This proposal is intended to utilize existing NDT technologies to develop and procure methodology and hardware for corrugated core spot-weld panels. Using this equipment, spot-weld flaws (if any) will be detected and recorded to support the Navy certification of corrugated core spot-welded sandwich panels.

N86-187. TITLE: Navy Surface Effect Ship (SES) Seakeeping Assessment Computer Program

CATEGORY: Exploratory Development

DESCRIPTION: The Navy has an urgent need for a means of predicting the seakeeping characteristics of Surface Effect Ships (SES). A computer program that does this should be capable of predicting SES motions (e.g., heave, pitch and roll angles and displacements, velocities and accelerations) for an SES of any form (e.g., defined hull lines with specific seals, lift fans, and moments of inertia) and of any displacement (taking into account the non-Froude scaled cushion dynamics). It should predict these SES motions for various conditions of speed, heading to the sea, and for various sea states. It should also predict these motions with and without heave motion attenuation devices, and for various classes of such devices (e.g., vent valve type and fan variable-inlet-guide vane type). This SES Seakeeping Assessment Computer Program (when validated against SES-200 trials data) should be useful in selecting favorable SES designs and design approaches, and in selecting subsystem parameters (e.g., optimum heave attenuation control system parameters, etc.) in the conceptual and preliminary design phase of the ship design process. These quantitative SES seakeeping assessments will be used to make predictions of the percent operability of given SES designs in given ocean area (e.g., winter northern North Atlantic) for specified operations (e.g., helicopter operations).

N86-188. TITLE: Tough High Modulus Castable Plastics

CATEGORY: Research

DESCRIPTION: Tough, high modulus casting materials are not available. In general as the modulus increases, the brittleness of the plastic also increases. High modulus (over a million psi) impact resistant castable plastics are needed for various applications e.g., cable terminations, potting compounds. The processing techniques for these castable materials must also be cost effective. Optimal properties include room temperature cure, low visosity, and good surface definition or low profile.

N86-189. TITLE: Long Life Non-Skid Coatings for Flight and Hangar Decks

CATEGORY: Research

DESCRIPTION: Current non-skid coatings are organic resins with inorganic particles that provide a skid-resistant surface for aircraft and Fleet personnel. Non-skid life is normally 18 months or less. High solids coatings are being explored, but profile and weight impact need to be addressed. Inorganic coatings such as thermal spray hold the potential for long-life performance. Initial work with aluminum thermal spray indicated porosity and adhesion problems to conventional deck. Typical coating properties that would be evaluated include bond strength, coefficient of friction, impact resistance, porosity, and wear resistance.

N86-190. TITLE: Microbubble Detector

CATEGORY: Exploratory Development

DESCRIPTION: A reliable microbubble detector with particle/bubble discrimination capability is required for the development of cavitation nuclei control. The ability to control cavitation nuclei in the laboratories offers a significant payoff in minimizing the cavitation scaling problem in model propeller cavitation testing.

Holography has been shown to have the ability to measure the size, concentration, and shape of bubbles, particles, and organic matter. This capability makes holography useful for monitoring cavitation nuclei in water tunnel and ocean water. A portable device is required which can have a sampling tube with optical windows placed in it. The device would illuminate water samples in a typical water path length of (a) 2.5 cm and (b) 20 cm and be able to resolve nuclei down to 5 microns in diameter moving at speeds up to 10 meters per second.

Topic AF86-103

ASD/YWB
Building 11, Room 014
Wright-Patterson AFB OH 45433

Topics AF86-104 to AF86-105

Deputy for Propulsion
ASD/YZYD
Building, Post B-14
Wright-Patterson AFB OH 45433

Topics AF86-106 to AF86-123

Avionics Program Office
AFWAL/GLXPA
Building 22, Room S110
Wright-Patterson AFB OH 45433

Topics AF86-124 to AF86-146

AFWAL/GLXPF
Area "B" Building 45, Room 149
Wright-Patterson AFB OH 45433

Topics AF86-147 to AF86-172

AFWAL/GLXPM
Area "B", Building 653, Room 406
Wright-Patterson AFB OH 45433

Topics AF86-173 to AF86-187

AFWAL/GLXPP
Programs Group
Building 18A, Room A-103
Wright-Patterson AFB OH 45433

Topics AF86-188 to AF86-272

BMO/MYSC
Building 523, Room 302
Norton AFB CA 92409-6468

Topics AF86-273 to AF86-287

HQ Aerospace Medical Division
AMD/RDO
(Attn B. Williams)
Directorate of Resources and
Operations
Building 150, Room 224
Brooks AFB TX 78235

Topics AF86-288 to AF86-293

AEDC/DOT
Building 900 Mail Stop 900
Arnold AFS TN 37389

Topics AF86-294 to AF86-300

HQ AFESC/RDXP
Building 1120
Tyndall AFB FL 32403

Topics AF 85-301 to AF85-304

AFWAL/GLXPF
Area "B" Building 45, Room 149
Wright-Patterson AFB OH 45433

Please note that, because of unique circumstances, proposal deliveries to the Wright-Paterson AFB OH complex will require additional time (about one day) for processing to the correct office. Accordingly, bidders should plan an additional time allowance for proposal delivery to the correct office as stated in this solicitation.

AIR FORCE SMALL BUSINESS INNOVATIVE RESEARCH PROGRAM
Submitting Proposals on Air Force Topics

Topics AF86-1 to AF86-15

AFOSR/XOT
Building 410, Room A113
Bolling AFB
Washington DC 20332-5000

Topics AF86-16 to AF86-36

AD/PMR
Room 428, Building 350
Eglin AFB FL 32542-5000

Topics AF86-37 to AF86-46

ESD/XRCT
SBIR Program Manager
Mitre D Building Room 1D237
Hanscom AFB MA 01731

Topics AF86-47 to AF86-57

RADC/DOR
Building 106, Room A112
(Attn: Mr M. Donovan)
Griffiss AFB NY 13441

Topics AF86-58 to AF86-69

WCO/AFSTC
PO Box 92960, WPC
Los Angeles CA 90009
(Mail)
WCO/AFSTC
2350 E. El SEgundo Blvd
Building A-2, Room 2219
El Segundo CA 90245
(Hand Carry)

Topics AF86-70 to AF86-71

HQ AFSTC/XN
Attn Lt Steele
Building 497, Room 205
Kirtland AFB NM 87117-6008

Topics AF86-72 to AF86-75

AFGL/XOP
Building 1107, Room 200
Hanscom AFB MA 01731

Topics AF86-76 to AF86-80

AFRPL/TSPR
Building 3853, Room 115
Edwards AFB CA 93523

Topics AF86-81 to AF86-86

AFWL/PRC
Building 413, Room 261
Kirtland AFB NM 87117-6008

Topics AF86-87 to AF86-91

Special Assistant for
Program Coordination
ASD/AE
Building 57/Bay 1
Wright-Patterson AFB OH 45433

Topics AF86-92 to AF86-93

ASD/ENO
Engineering Operations Office
Building 14, Room 208
Wright-Patterson AFB OH 45433

Topics AF86-94 to AF86-102

Directorate of Concepts &
Innovation
ASD/XRX
Building 11A, Room 201
Wright-Patterson AFB OH 45433

AF86-1. TITLE: Investigate Fluid Flow Phenomena to Improve the Performance of Flight Vehicles

DESCRIPTION: This project supports research in external aerodynamics, turbulent and unsteady flows, and internal fluid dynamics. The objective is to investigate the fluid flow phenomena that strongly influence the aerodynamic performance and efficiency of current and future flight vehicles, to understand the structure of turbulence in shear flows, and to improve our understanding of and capability to predict three-dimensional flow past geometrically complicated configurations. We are interested in methods for automatically generating solution-adaptive computational grids; exploiting the unsteady flow characteristics that will improve aerodynamic efficiency and enhance performance; improving experimental and theoretical modeling capability for deflected engine exhaust jets that may interact with solid surface and encounter cross flows; numerically simulating time-evolving turbulence features; passively, actively, and interactively controlling turbulence characteristics; numerically computing on- and off-design flows in low aspect ratio and high pressure ratio compressor blade passages. Proposals should be in one or more of the following areas: Effects of viscosity, turbulence, pressure and temperature gradients, compressibility, and non-steadiness of flows; interactions of the shock wave-turbulent boundary layer for a range of Mach numbers; severe separation from wings and wing and body configurations; turbulent structures and their interactions in free and bounded shear layers; the behavior of attached and separated unsteady shear layers affected by time-dependent boundary conditions; generic characteristics of driven, unsteady separated flows; flows in internal passages in lasers; compression system instability; dynamic stall on two and three dimensional lifting surfaces; aerodynamically forced response of stator blades; and effective active cooling for turbine blades.

AF86-2. TITLE: Improve the Long-Term Durability and Reliability of Aerospace Structural Systems

DESCRIPTION: This project supports research in structural mechanics, structural durability, and civil engineering. The objective is to explore the behavior of aerospace structural systems in a variety of environments, the long term durability and reliability of those structures, and the properties and behavior of new materials to be used for strategic and tactical structures. We are interested in developing structural response models, models for predicting damage growth and structural life, and constitutive models for geotechnical and construction materials; studying the strength and fracture characteristics of brittle materials; investigating explosion-induced soil liquefaction; and developing, identifying, and measuring *in situ* soil properties. Proposals should be in one or more of the following areas: The role of internal and external nonlinearities of structures; ways in which to control the behavior of the structures; interactions between flexible aerospace systems and their on-board controllers; ways in which fatigue and fracture damage structures, especially composite structures; new materials or approaches that will lead to the survivability of strategic structures in a nuclear weapons environment, the survivability of strategic and tactical structures in a conventional weapons environment, and rapid repair of tactical and logistical aircraft launch and recovery surfaces.

AF86-3. TITLE: Enhance the Performance of Flight Vehicles by Improving Air Breathing and Rocket Combustion and Plasma Energetics

DESCRIPTION: This project supports research in airbreathing combustion, diagnostics in reacting media, rocket combustion dynamics, and plasma energetics. The objective is to study the physical and chemical processes of combustion in an airbreathing propulsion system; develop techniques for sensing temperatures, concentrations, and velocities in energy conversion systems; understand combustion and reacting flow processes; and study advanced space propulsion. We are interested in models of turbulent fluid transport processes, photochemical and catalytic methods for more stable ignition and enhanced combustion of present fuels and future alternatives, noninvasive sensing and diagnostic techniques and strategies, methods for analyzing the stress of nonlinear viscoelastic materials, thermal protection techniques for isolating plasma from inert components, and noninterference techniques for measuring plasmas. Proposals should be in one or more of the following areas: Fluid transport processes; stable ignition and enhanced combustion of present and future fuels, control of the rate of combustion, and reduction of undesirable combustion products; the combustion of liquid fuel and high energy slurry fuels; reacting flows in the hostile environments of high performance systems; combustion instability problems in solid and liquid rocket systems; instability phenomena that degrade the performance of ramjet combustors; role of advanced energetic ingredients in solid propellant burning; state of combustion products in plumes; thermodynamic, kinetic, and transport properties of pure substances used for propellants; sources of physical (nonchemical) energy, such as electrically conductive flowing gases or plasmas; the mechanism of release of that energy; and the devices for converting that energy; the phenomena of energy coupling and transfer of energy flows in electrode and electrodeless concepts under plasmadynamic environments and conditions that orbiting plasmadynamic systems encounter; pulsed and steady-state equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, -electrode, -magnetic, and -electric fields; energy losses to inert parts; plasmas generated at high magnetic fields and pressures; and characteristics of advanced refractory materials exposed to working fluids and life-limiting mechanisms.

AF86-4. TITLE: Chemical Science

DESCRIPTION: This topic includes five principal subareas: chemical techniques, structural chemistry, surface chemistry, molecular dynamics, and chemical reactivity and synthesis. Research in chemical techniques focuses on developing new and improved analytical instrumentation and methods in electrochemistry and detection (specifically the nature of electrodes and electrochemical reactions). Research in structural chemistry encompasses programs in polymer science, glass, and advanced structural ceramics and ceramic composites. Research in surface chemistry investigates gas and solid surface interactions, surface characterization, surface reaction kinetics and mechanisms, the characterization of thin films, the interaction and reactivity of gases with thin films, the stability of substrate and thin film interfaces, film nucleation and growth, and interactions of intense light and thin films. Research in molecular dynamics examines well-defined microscopic molecular systems in reactive and nonreactive

molecular collisions by using selected energy states of reactants and analyzing the energy through available molecular energy levels or through emission of radiation. Research in chemical reactivity and synthesis seeks to explore new and better methods for characterizing and synthesizing new organic, inorganic, organometalliic, and organometalloid compounds (particularly organosilicon and fluorocarbon substances), preceramic polymers, and novel approaches for making reaction intermediates that can be used to tailor chemical stuctures with desirable properties.

AF86-5. TITLE: Atmospheric Physical Processes

DESCRIPTION: Basic research in this area includes studies of Atmospheric transmission and absorption to understand molecular absorption/emission line widths and shapes, and field and laboratory comparisons; Optical Aerosol Modeling to increase understanding of atmospheric aerosols and their effect; Remote Sensing of Atmospheric Quantities to illuminate knowledge of radiative transfer; Neutral Upper Atmosphere Dynamics to determine and model motion and chemistry above the stratosphere; Ionospheric Physics to understand global ionospheric dynamics and electron density variations; Ionospheric - Magnetospheric Modelling to define interactions and responses of the global atmospheric system; Large-Scale Dynamics to understand interactions between the troposhere and the upper atmosphere; Meso-scale Dynamics to produce new knowledge about the interplay between meso- and macro-scale systems and cconvective elements; Cloud and Aerosol Microphysics to understand molecular and particle-scale physics of cloud and precipitation systems; Atmospheric Electricity to understand characteristics of atmospheric charge separation and electrical discharges; Climate Physics to understand the fundamental physics underlying climate and climate change.

AF86-6. TITLE: Improvement in the Technology of Monolithic Microwave and Millimeter Wave Integrated Circuits

DESCRIPTION: This project includes three topics: monolithic microwave and millimeter wave integrated circuits, superconducting analog signal processing, and process modeling for compound semiconductor technology. The research in monolithic microwave and millimeter wave integrated circuits seeks to identify improvements in materials, processing techniques that can be automated, and device designs. Monolithic refers to the fabrication on a single semiconductor chip of active and passive components, such as transistors, capacitors, inductors, and interconnections. Needed research includes work on substrates, active layers, device modeling, millimeter wave device designs, and monolithic integration. Implementation will be in gallium arsenide or indium phosphide or related ternary compounds at frequencies up to 100 GHz.

One promising approach for future signal processing applications is the use of circuits based on superconducting analog elements. The basic functional needs for high speed, wide bandwidth signal processing are delay (compact structure), tapping (accurate), multiplication (dynamic range), and summation (phase coherence). Candidate research topics include more reprodicible and uniform tunnel oxides; discrete devices, such as convolvers and correlators; more complex circuitry, such as programmable matched filters and time-integrating correlators; a combination of superconducting and cooled-semiconductor devices;

and photo-introduction of signals into the cryostat to avoid wires.

Silicon device and integrated circuit technologies have been greatly fostered by the abailability of computer simulation tools, such as SUPREM and SPICE. Under the topic of process modeling for compound semiconductor technology, we are seeking suitable process models for compound semiconductor materials, such as gallium arsenide and indium phosphide. We are interested in research that proposes models for bulk materials processing, such as liquid encapsulated Czochralski (LEC) and horizontal or vertical Bridgeman. Other areas of interest include device and/or integrated circuit models that incorporate the standard fabrication steps, including implantation, thermal annealing, dielectric formation, metalization, etc.

AF86-7. TITLE: Development of Novel Thin Film Deposition Techniques

DESCRIPTION: This project includes research in novel thin film deposition techniques. Currently, Air Force optical systems are limited in performance by thin film properties. Existing deposition techniques, such as thermal evaporation and sputtering, result in films with a microstructure described by the structure zone model. Thin film performance could be improved with deposition techniques, such as energetically enhanced chemical vapor deposition, molecular beam epitaxy, ionized cluster beam deposition, or other ultrahigh vacuum epitaxial techniques, that permit more control over film morphologies. The ultimate goal of investigating these techniques is to find a technique for the deposition of a perfectly amorphous or a perfectly single crystal optical film that has thin film properties approaching those of the bulk material. We are interested in research that proposes to characterize novel deposition techniques or to model growth and deposition phenomena.

AF86-8. TITLE: Ceramic and Cement-Matrix Composite Materials

DESCRIPTION: This project supports research leading to the creation of new non-metallic structural materials in two categories: ceramic composites and cement-matrix composites. The new ceramic composite materials must possess mechanical properties of strength, toughness and durability which would permit their use as structural materials in oxidizing environments from 1600-2200°C. The new cement-matrix composites must possess strength, stiffness and toughness property values significantly greater than those of ordinary portland cement concretes while retaining the ability to be processed at low temperature.

AF86-9. TITLE: Research in Neuroscience

DESCRIPTION: There are two programs in neuroscience. Bioreactivity examines the mechanisms that control neuronal activity. The current focus is on neuronal regulation and adaptation, including control of neurotransmitter release and postsynaptic response, activation of second messengers and ion channels, and influence of neurohormones. We are particularly interested in studies that relate events at the different levels of organization involved in regulating the state of responsiveness of the intact organism. Research in adaptive network architectures explores the neural mechanisms of learning and memory and attempts to relate them to intelligent machine architectures. The roles of positive and negative reinforcement in neuronal adaptation and goal-seeking behavior in neurons and neural ensembles are emphasized.

AF86-10. TITLE: Research in Experimental Psychology

DESCRIPTION: A program in sensory information processing focuses on attempts to describe quantitatively the capabilities and limits of the human visual and auditory systems in complex, dynamic environments. Spatial and temporal interactions, perception of patterns, and the effects of memory, attention, expectations, the other senses, and eye movements are included. Also supported is experimental and theoretical work on the mechanisms by which humans recognize complex sound patterns. A program in mental workload supports fundamental behavioral and physiological research on stages of information processing and allocation of mental resources involved in performing complex demanding tasks.

AF86-11. TITLE: Research in Toxicology

DESCRIPTION: Air Force operations may result in the release of physical and chemical agents that may be harmful to Air Force personnel and the environment. The objective of research in bioenvironmental hazards is to obtain data on the biological effects of exposure to electromagnetic radiations from pulsed and continuous wave sources and to clarify how Air Force-relevant chemicals produce their toxic effects. Fundamental research on mechanisms of action is supported, but not studies that simply screen for toxicity.

AF86-12. TITLE: Research in Mathematics

DESCRIPTION: Basic research in mathematics covers the mathematics of computation, mathematics of dynamics and control, applied mathematics, computer science, and probability and statistics. Research in the mathematics of computation seeks to develop algorithms that can be coded reliably, efficiently, robustly, or automatically for serial, vector, and parallel computers with emphasis on ways to numerically solve partial differential equations and algebraic equations. Research in the mathematics of dynamics and control includes robust control, adaptive control; stability theory, optimal control, stochastic control, filtering, nonlinear control and identification, and optimization of lumped and distributed parameter systems. Research in applied mathematics includes thhe creation of new mathematical models and methods for solving physical, chemical, and biological systems; signal processing and communication; mathematical optimization; applied analysis; and finite mathematics. Research in computer science focusses on distributed and parallel processing, programming theory, artificial intelligence, and data management systems. Research in probabililty and statistics addresses new methods and the expansion and generalization of existing methods in probability theory, statistics, stochastic processes, statistical communication theory, and reliability for real systems.

AF86-13. TITLE: Research on Physical Processes of Plasmas, Lasers, Microwave Devices, Space Prime Power, and Directed Energy Concepts

DESCRIPTION: This project supports research in optical physics, pulsed power, atomic and molecular physics, particle beam technology, and the physics of collective phenomena. Optical physics addresses research in the vacuum ultra-light to the near millimeter range of the spectrum.

Emphasis is on coherent light and its interactions with matter. Pulsed-power investigations center on electron-beam, laser-triggered, and sustained switching, the spectroscopy of switch plasmas, an understanding of high power repetitive opening switches, and an understanding of the ways switch electrodes and insulators break down and erode. Research in atomic and molecular physics concerns the properties and interactions of atoms and molecules. Research in particle beam physics includes investigations of intense, high energy, charged and neutral beams and studies of negative ion sources. Studies of the physics of collective phenomena examine the collective effects of low temperatures and the physical processes associated with producing radiation at X-ray, soft X-ray, millimeter wave, and microwave frequencies.

AF86-14. TITLE: Study Near-Earth Space Conditions to Prevent Degradation of Military Systems Operating in Space

DESCRIPTION: Space environmental conditions produced by radiation and atomic particles can endanger the mission and degrade the performance of military spacecraft, disrupt the detection and tracking of missiles and satellites, distort communications, and interfere with surveillance operations. The objective of research in this project is to study the particles, electric and magnetic fields, and radiation that affect the environment of near-earth space. Studies should be designed to examine the following topics: Ways to specify and forecast solar wind and magnetospheric conditions with ground-based measurements, such as radio star scintillations and geomagnetic pulsations; celestial background radiation; ways to improve the resolution of space object images; distribution of plasma and magnetic fields within the magnetosphere; and the earth's radiation belts and their responses to natural and artificial disturbances.

AF86-15. TITLE: Improve the Accuracy of Locating Geographical Positions and Establish Methods to Reliably Differentiate Between Earthquakes and Underground Detonations

DESCRIPTION: The research in this project is stimulated by the need to guide and control missile systems, conduct advanced tests of components, site silos, discriminate among the sources of nuclear explosions, and conduct reconnaissance and surveillance missions. The scientific disciplines involved are geodesy, gravity, geology, and seismology. Research in geodesy defines the exact position of targets with respect to missile launch sites. Research in gravity examines the effect of gravity on missile guidance systems along flight paths. Research in seismology studies the effects of earthquakes, nuclear explosions, and other natural or system-generated noise on the degradation of missile guidance systems before launch.

AF86-16. TITLE: RF/Millimeter Wave Phenomenology Investigations

DESCRIPTION: The Air Force is currently in the process of developing a variety of RF and millimeter wave (MMW) seekers for both air-to-air and air-to-surface guided weapon systems. A program to understand and model the phenomenology on which these seeker designs are based is needed. In previous programs, both target and clutter data for a number of scenarios has been collected. Information gained from these data collection programs has been useful in understanding sensor performance in high clutter environ-

ments; however, the indepth analysis of millimeter-wave phenomenology necessary to achieve optimum, or in some cases even acceptable solutions to the target acquisition/discrimination problem has not been performed. With a better understanding of the basic phenomenology and advances in seeker technology, it is imperative that the data collection, analysis, and modeling be refined to better understand the critical phenomenology issues. This phenomenology includes target radar cross section signatures, background clutter backscatter characteristics, polarization signature of targets and clutter, high resolution imaging characteristics, clutter backscatter spatial correlation characteristics, countermeasures and counter countermeasures.

The objective of this program is to model these signatures from first-principles, physical models of target and clutter, and validate these models with data which currently exists. The first-principles approach shall make the models independent of the data base used to validate models and shall facilitate the evaluation of a large variety of seeker design concepts. In addition to validating the models with existing data, the program must identify deficiencies in the current data base, and interface with the Joint-Weather Seeker (JAWS) program to attempt to overcome these deficiencies.

AF86-17. TITLE: Gallium Arsenide Solid State Accelerometer (GASSA)

DESCRIPTION: Acceleration (deceleration) is always present during the launch and/or terminal engagement of air-launched weapons. Various devices, mainly mechanical, have been utilized to provide inputs to arm subsystem and fuzing logic for safe separation and/or detonation decisions. Due to the low sensitivity and poor accuracy of existing economical devices these fuzing decisions have of necessity been gross, limiting effectiveness parameters such as launch envelope and warhead detonation point. Previous development programs on the silicon solid state accelerometers have demonstrated the technology necessary to batch fabricate single chip accelerometers in the range from .01g to 10,000g with sensitivity versus natural frequency equal to or better than commercially available discretely fabricated accelerometers in the $100 to $300 price range. Although considerable progress has been made, the desired level of accelerometer sensitivity has not been achieved. Recent advancements in the use of gallium arsenide devices suggest that this technology can be applied to accelerometers with the potential of a sensitivity factor improvement of 5 to 20 over that of silicon.

The objective of this program will be to investigate the theoretical potential of gallium arsenide accelerometers to improve sensitivity levels. This program will concentrate on improvement in areas to include: temperature stability; yield, packaging for environmental survivability; reliability; and ease of interfacing with decision logic circuit. One of the main efforts will involve placement of all temperature compensation and amplifier circuitry on the accelerometer die instead of on a separate substrate as in the earlier development program.

AF86-18. TITLE: MMW Terminal Homing Sensors

DESCRIPTION: Strategic defense studies have consistently shown that due to limitations in sensor accuracy, a terminal homing sensor will be required on a hit to kill projectile. Furthermore, those studies have all identified MMW techniques as a potential solution, but the present technology limits its usefulness. Revolutionary improvements in the size, weight, speed, and accuracy of phased array antennas in the 60-300GHZ range are needed to mature MMW technology to where it can be useful in Electromagnetically Launched Guided Projectiles.

The objective of this program is to investigate innovative techniques to facilitate the development of monolithic phased array antennas. Small high speed phase shifters, which are required for beam steering, is one area of interest. Another area of interest is in insular wave guide techniques. For example, insular guide integrated monopulse antennas and pulse transeivers, and wide-band circulators.

AF86-19. TITLE: Non-Nuclear Weapon System Performance Measurement Techniques

DESCRIPTION: Accurate and realistic assessment of the effectiveness of conventional munitions where weapon system aiming at munition release is crucial can be obtained with current computer and sensor capabilities. Today's assessment of weapon system effectiveness often relies on input data from a small set of data where live munitions are fired at surrogate or mock targets. Often the targets are benign and unrealistic. The approach which should be taken is to use actual realistic targets (possibly manned) and simulate the munition using an on-board computer simulation. This approach is being taken by the Army and Navy with respect to training. Weapon systems are being developed with an on-board "embedded training" capability. With the munition being simulated, all subsystems as well as the man-in-the-loop can be trained and/or evaluated. The data records from such training exercises are invaluable to the weapon system effectiveness analysts. Furthermore, with the use of programmable, digital computers, new munition concepts can be evaluated in the field by computer software changes. To achieve this capability for the Air Force, innovative research is needed to package a rugged and reliable instrumentation suite consisting of sensors, computers and software applicable to both guided and ballistic munitions.

The near-term objective of this program will be to investigate performance measurement techniques and computer simulation techniques required for an aircraft "embedded training" capability applicable to both training and munition concept evaluation. The long-range objective will be to develop a similar capability to evaluate Strategic Defense Initiative concepts using a simulated kill mechanism.

AF86-20. TITLE: Fuze Design for Long Term Storage

DESCRIPTION: Fuzes are subjected to a wide range of environmental conditions prior to their one time usage requirement. During this time certain physical and chemical changes occur which may negate their successful operation. It is essential that the shelf life and service life be correctly established and extended to minimize destructive sample testing of inventory fuzes. The current fuze surveillance program is adequate to assess reliability but

does not address failure modes and causes of failures. It uses fuzes that are destroyed in weapons tests and determines reliability by statistical means. It is imperative to establish a firm service and shelf life that is based on physical and chemical analyses in lieu of destructive sampling techniques. This has an impact on the development, acquisition and operational cost of past, present and future fuze designs.

The objective of this program will be to develop a:

a. Methodology for the determination of the causes of fuze failure and suggest alternative materials, processes and designs to eliminate or reduce failures due to long term storage.

b. Plan for validating, methodology, alternative materials, processes, and designs.

Phase II of this program would require the accelerated lifetime testing of the end products of Phase I.

REFERENCE: Logistics Need 84030, Air Force Logistics Research and Studies Program, Air Force Coordinating Office for Logistics Research (AFCOLR) WPAFB OH 45433

AF86-21 TITLE: Target Acceleration Term in Homing Missile Guidance

DESCRIPTION: Air-to-air homing missile guidance laws have been derived from modern, optimal control theory by a number of researchers over the last seven years. Though various coordinate systems and cost functions have been used, all of the resulting guidance laws contain a term which is proportional to the target's acceleration. While the overall performance of these advanced guidance laws has been shown superior to more conventional proportional navigation, the significance of the target acceleration term is not well understood. In-house work at the Air Force Armament Laboratory has shown that the inclusion of this term often does not improve miss distance against an evading target even when the guidance law is provided (unrealistically) with perfect knowledge of the target's acceleration. The contribution of the target acceleration term varies from one engagement geometry to another with no obvious pattern. In addition, some linear analysis recently accomplished as part of a larger effort indicates the target acceleration term degrades the guidance loop stability margins making the system more susceptible to noisy, inaccurate target acceleration estimates (AFATL-TR-84-47).

This program, then, will concentrate on understanding and improving the target acceleration term in modern, optimal guidance laws. The contractor should first address the simplifying assumptions made during the formulation of the optimal control problem and arrive at a theoretical understanding of their impact on the resulting guidance law performance. These assumptions include, for example, linear or constant radius curvilinear target motion, and instantaneous, unlimited control of missile acceleration in all directions. The contractor will then rederive the optimal control problem from first principles removing or relaxing those

assumptions which most severely degrade the resulting performance. Recognizing that target acceleration can only be estimated (not directly measured), the contractor then should relate, in a statistical sense, the accuracy of those estimates to the performance of the guidance law in general and the target acceleration term in particular.

AF86-22 TITLE: Use of Artificial Intelligence for Target Vulnerability Assessment

DESCRIPTION: The assessment of the vulnerability of targets to conventional weapon kill mechanisms has evolved over the years to an emperical science based on target descriptions, damage effects modeling and vulnerability analysis. Major methodology development efforts have been directed toward developing analytical tools and techniques for predicting the target component damage resulting from the kill mechanism/target component interaction. These efforts have resulted in several models, one of which is the Pointburst Damage Assessment Method (PDAM), used largely in the vulnerability assessment of armor targets. These analytical models and algorithms, used to estimate vulnerability, rely on an experimental data base to make realistic estimates of actual damage achieved. Frequently, there is a data base deficiency from which to make vulnerability assessments; thus the vulnerability analyst is asked to use expert opinion in employing the methods of assessments. Artificial intelligence (AI) advancements have resulted in capabilities to substantiate machine intelligence for human decision making. There appear to be applications of AI to vulnerability methodology that may improve assessments. Use of artificial intelligence in making expert decisions in damage assessment is of interest.

The objective of this effort is to develop artificial intelligence techniques for target vulnerability assessment methodologies. Consideration should be given to development of algorithms for making expert decisions in damage assessments. Also of interest are techniques for alternatives to expert opinions on assessing vulnerability.

AF86-23 TITLE: 1.3 Micron Integrated Optic Frequency Shifter

DESCRIPTION: Increased Air Force emphasis on standoff, launch and leave tactical weapon delivery has created a need for small, very low cost inertial reference systems for weapon control, guidance, and seeker stabilization. Inertial sensors (gyros and accelerometers) which are critical to these inertial reference systems, meet cost, size and adverse environment requirements imposed by these weapons. The passive laser gyros have the potential to meet these requirements. Current passive laser gyros use bulk optic components and operate at 0.85 micron wave-length. A passive laser gyro component of particular interest is the frequency shifter. Bulk optic frequency shifters do not show the low-cost mass production potential promised by integrated optics. Incorporation of 1.3 micron technology in lieu of 0.85 micron will reduce losses on order of magnitude and enhance performance.

The objective of this program will be to investigate the potential of integrated optic frequency shifters for passive laser gyros that operate at

1.3 microns. This program will concentrate on the design of such a frequency shifter that could be coupled to a fiber optics gyro.

AF86-24 TITLE: Insulating Rails for Electromagnetic Guns

DESCRIPTION: An electromagnetic rail gun barrel consists of two current carrying rails separated by two insulating rails. During firing, the projectile is accelerated down these rails by an intense (0.5 - 2.0 megamp) current flowing in the rails and in an armature behind the projectile. The armature may be a plasma, in which case the rails are exposed to the plasma temperature and pressure.

Materials presently being used for insulating rails are glass fiber/epoxy composites or ceramics. The glass fiber/epoxy composites suffer erosion and ablation damage during firing. The ceramics frequently crack or flake off. Neither material is usable for more than a few shots, and a new material is required.

The new insulating material should be an electrical insulator. It should not be degraded by exposure to the arc plasma for a short time. The arc plasma is estimated to be at a temperature of a few tens of thousands of degrees Kelvin, and pressures are a few thousand atmospheres. Exposure times are less than a millisecond. The material may be installed in the barrel for long periods of time under preload, so it must not creep under loads equivalent to thousands of atmospheres. Candidate materials are toughened or fiber reinforced ceramics. Other material concepts are welcomed.

AF86-25 TITLE: Scaled Down Physical Model of an Air Target for Performance Evaluation of Imaging IR Seekers (Short Title - IR Air Target Model)

DESCRIPTION: Infrared (IR) radiation from an air target serves as the source of energy from which an airborne IR seeker, in conjunction with a guidance system, tracks, and intercepts the target. At relatively long range, the target appears as a point source radiator. As the seeker-to-target range decreases, an IR imaging seeker images the IR target and by employment of proper algorithms, is able to discern targets from background. Furthermore, with sufficient seeker resolution, a track point on the target is established and maintained, and the missile is guided along a trajectory to intercept the target. During development of the seeker/guidance system, performance evaluations of the system may take place by way of simulations, which may take the form of digital, analog, hybrid, or hardware-in-the-loop (HIL). One aspect of HIL testing requires an IR target for presentation to the developmental seeker hardware. The IR target under consideration for this effort is a scaled down physical model of an actual air target incorporating a method to reproduce the IR signature of the actual target. As seeker-to-target range decreases, the angular extent of target increases. Since in simulation testing the seeker-to-target range is fixed, an optical system will be necessary to simulate this condition and at a rate corresponding to the closure rate. The IR signature characteristics, bandpass(es) of interest and actual target size(s) will be provided as GFP.

The objectives of this program are:

a. To explore methods which will produce all aspect IR signature characteristics on the scaled down physical target which reproduces that of the actual air target.

b. To perform a preliminary design of the optical system which will compensate for seeker-to-target range closure (approximately 20,000 ft to 100 ft) at closure rates of up to 6,000 feet/second.

AF86-26 TITLE: Target Spall Data Collection System

DESCRIPTION: Target spall and fractured projectile particle debris are always present when a warhead fragment or a bullet impact a target at high velocities. The total amount of behind target debris is important to effects analyses of conventional weapons attack on target structures--aircraft, tanks, trucks, bunkers, etc. This type of detailed data is difficult and costly to acquire. Past methods have used wallboard materials to collect all the particles, with subsequent determinations made of the weight of each particle, its position in space behind the target, and the velocity at which it came off the target rear surface. This method has not been very successful because of the time involved in collection of data.

The objective of this program is to develop an automated method for collecting behind target debris data. A possible method is to obtain orthogonal flash radiographs of the debris at two different times behind the target, and analyze the resulting radiographs with automatic scanning microdensitometers. (Radiographs are needed to "see" through the highly luminescent flash accompanying, the impact phenomena.) Other possible methods may use a collection medium that permits easier extraction of data than does wallboard materials. Also, holographic methods may prove useful, if the impact flash problem can be solved. The primary thrust of this topic is to move this type of work from the highly labor intensive category it presently requires to an automated task requiring little personal effort, since the labor pool available for this kind of work is nonexistent.

REFERENCE: AFATL-TR-70-51, "Penetration of 60-grain and 240-grain Bomb Fragments Into Wallboard, Air Force Armament Laboratory, Eglin AFB FL, June 1970.

AF86-27 TOPIC: General Research

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of nonnuclear munitions and armaments. These include chemical and fuel-air explosives, energy sources and conversions, bombs, submunitions, warheads, fuzes, dispensers, guns, rockets, ammunition, ammunition feed systems, mines, sensors and seekers, explosives, propellents, carriage and release equipment, aerodynamic and structural technologies, tactical missile guidance and control technologies, exterior ballistics analysis, lethality and vulnerability assessment techniques, and

chemical warfare technology. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fuzing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal self-forging fragments, heavy metal shaped charges, long rod penetrators, reactive fragment warhead, and Computational Fluid Dynamics.

AF86-28 TITLE: Smart - Mux for Digital Microwave Systems

DESCRIPTION: Digital microwave systems are being widely used on USAF Tactical Test and Training Ranges for transmitting data from remote locations to control complexes to provide real-time mission control, data analysis, etc. The digital microwave systems are commercial off-the-shelf systems designed to carry 24, 56 Kbts channels on a T-1 (1.544 Mbts) lines. Additional high speed data (1.544 Mbts) may be transmitted on individual T-1 lines. Many ranges have data communications requirements which cannot currently be met using digital microwave equipment. Telemetry data from aircraft and missiles are typically transmitted at a data rate of up to 1.8 Mbts. Currently, equipment is not available to multiplex one or more telemetry data streams (over 1.544 Mbts) together for transmission via digital microwave systems.

The objective of this program will be to investigate the potential of developing equipment which will allow multiplexing of telemetry and other high speed data streams (over 1.544 Mbts) for transmission over digital microwave systems utilizing 2 or more T-1 lines and/or at the DS-2 level and demultiplexing that signal at the receiving end.

AF86-29 TITLE: Robotics

DESCRIPTION: A typical loading process is the transportation of munitions to the flight line loading points for loading onto the aircraft. The munitions are taken off the trailer with the use of a hydraulically operated Bomb Lift Truck. The truck is then driven to the aircraft where the munition is then loaded onto the aircraft. Loading of numerous munitions becomes a labor intensive effort and to some degree is a strain on the operator. The application of robotic systems to accomplish the loading process would provide a significant increase in loading times and saving of manpower.

AF86-30 TITLE: Muscle Multiplier

DESCRIPTION: The handling and loading of missiles in the 400-600 lb class has become an equipment intensive and time consuming effort due to missile packaging and loading onto aircraft where space limits the use of equipment. Loading and handling of the 200 lb class missile many times is accomplished by hand, thus eliminating the problems due to packaging and space limitations in loading onto the aircraft. Application of technology in the area of exoskeletal devices is needed to solve the problem. Such a device would be worn by the loader and with use of hydraulics and sensor systems would multiply his strength 4 or 5 times his normal strength.

AF86-31 TITLE: Innovative Guerrilla Warfare Munitions

DESCRIPTION: Current and developmental weapons are designed to be effective against large concentrations of enemy forces. The majority of these weapons are expensive because they are designed to destroy hardened targets such as tanks, armored personnel carriers, bunkers, and bridges. Most of these weapons explode on impact and must thus be delivered on current enemy positions. Guerrilla warfare presents new requirements for weapons in that large areas need to be secured without destroying the local economy. Weapons are needed which work well against small groups (5-10 personnel) which are difficult to identify. We have a situation here which is akin to air-to-air combat identification wherein the weapons need to be selectively employed only against the combatants. Guerrilla warfare also presents the need to rapidly close borders to both ground and light aircraft transportation to prevent third party intervention. What is needed is a new family of weapons which are designed specifically to deter guerrilla warfare.

The objective of the program is to define air delivered weapons concepts which will have a significant contribution to defeating guerrilla warfare in such places as Central America. Extensive studies of the Afghanistan conflict, Central American conflicts, as well as the Middle East, guerrilla warfare should be conducted to formulate innovative weapons concepts. Concepts would include weapons which would not only kill insurgents but would also provide information on their movements. The weapons would need to be low cost, unsophisticated and tamperproof. Critical components would be built or simulated to ascertain feasibility after completion of a study.

AF86-32 TITLE: Graphical Optimization for Missile Layout and Weapon Physical Fit on Aircraft

DESCRIPTION: Background: The present method for determining the maximum number of submunitions that can be contained in a missile dispenser is to fill the dispenser with the inert submunitions and vibrate and refill until full (for example, BLU-63 bomblets in a TMD). The submunitions are poured out and counted. Other submunition shapes require scaled trial and error methods with three dimensional hand drawings to determine the maximum number of submunitions as well as their location and orientation within the container. Internal missile components such as warheads, inertial measurement units, actuators, motors, electronics and batteries are laid out graphically by hand to determine optimal packaging. A similar problem exists with the physical fit of weapons on an aircraft. Three dimensional hand layouts are used to determine the interference points of weapons loaded on racks and rails fitted to various aircraft. Physical interferences between a missile exiting the launch rail, aircraft and/or other weapons is also to be determined in a similar manner. Future unconventional weapon designs will aggravate all of these problems.

Overview: A graphics computer program that can operate on a VAX/780 mainframe with a Tektronics 4125 type of terminal for a VAXstation 500 workstation is needed. It is desired that the graphics optimization be semi-automatic and reasonably fast with user interaction being desirable.

Interferences between objects or points of contact should be highlighted with color graphics and there should also be a capability during the optimization/weapon fit process to interactively increase the size of the container or reduce the size of the weapon being fitted. The program must be capable of easily building data bases of weapons/submunitions from existing submunitions or scaled three dimensional drawings. Adaption of existing aircraft, racks, rails and weapon data bases is also required.

Phase 1 Objectives: A survey of existing optimization techniques is needed and a particular graphical optimization methodology should be proposed in detail. A survey of existing/developmental aircraft, weapon, racks, rails and submunition data bases should be undertaken to determine the feasibility/difficulty of building and/or reformating these data bases. The feasibility of reformating the output data for use in aerodynamic and radar prediction programs should also be addressed. The proposer must give a demonstration of his graphics capability at his facility that can perform some of the tasks mentioned in paragraphs 1 and 2. It is desirable that the proposer deliver and install at Eglin AFB, with appropriate documentation, a graphics program that is capable of performing some of the tasks mentioned in paragraphs 1 and 2 above.

AF86-33 TITLE: Damaged or Destroyed Target Discrimination

DESCRIPTION: In any intense combat such as might be expected in Central Europe, the battlefields and lines of communication will be littered with destroyed or severely damaged targets after the first period of encounter. The precision guided weapons and airborne target detection devices may well select a target that is no longer a threat, thus lowering the overall force effectiveness by wasting weapons. It is highly desirable to develop means of discriminating between functioning targets and those that have already been destroyed.

Concepts for discrimination are required that are compatible with various sensor devices such as MMW, infrared, and microwave radar as well as imaging from each of these type of sensors. Target types such as vehicles, air defense sites, command centers, and lines of communication should be considered. While it is not probable that one concept would encompass all target and sensor types, it is desired to have concepts that cover as much of the spectrum as possible. Concepts should work as closely as possible to the same operational range and environment as the sensor they will augment.

AF86-34 TITLE: Propelled MK-82 and MK-84 Warhead Designs

DESCRIPTION: Low Level Laser Guided Bombs and other Air Force guided weapons utilize the MK-82 500 pound and MK-84 2,000 pound high explosive warheads. It would be desirable to increase the range from the target at which these weapons could be launched by incorporating an integral propulsion capability into the MK-82 and MK-84 warheads.

An integral propulsion concept is required for the MK-82 and MK-84 warheads to allow increased standoff range to be achieved by weapons employing these warheads. Concepts which would remove a portion of the

current warhead explosive fill, and incorporate a separating bulkhead, rocket propellant, rocket engine blast tube, and rocket nozzle to provide an integral propulsion capability, while maintaining approximately the same center of gravity need to be defined.

AF86-35 TITLE: Low Drag Gun Projectile Concept Designs

DESCRIPTION: Electromagnetic guns and guns employing telescoping ammunition designs are capable of achieving projectile muzzel velocities of the order of 5,000 to 10,000 feet per second. The high projectile velocity is rapidly dissipated in the current projectile designs due to their high aerodynamic drag.

A gun projectile concept is required which has low aerodynamic drag allowing the high muzzel velocity to be maintained over a larger portion of the projectile trajectory. Concepts which employ tubular designs--a design in which an annular low drag projectile is employed due to its low frontal area--aerospike projectiles, and other low drag design concepts should be considersd.

AF86-36 TITLE: Subcaliber Gun Projectile Concept Designs

DESCRIPTION: Aircraft anti-armor gun systems use 30 millimeter caliber, gun launched, anti-armor projectiles incorporating a subcaliber kinetic energy penetrator--a rod having diameter of approximately 10 millimeters and a length to diameter ration of ten--to achieve target defeat. The current concepts employ discarding sabots designs to accelerate the projectile in the gun barrel. These sabots are then separated from the subcaliber penetrator after the projectile leaves the gun barrel. The penetrator continues in its trajector without the sabot. The discarded sabots, due to possible ingestion by the launch aircraft engines, present a hazard to the aircraft.

A subcaliber gun projectile concept is required which does not use conventional sabot techniques to launch the subcaliber kinetic energy penetrators. Concepts which employ consumable sabots, compound designs--the design would consist of a kinetic energy rod surrounded by a tubular projectile where the ballistic coefficient of the rod is greater than the ballistic coefficient of the tubular projectile allowing the rod to separate from the acceleration structure aftrer launch--and non-sabot concepts should be considered.

AF86-37 TITLE: Advanced Network Concepts

DESCRIPTION: Based on a concept of distributed information centers, an advanced distributed network concept will be developed. The important areas of interest are data entry, automated routing schemes, priority accesses, flexibility of the concept, and possible examples of different network designs. Critical areas are single point and multiple point entries into the network (nodal points). The network design concept computer language should be ADA or PASCAL.

AF86-38. TITLE: Distributed C^3I Data Base

DESCRIPTION: In order to develop a survivable Command and Control structure for the 2000 time frame, a distributed Command and Control systems concept will be investigated. For this system to work, the contractor will inplement/design a distributed C^3I data base to meet the needs of the user. This system must be user assessible, user friendly, provide near real-time or real-time data, provide real-time updates, and be reliable and maintainable.

The design of the data base must be flexible enough to allow growth and security. Several options must be explored in terms of design, feasibility of each design, and complexity of such a design. The options will be looked at, and the best survivable design will be specified. Priority accesses must be built into the data base design and recognized from several access points.

AF86-39. TITLE: Automated Airborne Vehicle Detection and Reporting

DESCRIPTION: Apply innovative techniques for the surveillance, detonation, detection and reporting of airborne vehicles operating below 1000 feet altitude. The system may be portable and capable of unattended operation with its own primary power. It should be capable of standard commercial network connectivity for passing an alert message or signal to an unattended central display. The phase one activity shall develop the technical approach and implementation of the demonstration at a Test Range.

AF86-40. TITLE: Integrate Fiber Optic Theory Into Integrated Circuit Technology

DESCRIPTION: The purpose of this research would be to merge the fields of fiber optics, microwave theory, and integrated circuit technology to develop an optical signal processor. This device would input and output digital laser light signals, rather than electrical signals. The recurring problems of heat dissipation, EMP, and radiation hardening would therefore be eliminated, as well as the need for optoelectrical converters and/or metal wiring. The goal of a Phase 1 effort would be to determine how microwave theory could be reduced to the size used by current fiber optic waveguides and IC circuits, and to propose how such devices could be made for optical switching.

AF86-41. TITLE: Two-Way Testing of Voice Communication Systems

DESCRIPTION: Methods currently used for specifying, evaluating, and comparing the performance of USAF voice communication systems measure intelligibility and, in some cases, quality. Typical test methods are Monosyllabic Word Intelligibility (American National Standard ANSI 3.2-1960), the Modified Rhyme Test (MRT), the Diagnostic Rhyme Test (DRT) and the Diagnostic Acceptability Measure (DAM). All of these measure performance in a one-way speech transmission situation.

These measurements are useful to equipment designers but do not tell the operational user how well the equipment will serve his needs. For example, one-way test data do not reveal the effects of time delays, interruptions and other processes that occur in operational voice communication.

A few test methods have been designed to provide measures of performance and acceptability in the two-way, talker-listener interactive mode that is representative of the actual use of voice communications in military operations. Examples are a picture-matching Free Conversation Test (FCT) developed by the British Post Office, a Communicability Test developed by the US Naval Research Laboratory, the Diagnostic Communicability Test (DCT), and an Operational Acceptability method currently in use by the JTIDS program office.

Although each of these methods has been found useful in limited applications, none has been widely accepted. Some guidelines are emerging, and there is general agreement that additional refinement is needed. For the SBIR program, we require new methods that might lead to wider use and standardization .

AF86-42. TITLE: Communications Between Bistatic Radar Elements

DESCRIPTION: Multistatic radars use multiple, spatially separated receivers and transmitters to get several "looks" at a target simultaneously. To realize the full benefits of the multistatic approach, the target reports must be communicated to a site which sorts and processes all of the sensor returns. The radar transmitters are projected as being inexpensive and vulnerable to anti-radiation missile (ARM) attack while the passive receivers are projected as being expensive and concealed. The entire system is touted as being mobile and survivable.

The method of communicating the sensor information from each of the receivers to the processing site is an area of concern. Landline or fiber optic cables are jam-resistent and can provide reasonably high data rates. However, installation and maintenance costs are substantial and, once in place, mobility is limited. Radio frequency (RF) communications enable flexibility in locating the communications end points but are more vulnerable to jamming. Microwave links, as well as laser communications, are more resistant to jamming due to their directionality, but the line-of-sight requirement limits mobility and flexibility in locating the communications end points. An innovative solution is required to provide high data rate, jam-resistant, mobile, and maintainable communications for bistatic field radars.

AF86-43. TITLE: ADA Software Cost Estimating Models

DESCRIPTION: The Department of Defense (DOD) has mandated ADA as the software language for advanced development and engineering for weapon systems. All weapon system programs require extensive cost estimates before budget approval. Several cost estimating models exist (e.g. COCOMO, Price-S, etc.) for programs with large software projects, but the model parameters have not been designed to accurately reflect the costs associated with ADA. Since ADA requires a much higher degree of software engineering than other languages, and there is not much ADA project experience to draw on, current models produce cost estimates of questionable accuracy. This project would develop parameters and/or new cost estimating models specifically for ADA projects. The models must accurately estimate development and post deployment support costs of weapon system programs designed and coded in ADA.

AF86-44. TITLE: Millimeter Wave Monolithic Phased Array Technology

DESCRIPTION: There is a desire for airborne conformal arrays for satellite communications at the MILSTAR frequency bands (45 GHz/20 GHz). We request an array design, which takes into account antenna RF, mechanical and thermal design, and both the transmit (45 GHz) and receive (20 GHz) frequency bands.

AF86-45. TITLE: Methods for Measuring Talker Identification in Voice Communication Systems

DESCRIPTION: Methods currently in use for evaluating and comparing USAF voice communication systems measure only the intelligibility. Typical test methods are Monosyllabic Word Intelligibility (American National Standard ANSI 3.2-1960), the Modified Rhyme Test (MRT) and the Diagnostic Rhyme Test (DRT). All of these use a carefully structured procedure for obtaining quantitive, repeatable measurements in a one-way speech transmission situation.

These measurements are useful to equipment designers but do not tell the operational user how well the equipment will serve his needs. One very real requirement that has long been expressed (but never formalized) by operational users is the listener's need to be able to identify the talker.

Very little has been reported in literature on the auditory mechanisms by which listeners recognize and identify speakers. The need to understand these mechanisms and to develop test methods is becoming more urgent because of USAF'S growing use of narrowband digital voice systems. Such systems produce speech that sounds "artificial" but still provides some degree of identifiability.

We require innovative test methods to measure how well a given voice communication link can enable a listener to recognize and identify the speaker.

AF86-46. TITLE: Computer Software Security Development Process

DESCRIPTION: Modern computer systems have to be readily accessible to authorized users, adaptable, user friendly and capable of providing a wide range of services. This makes them vulnerable to break-in by unauthorized users and abuse by otherwise legitimate users. Of particular concern here is the vulnerability of large computer systems to the phenomena known as backdoors, trapdoors, and time bombs. A backdoor is an opening, usually inadvertent, left in software (including firmware), which permits unauthorized access to the operational software, data base contents, or hardware. Trapdoors, usually deliberately made in software, cause information of interest to be duplicated elsewhere in the system while it is being processed legitimately. The duplicate information may be stored for later pickup. Time bombs are also usually deliberate and have been known to cause the total loss of an operating system, software, and data base contents. They are usually set to act at a pre-set date or time. These problems can be extremely difficult to find, particularly the deliberate ones. For full security, all the possible backdoors, trapdoors, and time bombs must be found. Some techniques are already in use by computer manufacturers, NSA, etc. Others might be developed from commercial debugging software. Innovative solutions for a security configuration are sought. These solutions may affect software and/or hardware.

AF86-47. TITLE: Phase Shifters for Phased Arrays

DISCRIPTION: Ferrite phase shifters are a major factor in the development and acquisition of phased array radars. They are inferior and expensive; sources of supply are very limited. Other alternatives may either lack the power-handling capability of ferrite phase shifters or suffer greater losses. Alternatives to current 4-bit and 6-bit ferrite phase shifters with respect to performance (insertion loss and peak power handling capacity) and cost (phase shifter and driver) are sought.

AF86-48. TITLE: Fiber Optic Based Millimetric Wave Electromagnetic Field Sensor

DESCRIPTION: Fiber optics are continuing to gain emphasis as a transmission medium. Single mode optical fibers have a bandwidth potential of greater than a Terahertz (10 to power 12 Hz). Single model fiber has also been studied for sensors, e.g. pressure, temperature, velocity, etc. There has been some experimentation with optical fibers as magnetic or electric field sensors with published results sensing fields at frequencies up to a few kHz. This medium (single mode optical fiber) offers the potential of a fully covert, non-mettalic (zero radar cross section) receiver. What is necessary is a method of implementing optical fiber electromagnetic field sensors capable of functioning at gigahertz (GHz) frequencies. Novel material coatings (e.g. magnetostrictive) sensitive to VHF/SHF/EHF frequencies or other known interactive effects such as Faraday rotation induced by an electromagnetic field on an optical beam need to be addressed and exploited. Improvements in the Verdet constant of the optical fiber by special dopants may provide the key to high field sensitivity at these frequencies.

AF86-49. TITLE: Ultra-Violet (UV) Surveillance Optics

DESCRIPTION: Future space surveillance systems may deviate from the traditional infrared (IR) wavelengths to include the visible and low UV wavelengths. Very little is known about the optical specifications for a UV space qualified surveillance telescope. These telescopes will most likely be required to stare at the earth's extended background, the earth's atmospheric limb and objects against the cold background of space. This topic will develop the specifications for a UV surveillance telescope. Tasks will include understanding system requirements and developing initial optical specifications, i.e. materials, surface and figure requirements, and coatings. It would also include a small brassboard demonstration of the optic specified.

AF86-50. TITLE: Magneto-Optic/Dye Polymer Film Quantification

DESCRIPTION: Magneto-optic and/or Dye Polymer materials have proliferated to a point where they can be applied to many mass storage and retrieval applications. Predictions of $10E^{8}$ bits per square inch have been made which represent an order of magnitude advantage over today's magnetic capability with the versatility of read/write/erase. This topic will determine the best material with respect to throughput rates, packing density, signal-to-noise ratio, etc.

AF86-51. TITLE: High Temperature Heat Pipe Technology

DESCRIPTION: Heat pipes have been shown to provide superior growth conditions for the growth of bulk semiconductor crystals. Heat pipes allow for the establishment of isothermal conditions over large areas. This thermal property controls the distribution of impurities, and hence the electrical characteristics of the processed semiconductors. The isothermal conditions that they establish (for bulk growth and epitaxy) are essential to achieving optimum processing conditions for advanced electronic device applications. Currently, this technology suffers from two limitations: the inability to operate at high temperature and the inability to operate at high pressure. The development of technology to fabricate reliable high temperature heat pipes to operate at 1325 degrees C with inert overpressures of 60 atmospheres is required for the processing of III-V compound semiconductors. Innovative fabrication methods are sought.

AF86-52. TITLE: Fluoride Glass Optical Fibers

DESCRIPTION: Heavy metal fluoride glasses (HMFG) are a large family of vitreous materials potentially suited for use as low-loss, radiation hard optical waveguides operating in the 2-4 micron region of the spectrum. These non-oxide glasses may contain zirconium fluoride, barium fluoride, lanthanum fluoride, aluminum fluoride, and sodium fluoride. A research program concerned with techniques for reproducibly fabricating HMFG into multikilometer lengths of optical fiber is sought. Optical waveguides prepared by the proposed method should be provided for testing, and consist of an HMFG cladding, and a protective overcoat. Such a program should be cognizant of the difficulties currently encountered in reliability preparing the HMFG, and suggest solutions. These problems include the short working range of the glasses (i.e., their low viscosity at elevated temperatures), mid-infrared absorption due to oxide, hydroxyl, transition metal and rare earth impurities, light scattering from crystallites and inclusions, and optical losses due to defects in fiber geometry.

AF86-53. TITLE: Adaptive Nulling by Electrical Surface Control of a Reflector Antenna

DESCRIPTION: This topic requests an innovative technique for placing nulls in the sidelobe pattern of a reflector antenna by changing the signal retransmitted from one or more small secondary antennas mounted on the surface of the reflector. This research should include both theory and a prototype for the proposed innovation.

AF86-54. TITLE: Inclusion Free Quartz

DESCRIPTION: Single crystal quartz is used in a number of military frequency and timing applications both in C^3 and in surveillance systems. The availability of superior quartz material is essential for the proper operation of these systems under different environments, since the fabricated quartz resonator is essentially the heart of all frequency control devices. The Air Force and the Army have performed research on quartz material in the past few years with the result that high purity, low dislocation material is now available. One problem that has not been addressed, however, is the presence of inclusions in quartz. In fact, while inclusion counts are performed by

commercial suppliers, there is no standard method for the test, so that the values reported are often meaningless. The presence of inclusions can be damaging in two ways. First, in some quartz, it creates dislocations, formed at the inclusion, which can result in the formation of etch channels during the fabrication of resonators, weakening the resonator. Second, there are now some applications where electronic circuits are directly deposited on the resonator surface. Inclusions near the surface can cause poorly deposited devices which will not function properly.

AF86-55. TITLE: III-V Compounds Trace Element Characterization

DESCRIPTION: Novel and sensitive techniques are being sought for the analysis of III-V compounds such as InP, InGaAs, and GaAs. InP and its lattice matched compounds are the materials of choice for long wavelength (1.1-1.6 micron) fiber optic systems; they also show promise for use in very hgih frequency radar systems. The characteristics of devices made from these compounds are determined by the presence of atomic impurities in both adverse and favorable ways. A quantitative analysis technique to map these impurities is vital to advancement of this technology. Existing techniques are limited by mass interferences; for example, measurements of iron (Fe) in a silicon (Si) matrix are obscured by the concurrence of 28 Si_2 and 56 Fe. Both Fe and Si are important impurities in III-V compounds that must be accurately measured in parts per billion.

Sensitive analysis methods which can selectively discriminate against such interferences are being sought. It is desirable that these techniques allow for a depth profiling capability. A priority will be placed on methods of analysis which have the potential for high depth and lateral resolution in the ppb range.

AF86-56. TITLE: Superconducting Millimeter Wave Phase Shifter

DESCRIPTION: Develop a programmable 360 degree single bit phase shifter, employing superconducting electronics technology, suitable for incorporation into a millimeter wave phased array antenna. The phase shifter should employ planar construction techniques and should operate in the wavelength region around one millimeter. Device construction should emphasize simplicity, with a minimum number of nonlinear switching elements and programming should be by means of an external DC bias. Performance should emphasize broad bandwidth and low insertion loss for low power (receive only) application. Although only a single device is required to be constructed and demonstrated, the construction should anticipate the potential future need for large scale reproducibility with a minimum of variation in electrical characteristics between individual devices. In addition, the design should be compatible with a potential future extension to a larger number of phase shift increments.

AF86-57. TITLE: Hermetic Coating of Fluoride Glasses

DESCRIPTION: Recent advances in materials processing have provided the optics community with a wide array of low distortion, low loss optical materials. However, many materials which are chemically stable in inert environments may be subject to corrosion and/or erosion in operational environments. Moreover, many materials which are otherwise attractive for multispectral applications are compromised by some susceptability to corrosion in even relatively benign

environments. For such materials to be suitable in operational environments, as optical components or optical waveguides, their surfaces must be protected in some fashion. The heavy metal fluoride glasses (HMFG) are a good example of such materials. These non-oxide glasses may contain fluorides of zirconium, barium, lanthanum, or aluminum. Innovative techniques are sought for hermetic coating of heavy metal fluoride glass in bulk form while maintaining the optical transparency of the glass, as well as in optical fiber form. The contractor will be asked to prepare or acquire the necessary glass and fibers.

AF86-58. TOPIC: Remote Sensing of Meteorological Parameters

DESCRIPTION: The purpose of this effort is to develop spaceborne sensors to measure meteorological parameters to the accuracy required by the Air Force. The sensor in use by the Defense Meteorological Satellite Program (DMSP) meet the primary requirement for cloud cover imagery. The "mission" sensors provide much useful data, but improvement in their capability is desired. New measurement techniques or approaches, improvements in critical sensor components, subsystems, and proof of concept sensors for use on future DMSP spacecraft are desired. These improvements must be consistent with the limited power and size onboard the spacecraft. examples of the parameters desired are clear air turbulence, surface temperature, snow and landlocked ice cover, soil moisture and sea state. Snow and landlocked ice cover is qualitatively measured using the imagery from the OLS. It can determine snow cover under cloud free conditions only (resolution 0.3 nmi). The SSM/I passive microwave sensor to be flown in FY87 will have the ability to detect ice cover with resolution approaching 10 nmi.

AF86-59. TOPIC: Launch Vehicle Cost Model

DESCRIPTION: A requirement exists to conduct research towards development of a parametric cost model to assist analysts in formulating independent assessments of program costs. The tasks involved are:

a. Develop a comprehensive data base:

- Collect historical launch vehicle data that represents actual development, and launch services costs.

- The data base must be representative of cost behavior; i.e., a realistic reflection of redirections, delays, reconfigurations, etc., and the resultant impacts. Data must be normalized to reflect technology advances and lessons learned.

- Categorize the historical data into typical systems, components, functions, etc.

b. Establish physical and performance characteristics of launch vehicles and the performance requirements of launch services.

c. Establish parametric cost estimating relationships (CERs).

Statistically correlate the cost data to the physical and performance characteristics. Establish mathematical relationships between the variables. Establish algorithms to be used as the basis for an automated parametric cost model.

Further activity in this project would be to produce an actual cost model that typifies cost behavior of the technical parameters. The model would be used for consistent and objective cost estimates in concept phase definitions, planning studies and other instances where a parametric cost estimating approach would be applicable. The model would be a micro-based system with a user friendly interface for the analyst. Simple procedures would also be developed for each maintenance and update of the data base and the cost estimating relationships.

AF86-60. TOPIC: Doppler Lidar Wind Sensors and Differential Absorption Lidar (Dial) Sensors

DESCRIPTION: Spaceborne Lidar sensors have the proven potential of measuring global horizontal wind velocities by measuring the doppler frequency shift of laser radiation backscattered from atmospheric aerosols. Spaceborne DIAL sensors have the potential of measuring temperature and moisture profiles with great accuracy and vertical resolution using the absorption bands of O_3 and H_2O, respectively. There is also potential for quantified measurement of visibility using Lidar sensors. The goal is to develop active Lidar sensors for DMSP spacecraft capable of satisfying validated requirements for wind, temperature, moisture and visibility.

The difficulty lies in the development of laser sensors with the necessary lifetime (two to three years at a 10 Hz repetition rate), wavelengths (tunable for DIAL), energy (2-10 joules/pulse), laser efficiency, lightweight optics, efficient detectors, and accurate data processing algorithms.

AF86-61. TOPIC: Solid State Laser Pumping Efficiency

DESCRIPTION: The use of solid state lasers in space is limited by the efficiency in the laser sources. This is primarily due to the inefficient coupling of pumping energy used to excite the lasing medium to energy level required for the spontaneous and stimulated emission of photons to take place. Most solid state lasers are currently pumped using flashlamps. This is inefficient because of the broadband nature of the flashlamp being used to pump a laser medium with a narrow absorption band. The efficient conversion of flashlamp emissions to a more narrow bandwidth could increase efficiency. Laser diodes are a potential narrow band pump source. They have been used in pumping low power level Nd:YAG lasers in laboratory conditions. The laser diode temperature tunability makes temperature stability a critical issue. The ability to fabricate large laser diode arrays has yet to be adequately demonstrated. The lifetime of the laser pumping mechanism is another critical issue. The goal is the development of efficient laser pumping techniques with the ability to provide laser output power of at least 2 joules/pulse at 10 Hz over a three-year untended

lifetime. The laser mediums considered most likely to be used in the near term are Nd:YAG and the tunable sources Alexandrite and Titanium:Sapphire.

AF86-62. TOPIC: High Quantum Efficiency Photocathodes for 1.06 μm

DESCRIPTION: Nd/YAG lasers are currently planned to be used in future DMSP Doppler Lidar wind sensors. The efficiency of the commercially available photocathode materials leaves a lot to be desired in the 1.06 μm region (less than 0.1%). Improvement in photocathode quantum efficiency will reduce the required laser transmitted power and consequently, the power required by the laser from the spacecraft. In the past, more efficient photocathodes in this region had been manufactured (e.g., Varian), but these are no longer available. The material considered very promising at this time is GaAlAs. The goal is the development of a photocathode with a quantum efficiency at 1.06 μm of more than 1%.

AF86-63. TOPIC: Multiple-Band EHF/SHF Antenna Concepts

DESCRIPTION: As communication satellite payload throughput requirements increase, available resources become scarce. One solution to conserving resources is to utilize antennas designed for several different frequency bands (SHF-EHF, for example) to meet system needs. A first effort towards that solution, is designing dual-band transmit/receive (T/R) antennas of high resolution and gain. These designs should then evolve to handle two T/R bands with one antenna, permitting full duplex operation across each frequency band.

Task output will be proposals for designs capable to being built and tested. Analytical support for conceptual designs should be supplied with task output.

AF86-64. TOPIC: Test High Efficiency High Power Diodes

DESCRIPTION: Space Division needs to demonstrate the operation of high performance 20 GHz GaAs IMPATTs in a power combiner/amplifier at 19.5 to 21 GHz. Power combiner should be capable of operating in a 20 Watt, 40 Watt and 60 Watt mode with 30 dB, 40 dB and 50 dB of gain respectively. All diodes will be GFE and capable of over 7 Watts power output and over 20% power added efficiency. Maximum allowable temperature rise at the junction is 175°C for diode operation. Amplifier must be space qualifiable without the benefit of active cooling.

Required tests include Bit Error Rate testing, determination of gain and phase variation over frequency, and amplifier stability while the amplifier is in a frequency hopped mode. Contractor must determine the maximum rate of frequency hop for the amplifier as well as maximum bit rate.

AF86-65. TOPIC: Thermal Cooling of a Low Noise Preamplifier

DESCRIPTION: Study the problems and technologies associated with cooling HEMT ar FET devices in a preamplifier from 270°K to 200°K in a satellite

receiver. Study emphasis should be on achieving a simple, lightweight, low cost space qualifiable design. Study must account for parasitic heat transfer associated with actual space operation. Respondees must have experience with active cooling of space components.

AF86-66. TOPIC: Design of a Continuous Real Time Empty Expert System

DESCRIPTION: The components of an expert-system-based control element of a complex system, which includes satellites and networks, need to be specified. Requirements dictate that the control element be able to control either a part of, or the entire system. This includes scheduling, telemetry tracking and commanding, as well as anomaly detection and diagnosis of space and ground based systems. This system will be hosted on a machine that is approximately six times the power of a VAX 780. The development environment will be Lisp based.

A major requirement of an expert system control element is that it run continuously in real time and be interactive. Continuous implies that the inference engine should not terminate when no rule is eligible to fire; the system should automatically restart when the host system boots; and working memory elements that have served their purpose must be removed. Real time operation implies requirements of speed and that a low priority diagnosis can be preempted for a more important one. Interactive implies that the system be able to deal with a command sequence, possibly with pauses between the command elements. Also, this environment will require that multiple expert systems be able to communicate. These considerations of requirements are examples of the type of concerns that must be dealt with. The project will require an in-depth consideration of the problem.

The specific tasks for this effort are:

1. Determine the requirements.

2. Analyze the requirements with a discussion of the rationale and tradeoffs involved for each requirement.

3. Predict and document the projected availability of such a system in 1990.

AF86-67. TOPIC: Specification Methodology for an Expert System

DESCRIPTION: The components of an expert-system-based control element of a complex system, which includes satellites and networks, need to be specified. Requirements dictate that the control element be able to control either a part of, or the entire system. This includes scheduling, telemetry tracking and commanding, as well as anomaly detection and diagnosis of space and ground based systems. This system will be hosted on a machine that is approximately six times the power of a VAX 780. The development environment will be Lisp based.

The study of acceptance and assurance testing of software systems has produced many theories and practices. Some of these are specified as Military Standards. It is not clear if these standards can or should be adapted to expert systems. How does one determine if an expert system works? How should

a military program decide that the builder of an expert system has met the requirements? How should the functional requirements be specified?

As with testing, costing theories and methodologies for software systems abound. Can these be adapted to expert systems? How should one charge for the development of an expert systeem? How does one compare two systems?

The specific tasks for this effort are:

1. Develop a method of specifying the requirements for an expert system. Provide the rationale for the method.

2. Develop a method of determining the cost for the development of an expert system and provide the rationale for the method.

3. Develop a method for acceptance and assurance testing of an expert system and provide the rationale for the method.

4. Analyze the applicability of the existing Military Standards for saftware development to expert systems development.

AF86-68. TOPIC: 44 GHz Low Loss Diode Phase Shifters

DESCRIPTIONN: Diode phase shifters are a key part of certain communications subsystems because of low weight and volume. However, typically the insertion loss is four dB or often greater over wider bandwidths. The subsystem using phase shifters has to be designed to minimize the deleterious impact of the high insertion loss. This is true especially in low-noise front-ends of millimeter-wave receivers.

Test data has shown that the insertion loss can be reduced by making improvements in the diodes and the microwave circuit layout.

Designs are sought which will reduce phase shifter losses and non-linearities, and yet accommodate 5% or greater passbands when operating as high as 44 Ghz in space environments. Operation is required in radiation environments so hardness is a definite consideration when designing fundameental curcuitry and implementing it in hardware.

AF86-69. TOPIC: Low-Cost Autonomous Navigation for Spacecraft

DESCRIPTION: The objective is to develop an attitude determination and control system (ADACS) for Defense Meteorological Satellite Program (DMSP) 3-axis stabilized spacecraft that is lower in cost than the present ADACS. The performance requirements for normal operations are 0.01 degree per axis with jitter of less than 0.03 per second per axis. For autonomous operation, the requirement is for 60 days of operation at 0.12 degrees per axis. The reliability for the system should be 0.9 probability success over three years. The current system uses a celestial sensor, and an inertial measuring unit (IMU) containing four single-degree-of-freedom gyros for primary control. The system uses an earth sensor and a sun sensor to monitor performance. Any proposed development effort must lead to a lower cost system that can meet the requirements of the present ADACS.

AF86-70. TOPIC: Detection of Cruise Missiles from Space Using Sparse Aperature Infrared Technology

DESCRIPTION: The Air Force Space Technology Center (AFSTC) has been assigned a program to develop the enabling technology to accomplish space borne surveillance of cruise missiles approaching CONUS. This effort shall provide an estimate of the effectiveness with which sparse aperature infrared technology is applicable to the cruise missile surveillance mission. This technology offers the capability of spectral, spacial and temporal filtering of dim targets against a highly cluttered background. The contractor shall provide thee necessary personnel, facilities, and equipment to perform the following tasks.

Task 1 - Review the recent government contracted activities of technology assessment of the sparse aperature concept.

Task 2 - Perform a critical design sensitivity study of the reticle spacing requirements, detector uniformity, aperature spacing and mechanical stability requirements, spacecraft jitter tolerance and signal processing requirements for multiple target detection.

AF86-71. TOPIC: Estimation of the Atmospheric Propagation of UHF/VHF Waveforms

DESCRIPTION: The Air Force Space Technology Center (AFSTC) has been assigned a program to develop the enabling technology to accomplish space borne surveillance of cruise missiles approaching CONUS. This effort shall provide an estimate of key technology requirements and limitations imposed on a space borne platform providing cruise missile surveillance while operating in the UHF/VHF regime. This frequency regime offers enhanced target radar cross section which must be balanced against atmospheric attenuation,, poorer range resolution and larger aperatures. The contractor shall provide the necessary personnel, facilities and equipment to perform the following tasks.

Task 1 - Review the UHF/VHF technology concepts proposed in recent government procurement actions.

Task 2 - Prepare an energy/return signal amplitude in dB for the target RCS, antennae, transmitted power, atmospheric propagation in 100 MHz increments from 200 to 1000 MHz. The effects of rain, clouds, auroral activity and diurnal variation are to be quantified.

AF86-72. TOPIC: High Resolution UV Filter

DESCRIPTION: AFGL is engaged in a program for obtaining high resolution ultraviolet (UV) images of missile plumes. To obtain the UV images, filters are used to eliminate the visible radiation. These filters do the job well, but they degrade the resolution of the image. It is desired to design and construct a filter that has the following characteristics:

a. It eliminates visible light by 6 to 8 orders of magnitude.

b. It does not degrade the resolution of the image by more than 5 lines per mm.

c. It does not diminish the transmission by more than 3 orders of magnitude.

d. The center wavelength of the filter is to be between 2100 and 3000 Angstroms.

e. The FWHM bandwidth of the filter is to be between 100 and 200 Angstroms.

AF86-73. TOPIC: Scribe Data Validation and Analysis

DESCRIPTION: SCRIBE (S tratospheric C ryogenic I nterferometer B alloon E xperiment) is a liquid nitrogen cooled high resolution interferometer system designed to measure the infrared emission spectra of the atmosphere from ground and altitudes up to about 30 km. The data will be used to establish the background radiation levels that Air Force electro-optical systems must contend with and to detect the presence and abundance of trace gases in the stratosphere. Emission spectra from several flights of this system are available for several viewing angles (nadir, -4 deg. to 7 deg. elevation). Research is needed to validate the measured spectra in terms of absolute radiometric calibration, spectral calibration and resolution. Also, research is needed in methods to retrieve profiles of trace gases and of temperature from the measurements; as well as in the sensitivity and limitations of such methods.

AF86-74. TOPIC: Initial Processing of Space Shutle Cloud Photographs

DESCRIPTION: Series of photographs of clouds taken during space shuttle missions in 1984 and 85 are to be digitized and rectified. The original film record is 35 mm black and white transparencies. The number of photographs to be processed is approximately 100. The film record and shuttle orbit information will be provided at no cost to the contractor.

Digitization will be in raster-scan mode with resolution at least as fine as the film itself, specifically at least 2000 pixels per scan line and at least 20 grey-shades per pixel. The recording medium is appropriately labeled 9-track tape or more versatile memory device. Physical tapes, discs or chips along with the documentation of digitization equipment, process and recording parameters are the digitization end products.

Rectification means 1) determination of the angle relative to nadir at which each photograph was taken, and 2) specification of the scale at all positions on each photograph. Complete documentation of software developed or tailored for this rectification and a report containing 1) and 2) for each photograph and referenced to each physical tape are the rectification end products.

This effort has a 6 month duration and a $50,000 budget ceiling. More favorable consideration will be given to proposals which provide computer-efficient yet universally readable digitized products.

AF86-75 TOPIC: Electron Gun for Preionization of High Energy CO_2 Tea Laser

DESCRIPTION: The electron beam injection high energy CO_2 TEA laser is a strong candidate for the laser system to be incorporated into the global wind measuring satellite system (Windsat). A number of different electron gun designs for generating the electron beam used to preionize the laser plasma are possible. In addition a number of areas of further technology development have been identified. These include increasing the foil electron beam window lifetime, increasing cathode lifetime, as well as improvements in high voltage electronics design and control. AFGL currently has an electron beam injection CO_2 TEA laser using the General Electric electron gun design as part of a ground based laser wind measurement system. Further work however must be undertaken to improve the reliability and efficiency of such a system before it could be considered for space based operation.

To investigate and recommend suitable systems and technologies for an electron gun capable of supporting a high energy CO_2 TEA laser with the following projected parameters:

Pulse repetition frequency = 0-50 Hz
Pulse length = 1=10 micro seconds
Pulse energy = 5-12 Joules
Chirp = less than 0.2 MHz
Number of shots during lifetime = 10^9

Consideration should also be given to the possible operation of the system in a vacuum environment as well as to the reliability necessary to fly on a satellite platform. Based on the results of this investigation, a following hardware development and testing program may be undertaken.

AF86-76. TOPIC: Adaptive Feedback Controls for Acoustic Cavities

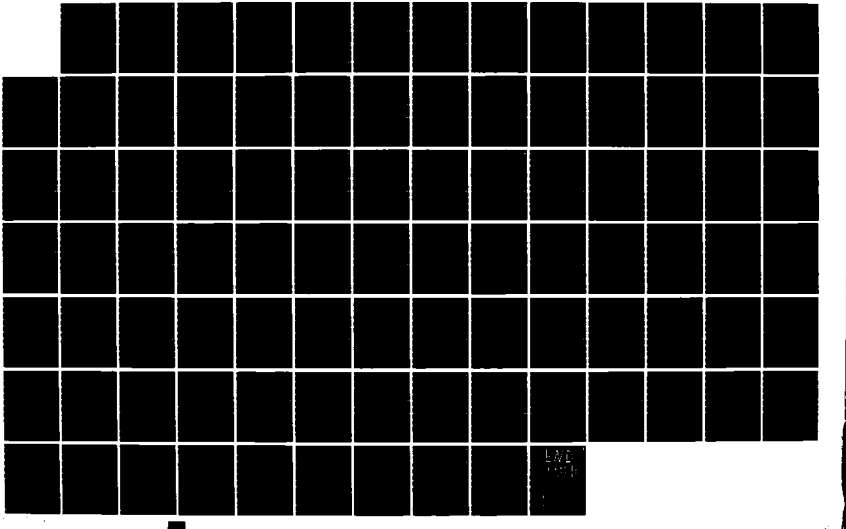
DESCRIPTION: A thorough review of current analytical and experimental methodology to design acoustic cavities in liquid rocket engines shall be conducted. This review will identify key elements in the design of the acoustic cavities. The design parameters will then be optimized for a typical liquid rocket engine. The parameters will also be examined to determine dynamic control systems which would keep the acoustic cavities tuned for maximum damping over the range of engine conditions from ignition to shutoff. The results of this project will provide valuable guidance and data for future advanced liquid propellant engine development work.

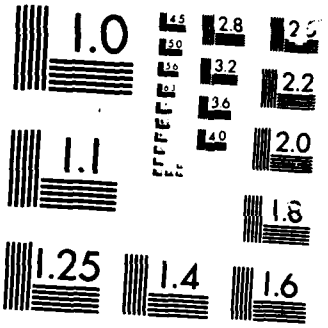
AF86-77. TOPIC: Non Conventional Propulsion Concepts

DESCRIPTION: Bold, new non-conventional propulsion concepts are solicited for launching and maneuvering payloads in space. Non-conventional propulsion includes all propulsion concepts other than conventional chemical rocket propulsion which is presently used by the Air Force and NASA. The specific areas in which the AFRPL is interested include: 1) Chemically bound excited state propellants including free radicals, metastable helium and tetrahydrogen; 2) Electromagnetic and beamed energy propulsion with particular emphasis placed on solar propulsion concepts; 3) Electric propulsion concepts with the main emphasis on plasma devices such as arcjets and self or applied-field MPD devices; 4) Nuclear propulsion including fission, fusion and metastable nuclear states with current interest focused on particle bed reactor fission concepts;

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processing techniques as a means of simplifying and reducing the cost of this process. Specifically, the contractor shall develop, or modify existing, sub-scale equipment to demonstrate the feasibility of continuous processing for solid propellant rocket motor manufacture. Principal solid propellant ingredients include on elastic binder (10-16% by weight), dispersed solid fuel particles (10-20%) and various sizes of dispersed solid oxidizer 9articles. Inert ingredients with analogous behavior may be substituted for energetic ones in this feasibility program.

AF86-81. TOPIC: Diagnostic for Vibrationally Excited Ground State Nitrogen

DESCRIPTION: Vibrationally excited gorund state nitrogen, N_2 is an important energy carrier in several proposed chemical laser schemes. An evaluation of the efficiency of these schemes will depend on the ability to measure number densities in various vibrational levels. A non-intrusive diagnostic is required which can detect densities as low as $10^{13}/cm^3$ in a gas flow containing species such as HF, DF, NF(a), NF(b) and various electronically excited states of N_2.

AF86-82. TOPIC: High Power Microwave Amplifier

DESCRIPTION: Air Force requirements dictate higher power pulse microwave sources with improved efficiencies. One method to help meet these requirements is to phase-lock or couple two or more sources together. Thus, research proposals are requested which will demonstrate the feasibility of amplifying input powers of megawatts to output powers of gigawat. Amplifiers with an operating frequency between 0.5 and 10 GHx, a 50 to 100 ns pulse width, and an efficiency greater than 10 percent are needed.

AF86-83. TOPIC: Phased Array Imaging in Partially Coherent Light

DESCRIPTION: Resolvable space objects may reflect or emit radiation that when propagated over large distances may exhibit partial coherence. The imaging performance of a phased array optical receiver will therefore be affected. Proposer is to develop a mathematical and physical optics model for determining the imaging characteristics of a phased array telescope in partially coherent light.

AF86-84. TOPIC: Pattern Recognition Methods in Civil Engineering

DESCRIPTION: An exploratory study is needed on the utility of pattern recognition techniques in the study of problems with evolving experimental data bases in simulated nuclear weapon effects environments. Such topical areas as ground motion, structural response and damage evaluation are associated with empirical evidence which might be better synthesized and analyzed using modern signal analysis and pattern recognition techniques. These techniques are capable of handling and classifying far more data features than current procedures for purposes of detecting similarities or differences in the response of a physical system to a given input, such as a simulated nuclear airblast or ground shock.

5) Antimatter propulsion which emphasizes antiproton/proton or heavy nuclei annihilation concepts; and 6) Esoteric energy sources for propulsion including the zero point quantum dynamic energy of vacuum space and various multidimensional theoretical developments offering sources of new energies previously unknown. Each of these areas of interest has its special set of problems. Survey programs to find new ideas and study programs to investigate and evaluate highly promising concepts will also be considered when proposed by qualified organizations. Particular attention will be given to revolutionary concepts based on sound scientific principles offering quantum increases in performance and mission capability.

AF86-78. TOPIC: Mechanical Properties of Rocket Nozzle Adhesives

DESCRIPTION: The structural/mechanical and thermal properties of rocket nozzle adhesives are used as an aid in manufacturing and in handling; in a hot motor environment the adhesive does not play any structural or stress bearing role, although its thermal characteristics are important. A general lack of structural property data exists for adhesives used in the major bondlines in rocket nozzles (for example: rubber/composite, metal/composite, and composite/composite interfaces). The objective of this study is to characterize the important properties of the most commonly used bonding agents and adhesives used in the manufacture and handling of rocket nozzles. Properties/parameters that should be considered for study include the following: strength, modulus, microstructure, composition, property degradation during typical manufacturing/handling environments, adhesive application methods, etc. The bonding between the adhesives and materials typically found in rocket nozzles should also be considered; such materials may include carbon-carbon, carbon-phenolic, silica-phenolic, fiberglass-epoxy, graphite-epoxy, graphite, rubber, aluminum, titanium,, steel, etc.

AF86-79. TOPIC: Development of New Thermoplastic Elastometers for Solid Propellant Applications

DESCRIPTION: Solid rocket propellants are currently produced by incorporating energetic ingredients into a chemically crosslinked elastometer binder. These systems are castable and highly filled (84-90% solids by weight). Thermoplastic elastometers offer a unique, alternative approach for making propellants without chemical crosslinking, thus expanding the number of possible manufacturing approaches and dramatically reducing processing costs. The work envisioned here would involve the synthesis (or derivation) and characterization of new thermoplastic elastometers for use as solid rocket propellant binders. These elastometers could be either energetic or nonenergetic. Some of the basic requirements of a thermoplastic propellant binder would include: 1) low cost; 2) wide service temperature range (145 to -65 degrees fahrenheit); 3) compatibility with energetic ingredients; and 4) capable of high volumetric loading.

AF86-80. TOPIC: Continuous Low-Cost Processing Techniques for Manufacturing Solid Rocket Propellents

DESCRIPTION: Solid rocket propellants aree generally manufactured in large vertical mixers, then dump casted into rocket motor casings. For large motors, this process involves pre-batching of ingredients, numerous individual mixes, and a 10-day cure cycle. This program will investigate the use of continuous

AF86-85. TOPIC: Development of the PDA/PATRAN-G Post-Processing Capabilities of the ARCCS Vax for MSC/NASTRAN Results Generated on the CRAY-1S.

DESCRIPTION: With MSC/NASTRAN now being run on the CRAY-1S, the capability for post-processing the results using PDA/PATRAN-G has been lost. Theoretically,, MSC/NASTRAN results can be brought to the ARCCS VAX and displayed using the post-processing capabilities of PDA/PATRAN-G. Currently, MSC/NASTRAN output files are translated by NASPAT into ASCII files and then into neutral file format, brought across to the ARCCS VAX, and translated into VAX readable binary for PDA/PATRAN-G. However, PDA/PATRAN-G will not accept the files for post-processing. It is desired to reinstate this post-processing capability of PDA/PATRAN-G by modification of existing software.

AF86-86. TOPIC: Adaptive Grid Techniques or Use in Computational Fluid Dynamics

DESCRIPTION: High energy laser systems are typically built using a flowing media to control large amounts of head release due to chemical reaction or energy deposition in making the lasing specie. The ability to computationally model these flowfields using the shortest amount of computer time is imperative. One of the methodologies employed to study the effects in lasers whether shock and acousins logical connectivity and adapts to the data, optimizing to several measureable properties of the computational mesh.

AF86-87. TITLE: MATE Interface Connector Assembly (ICA) Standard

DESCRIPTION: The purpose of this standard is to ensure interchangeability of the input/output interface used with modular automatic test equipment (MATE), and provide compatibility between the input/output interface with MATE unit under test (UUT) test adapters. This standard establishes the mechanical and electrical requirements of the I/O interface. These requirements include physical size, fastening/locking method, mechanical and electrical interlocks, operator safety, method, mechanical and electrical interlocks, operator safety, method of connection, pin type, pin field, and total number of interface pins.

Research is required to update the MATE ICA to keep pace with emerging test requirements and interface connector capabilities. The following ICA areas require research:

a. Does the existing standard need an increased digital capability? How do we make the digital area transportable when there are so many different logic levels used on weapon systems? Should the MATE ICA standard permit differential line drivers and receivers at the interface to preserve high signal quality and maintain system throughput?

b. The existing MATE ICA standard provides a rigid partition between stimulus and measurement capabilities of the automatic test equipment (ATE). Can we provide a universal pin capability in the ICA in which many of the pins at the ATE interface can be switched between

stimulus and measurement functions under test program control.

c. Research is needed in the area of pin electronics to determine if this technology can be inverted into the MATE ICA standard without impacting the MATE objective to achieve test program set interoperability between MATE ICAs.

d. Identify the quantity and types of test signals required to satisfy current and future AF test requirements.

e. Survey new technologies in this area and identify possible improvements to the MATE ICA that would increase its performance, decrease its size, decrease life cycle cost, and improve test program set transportability.

AF86-88. TITLE: Electro-Optic Unit Testing

DESCRIPTION: Research is required to assess the automatic test requirements for electro-optic units under test (UUTs) and identify automatic test equipment (ATE) interface standards for testing these devices. Electro-optics is being used in a wide variety of applications and there does not exist a set of accepted standards for testing electro-optic UUTs. Substantial savings can be achieved if we can identify suitable modular automatic test equipment (MATE) testing methodologies and standards for interfacing the electro-optic UUTs to the ATE.

AF86-89. TITLE: Chemical Agent Dosimeters

DESCRIPTION: The purpose of the dosimeter is to detect and visibly warn of accumulated doses of chemical agents. The device must be sufficiently sensitive to provide warning prior to miosis (pupil dilation, tunnel vision, etc.) effects being encountered by personnel. The dosimeter must withstand use in the field in a combat environment. It should be small, lightweight, inexpensive, easily renewed/reset, and rugged. It is desirable for the dosimeter to indicate what class of chemical agent is being detected since the treatment varies. Differentiation between nerve agents and blister agents is sufficient. This device would provide individuals with a means to monitor their own exposure to chemical agents. It is an adjunct to the primary detection devices which provide indication of area contamination. Use of the device can provide improved morale by removing uncertainty as well as avoiding unnecessary treatment which is incapacitating by itself.

AF86-90. TITLE: Filter Life Indicator

DESCRIPTION: The purpose of the filter life indicator is to show when an air filter has nearly reached the end of its useful life. The filters are used to remove chemical and/or biological agents from the air. There are two types of filters that need indicators: personal chemical mask filters and large filters in the hardened shelters. It is desirable for the device to activate both audible and visual alarms, especially for the

large filters, when approximately 75 percent of the useful life of the filter is reached. The indicator must provide advance warning so that the filter does not pass chemical or biological agents, even if the filter has been exposed to some non-hazardous, but still contaminating, vapor. The device must be cheaper than simply changing the filter on a regular basis. It is desirable that the device provide alarm within 15 seconds and that graceful degradation be observable.

AF86-91. TITLE: Aluminum-Graphite Fiber and Titanium-Graphite Fiber Composite Structural Materials

DESCRIPTION: The purpose of the composite materials will be to provide aircraft structural components with high strength, high temperature, electrically conductive, and long service life properties that can be produced using cost effective, state of the art manufacturing technology. The weight of the composite panels shall be less than equivalent strength metal panels. The metals and fibers must be atomically bonded to provide the required properties. The utilization of powder metal technology may be considered. The proposal tasks shall include tests of specimens to verify the required properties and submittal of specimens.

AF86-92. TITLE: Networking Engineering Workstation Network With Other Computer Systems

DESCRIPTION: The Deputy for Engineering, Aeronautical Systems Division (ASD/EN) is currently in the process of procuring 32-Bit engineering work stations. The contract for these engineering work stations is projected to be signed not later than 1 July 1985. These work stations are to be placed throughout the organization and used by the approximately 1600 assigned engineers. This contract includes a network protocol for the engineering work stations in a UNIX operating system environment.

The task at hand is to develop a network linking these workstations with the Digital Equipment Corporation Vax 11/782's, 11/780's and 11/750's currently in place. Research should be done to find the most cost effective way of establishing this network.The concept developed should allow for easy addition of computer systems from numerous vendors. The research should consider not only the current environment, where ASD/EN is located in at least eight (8) buildings throughout Area B, but also the proposed environment where EN is located in a single complex. The concept should provide sufficient redundancy or alternative paths to prevent a single point of failure from disrupting a significant portion of the network.

The concept developed should span the planning and implementation stages of this network. Established check points should be included in the plan to ensure correct installation.

AF86-93. TITLE: Automated Technical Presentation Package

DESCRIPTION: The Deputy for Engineering, Aeronautical Systems Division (ASD/EN) has procured over ninety Air Force Standard Zenith Z-100 micro-

computers. The Z-100's considered will run under MS-DOS 2.1. Utility packages such as dBASE II, Lotus 123, and Wordstar are used as tools in the accomplishment of mission objectives. Results are transformed to overhead slides for use in support of engineering/technical briefings.

The task at hand is to develop a system by which the briefer could assemble an automated presentation on the Z-100 that could integrate test and graphics generated by the utility programs. The briefer would then be able to take this presentation, via a floppy disk, to a Z-100 connected to a Large Screen Projection System (LSPS).

The system developed should emphasize ease of use and employ a direct method of developing a comprehensive, professional automated presentation. The Z-100 operating the LSPS should be developed as a complete presentation system in itself. Software for designing presentations on selected Deputy Z-100's is a requirement. The concept developed should span the planning and implementation stages of this system.

AF86-94. TITLE: New Concepts and Innovations For Aeronautical Systems/Subsystems

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical system/subsystem research, development, and procurement. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, transatmospherics, etc). Emphasis is placed on potential long term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, applications of artificial intelligence, innovative R&D organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF86-95. TITLE: Three Dimensional Sound for Cockpit Information Transfer
DESCRIPTION: Pilot workload has increased tremendously with new generation vehicles, and display technologies have proliferated. These display technologies have all been directed to the visual sense, and with the exception of a few aural warning devices, the sense of hearing has been neglected.

A recent innovation has been the development of three dimensional sound. Three dimensional sound not only provides "presence" but also a sense of direction of the origin of the sound. With proper development and application, this technology could provide rapid information transfer to the pilot. For example, in conjunction with a radar warning receiver, information could be conveyed as to threat identification, relative distance, relative closing rate, and direction. Other potential areas of application are flight simulation and training. Maturation of this technology could provide a significant increase in aircrew capability.

AF86-96. TITLE: Sensor Penetration of Dust Clouds
DESCRIPTION: The objective of this topic is to develop an airborne sensor capability to allow detection and identification of small objects under degraded conditions caused by a high count of particles (e.g., ash, soot, dust, moisture) suspended in the atmosphere, such as could be expected during a severe dust storm and following natural or man-made explosions (e.g., volcanic, conventional, nuclear).

The sensor must be able to locate airborne objects against either sky or ground clutter, as well as objects actually on the ground. The sensor resolution should be capable of detecting and classifying the object. A resolution capability to identify objects is highly desirable.

AF86-97. TITLE: Weight Prediction Techniques for Single Stage Transport Systems

DESCRIPTION: Innovative structural and thermal protection system weight prediction techniques are sought for application to conceptual design studies of single-stage, transatmospheric transport systems which have self-contained landing gear and are capable of horizontal takeoff and landing from conventional runways. Methods are needed for vehicles having takeoff gross weights in excess of one million pounds. Propulsion systems range from all-rocket to hybrid rocket-airbreathing configurations, having storage and cryogenic propellants. Structural concepts include both hot and thermally protected primary structure. Conventional empirical weight equations for transport aircraft structural components are not suitable for this kind of vehicle because of the unique environmental requirements and the structural arrangements that must be used to minimize structural fraction and provide tankage for propellant quantities that are large in ratio to takeoff gross weight. Weight prediction methods must be sensitive to variations in loading and environmental conditions, to durability and damage tolerance considerations, to the application of conventional and advanced materials and structural arrangements, and to variations in vehicle size and design criteria. Methods must account for the weight of material derived from simplified load/allowable relationships plus the weight increments that characteristically must be added to these basic weights in order to achieve practical realistic weight estimates. Empirical methods, when appropriate, may be considered for use in part of the methodology.

AF86-98. TITLE: Submicron VHSIC for Enhancing Aircraft Self-Sufficiency

DESCRIPTION: There is a need to show how the self-sufficiency of deployed aeronautical weapon systems would be enhanced through the use of submicron very high speed integrated circuits (VHSIC) for embedded diagnostics and embedded training. The operational benefits and penalties need to be quantified in relative terms; i.e., relative to a fleet without these embedded features and relative to a fleet with these features but using non-submicron VHSIC technology.

AF86-99. TITLE: Means of Modifying Local Hypervelocity Flow Fields

DESCRIPTION: This project shall define and investigate innovative methods of modifying the flow field around vehicles traveling at hypersonic speeds at altitudes above 100,000 ft. The intent of this project is to define non-mechanical methods of selectively modifying the flow field to, for example, control local aero heating, decrease the interference on sensors, and improve control surface effectiveness. The methods of achieving the flow field modification, estimates of the systems necessary to achieve the flow field modification, and the effectiveness of each approach shall be determined.

AF86-100. TITLE: New and Novel Ramjet Cycles

DESCRIPTION: This project shall define and investigate innovative aero propulsion engine cycles that utilize the energy released from the recombination of disassociated O_2 and N_2 which is produced by hypervelocity flight. The potential application of this technology is for vehicles operating above 100,000 ft. altitude. This program should include a literature search of previous or existing work in the area of scramjet engine and hypersonic nozzle design.

AF86-101. TITLE: Innovative Advanced Packaging Techniques for Future Avionics Systems

DESCRIPTION: A number of technological advances in the area of microcircuits and materials are creating a design environment which will require a major rethinking on how we package avionic systems in the next century. With the advent of very high speed integrated circuits (VHSIC), microwave integrated circuits, GaAs phased arrays, composite materials, etc., the opportunity to design innovative packaging techniques is essential to take advantage of these technology advances. Since very high mean time between failure (VHMTBF) will result from the ability to have redundance, self heal systems and SW reconfiguration capability, the avionic systems may exceed the life of the vehicle. Packaging techniques which look at avionic systems as an integrated part of the aircraft structures or part of the pilot equipment should be considered. An example of potential areas of investigation would be the helmets to house a major portion of avionic sensors. Helmet avionics may also become mission related. This could result in standardized platforms with man carry on missionized interface avionics. This topic is targeted to innovative approaches beyond rack mounted or line replacement unit packaging techniques.

AF86-102. TITLE: Survivable Tactical Aircraft Basing Concepts

DESCRIPTION: This project shall define and investigate innovative concepts for basing tactical aircraft that are less vulnerable to damage from attack by non-nuclear weapons. The objective of this project is to develop fixed basing concepts for tactical fighter, interceptor, and attack aircraft that are significantly less vulnerable to attack and can

sustain normal operations while under attack or can quickly (less than 10 minutes) return to normal operations following attack. This project shall also investigate innovative methods of supporting aircraft during taxi, takeoff, and landing. The systems so defined are intended to replace conventional mechanical landing gear systems. Emphasis should be placed on new approaches--not previously investigated--and significant improvements in previously defined alternative systems such as air cushion landing systems. The investigation shall consider both conventional and short/vertical takeoff and landing aircraft.

AF86-103. TITLE: Infrared (IR) Sensor Simulation

DESCRIPTION: The objective is to evaluate known IR phenomena and to identify those effects most significant from the standpoint of effectiveness in training simulation; that is, effects which contribute to the quality and effectiveness of the training. The immediate task is to collect existing IR research data and analyze it, using the contractor's expertise in IR sensors and IR operational use. The desired results would be candidate IR sensor effects and either display or data base parameters, that can then become appropriate subjects for experimental studies on the part of the Air Force.

AF86-104. TITLE: Tech Mod for Small Businesses Supplying Products to the Propulsion Sector

DESCRIPTION: The Tech Mod Program addresses the development, integration, and implementation of new manufacturing technology that can be applied to the propulsion sector. Small businesses that are currently either supplying machine tools or processing equipment to the propulsion sector, or companies that are supplying parts and hardware to the propulsion sector are encouraged to submit proposals. The proposals may either relate to improvements that are or will be offered to the propulsion sector or improvements that are or will be implemented within the company offering the proposal and that will significantly reduce the cost of propulsion systems to the United States government. The types of work included in Tech Mod are study, development, and implementation efforts relating to:

a. Enabling technology;

b. Design of material handling, storage, and movement systems;

c. Design of special tools, test equipment, and inspection equipment;

d. Design and integration of factory layout and work cells;

e. Qualification of new processes, cells, and work centers;

f. Qualification of hardware produced by new processes;

g. Integration of new technology into the production systems;

h. Management information systems (internal to the company only).

AF86-105. TITLE: Operational/Maintenance Histories in Measuring and Predicting Reliability, Maintainability, and Operational Cost for Aircraft Engines

DESCRIPTION: The objective is to develop a set of maintenance histories of current fighter aircraft engines to use as a baseline for new engines. The analysis will demonstrate the methodology and the technique used in the development of the specific operational histories and consolidate the data to allow direct one-to-one comparison. The technique will utilize available data allowing the integration and traceability between the different levels of maintenance to identify the major hardware maintenance cost drivers.

AF86-106. TITLE: Display Techniques for Pilot Interactions with Intelligent Avionics

DESCRIPTION: Over the next few years, intelligent systems will be developed to analyze air threat information and identify, characterize, and prioritize threat aircraft. Combined with advances in high-speed, three-dimensional graphics, such systems have the potential to greatly increase the pilot's situational awareness and combat effectiveness. However, this potential can only be reached if presentation methods and formats are developed to provide the pilot with this information in an easily and quickly digestible form. In view of the above, research is needed in the following areas:

a. Development of methods of displaying relative three-dimensional positions of threat aircraft along with their identification and relative threat value. Exploration of the uses of alternate viewpoints in concert to provide a more complete situation description.

b. Development of formats for displaying hostile formations, their intentions, flight path predictions, sensor and weapon coverage envelopes, and times to intercept.

c. Development of methods of displaying sensor information certainties-uncertainties and possible alternatives of identification and intent of threat aircraft.

d. Development of techniques for interactively modifying an individual display or display suite to enhance the pilot's understanding of the environment (e.g., zoom, alternate views, voice data).

AF86-107. TITLE: Growth of Laser Quality $AgGaSe_2$

DESCRIPTION: Nonlinear laser materials are useful for extending the wavelength range of a given laser source through doubling, mixing, and parametric oscillation. Silver-gallium selenide ($AgGaSe_2$) is one nonlinear material which shows promise as an optical parametric oscillator.

With a pump laser operating at 2.0 microns, continuously tunable output in the 2.5 - 5.0 micron region should be possible. However, use of $AgGaSe_2$ in high average power applications (greater than 1W) requires that crystals be grown with extremely low absorption coefficients in the mid-IR to prevent thermal degradation of performance and to reduce insertion losses. Also, bulk and surface damage thresholds of $AgGaSe_2$ crystals must be high enough to prevent crystal damage by the laser pump and output beams.

The goal of this program is to grow large (1 cm X 1 cm X 3 cm) single crystals of $AgGaSe_2$ with absorption coefficients less than .05 cm-1 in the 2 - 5 micron region and surface flux damage thresholds greater than 50 MW/cm2 when irradiated with Q-switched laser pulses. Commercial availability of improved $AgGaSe_2$ would make possible a high average power, tunable IR laser useful in a number of commercial, scientific, and military applications.

AF86-108. TITLE: Long Life Harmonic Generation Cells

DESCRIPTION: The Air Force has a number of programs which rely on the use of either angle tuned or temperature-tuned optical harmonic generators. A significant problem in the utilization of deuterated crystal doublers such as cesium dideuterium arsenate is deuterium loss from the crystal itself. This probably is due to an exchange process involving transports of hydrogen and deuterium, probably as H_2O and D_2O, from and to surroundings, respectively. Potential culprits are ordinary hydrogen-silicones for mountings, films on windows, and inadequate degassing of cells. Transport apparently occurs because of temperature cycling of the crystal holder, or of the environment. Cells are required that are sufficiently rugged for an airborne environment, prevent deuterium loss from the doubling crystal, have free apertures of approximately 2 cm^2, can heat as well as cool the doubling crystal to maintain a constant and near uniform temperature, and can double neodymium lasers with average powers in excess of 100 watts. If such cells were available, the lifetime issue associated with deuterated doubling materials would be eliminated.

AF86-109. TITLE: Fiber Distribution Network

DESCRIPTION: Optical techniques for signal distribution in phased-array antennas are of increasing importance as the trend toward higher system operating frequencies reduces the back-plane area available for each element. The use of optical fibers to distribute the various signals required by phased-array antennas is dependent on a distribution network consisting of up to 10,000 fibers. Techniques are required that minimize splitting and input/output coupling losses. The objective of this program is to demonstrate single mode coupling techniques for a 100 to 1 fiber splitter with less than 5% variation in amplitude between any of the output fibers. The coupling techniques should not introduce significant phase errors for microwave modulated light. These coupling techniques will provide a significant step toward applying fibers to radar operating at x-band and above.

AF86-110. TITLE: Organic Optical Parametric Oscillators

DESCRIPTION: The Air Force has need of lasers that are tunable over the visible and near infrared wavelength region. A demonstrated technique to accomplish continuous tunability involves the use of nonlinear materials in cavities, that function as optical parametric oscillators (OPO) or optical parametric amplifiers (OPA). Present OPOs are low power devices (1mw average power). While these devices are useful for laboratory spectrographic work, their low power is of little use for military applications. New organic nonlinear materials are being developed that have very high nonlinear coefficients and high damage thresholds. The objective of this program is to demonstrate the use of these materials in an OPO configuration to efficiently produce 100 milliwatts at 10 hertz with continuous tuning over at least 50% of the 500 to 1000 nm band. Approaches should take advantage of the nonlinear qualities of the organic materials to achieve a simple design for the OPO and its tuning mechanism. If this use of nonlinear organic materials is shown to be feasible, tunable lasers could be produced that are as simple in design as present nontunable lasers.

AF86-111. TITLE: Electron Multiplier Stability

DESCRIPTION: Because of ever increasing needs for high spatial resolution, high sensitivity sensors, it is becoming more attractive to use microchannel plates as an electron multiplier gain stage between photocathodes and detectors. This, to a large extent, circumvents detector and amplifier noise. Unfortunately, these plates have had limited lifetime while in use. Aging results in reduced gain and spatial non-uniformity. There is no known fundamental reason prohibiting long life. Possible causes for performance loss are residual gas and impact ionization interacting with open chemical bonds resulting from improper surface chemistry. Research and analysis are needed to determine the actual degradation mechanisms for microchannel plates. This is expected to result in identification of processes or methods of manufacture or curing which will substantially improve device lifetime.

AF86-112. TITLE: Infrared Target Modeling for Image Understanding Applications

DESCRIPTION: The interpretation of infrared (IR) imagery by humans or artificial intelligence (AI) methods requires a detailed understanding of the phenomenology associated with the infrared spectrum. The IR modeling of man-made targets (e.g., tanks, trucks) provides an analytical mechanism for embedding the phenomenological knowledge into an interpretation system. Research is required to define the proper level of model fidelity (thermal and spatial resolution, etc.) to support each stage in the interpretation process, to define the appropriate geometric representation required for the model theory used at each level, and to define the analytic relations between the representation levels that are necessary to support the use of AI reasoning techniques on the sensed target.

AF86-113. TITLE: Symbolic RF Signature Prediction

DESCRIPTION: Model-based vision systems have primarily been developed for photo-type inputs; however, they have not been actively researched for RF imaging sensors. Research is necessary to develop/adapt electromagnetic (EM) models (e.g., physical optics, geometric theory of diffraction) for use in these systems for applications concerning man-made object recognition. Possible research topics include:

a. Geometric Object Representation: The method of input to EM models, which entails representing the physical object in terms compatible with the model program, is quite tedious and complex requiring significant expertise. Capturing this expertise as part of the model-based vision system is important.

b. EM Model Compatibility: EM models normally output numerical information representing the combined effects of the total object scattering characteristics. Models and geometric representations that are decomposable, that are efficient yet rigorous, and that provide symbolic information are necessary for vision system compatibility.

AF86-114. TITLE: Design Automation Entity-Relationship Modeling

DESCRIPTION: A major issue in developing design automation technology for digital systems is the definition of formal entity-relationship (ER) models for multiple levels of design abstraction. Formal ER models must be created for the specification of each design level's requirements and for the hardware, software, and functional design components used within each level. For example, precise and internally consistent ER models are required for such system requirements as risk, availability, survivability, and maintainability.

Intuitively, multilevel digital system design can be visualized with a bullseye diagram comprising Physical Design at the center, Processor Functional Design as the first shell surrounding Physical Design, Multiprocessor Functional Design as the next shell, and System Level Requirements as he outermost shell. System Level Requirements propagate downwards towards Physical Design. Each design level physically implements part of the system requirements, transforms these requirements in some way, or propagates appropriate requirements to lower design levels. Physical Design spans all levels of functional design at the chip, board, motherboard, and box levels. It includes electronic design (layout, routing, packaging, wiring/cabling), electrical design (power distribution, power supplies), thermal design, mechanical design, and structural design. Processor Functional Design issues include microprogrammed horizontal machines, hardwired synchronous machines, systolic arrays, automatic microcode compliation, and automated microcode compiler targeting. Multiprocessor Functional Design includes distributed system design issues involved in networking distributed operating systems and distributed executives. Requirements, both at the system level and lower design levels, are specification models that logically imply system physical

implementation. Requirements models are independent of system application domains in the same way programming languages are independent of application domains.

The objective of this research is to define and verify high-level ER models for multilevel digital system design--specifically, models for System Level Requirements, for requirements at lower design levels, and for functional, software, and hardware design components likely to be used in each design level. Potential follow-on work will expand the high-level ER models into more detailed ones and will demonstrate the utility of these models in automated design synthesis.

AF86-115. TITLE: Multiprocessor Design Aids

DESCRIPTION: Several building-block multiprocessor architectures are becoming available to designers of embedded military electronic systems. These architectures allow a mix/match selection of processor modules to be flexibly configured to meet a range of system requirements. For example, one set of requirements may require several identical processors on the same linear bus; another set of requirements may demand several different processors connected by a hypercube bus configuration. Modularity and reconfigurability in the System Executive and Operating System support this reconfigurability, in ways similar to commercial computing systems. The amount of reconfiguration flexibility varies from architecture to architecture. Current architectures include the Westinghouse VHSIC Brassboard, the Raytheon Advanced Onboard Signal Processor the IBM Common Signal Processor, the Bell Labs Enhanced Modular Signal Processor, and the Bell Labs Generic Signal Processor Architecture.

To assess the suitability of candidate architectures to meet a specific set of system requirements, formal design tradeoff studies must be performed. Currently these studies are expensive and costly, because they are done with human experts by hand. However, the development of appropriate Expert System design aids for multiprocessor architectures is feasible with today's artificial intelligence technology. Such multiprocessor design aids would both greatly shorten the time and cost of contracted design trade off studies, as well as provide the government with expert design aids to perform many such studies in-house, at further time/cost reductions.

The objective of this research is therefore to:(1) study the structure and function of existing multiprocessor building-block architectures; (2) define structure and behavior (both internally and from the user's perspective) of an expert design system targeted to one or more multiprocessor architectures, and capable of addressing a broad range of system design requirements.

AF86-116. TITLE: Expert System for Pilot Decision Aiding

DESCRIPTION: In recent times, avionics systems have evolved to dramatically enhance the effectiveness and survivability of military aircraft.

However, the point will quickly be reached when further advances are offset by the inability of the human pilot to rapidly assimilate all the information presented to him. Something must be done to aid the pilot in making sound decisions under combat conditions, while taking full advantage of all available data. To address this need, a comprehensive program in the field of artificial intelligence (AI) is planned that will yield systems that are smart enough to integrate, in real time, vast amounts of data for the pilot. While many approaches will eventually be investigated, present areas of interest are focused on real time decision aiding. An expert system utilizing AI concepts could make recommendations to the pilot based upon its own rule table and knowledge database. The rule table would be specific to the area the system is "expert" in, and the knowledge database would be dynamically updated to reflect information derived from other avionics systems. The pilot would then make the final decision. In view of the above, research is needed in the development of AI techniques for application to expert systems in areas that include the following:

a. Expert system for aircraft route planning. The system would utilize stored terrain data, cultural features, and threat information to plan the most survivable route. Maximum advantage would be taken of terrain masking and threat characteristics, with real time dynamic route re-planning in response to changing threats or mission requirements.

b. Expert system for threat reaction aiding. The system would recommend various lethal or non-lethal countermeasures according to the mission requirements, threat characteristics, and the overall situation at that moment.

c. Expert system for overseeing the operation of other expert systems in the avionic suite of an aircraft. This "meta" expert system would coordinate data and decision information among all the other expert systems and ensure that their combined responses make sense.

AF86-117. TITLE: Distributed Kalman Filter Architectures

DESCRIPTION: Recently developed navigation equipment, such as the GPS Phase II User Equipment, have been implemented as self-contained navigation systems. These systems often contain their own Kalman filter, which either acts to smooth data when the unit is unaided, or as an estimating filter when inertial data are accepted. This type of implementation is suitable for austere systems, but causes difficulty when attempts are made to integrate several sensors of this level to form a hybrid navigation system. Often the hybrid system will take the form of a "cascaded" filter with one or more filtered sensors sending data to a central filter, with a potential loss of optimality and filter stability in certain circumstances. Integration is also hampered by difficulty in correlating the time of the measurements in different sensors, the different filter cycle times required by the sensors, and the different measurement rates of the sensors.

The objective of this work is to develop architectures and design techniques which will allow hybrid systems consisting of various independent sensors communicating via a mux-bus to achieve the performance and stability that the sensor set should provide. These techniques should minimize measurement timing sensitivity, and require reasonably low data transfer rates over the bus. The techniques developed should apply partitioned square root or upper diagonal filter algorithms to produce multi-rate filtering that permits significant decoupling of processing requirements for higher and lower rate sensor outputs while maintaining near-optimal estimation. These techniques can then be extended to the more general case of distributed filtering across the distributed navigation suite.

AF86-118. TITLE: Fiber Optics Infrared Sensor Device

DESCRIPTION: The exact placement and packaging of infrared imaging sensors aboard high performance aircraft is dictated by concerns for aircraft radar cross section and aircraft aerodynamics. Conformal packaging of sensors can meet these concerns. In order to control cost and meet packaging considerations, it is desirable to time share multiple independently positioned optics with a single detector/dewar assembly. The Air Force desires a device that would demonstrate the ability of an imaging system's optics to be remotely located away from the system's detector/dewar assembly.

One example of such a demonstration device would be a fiber optics bundle. This would involve forming optical fibers and integrating these fibers into an optical bundle. The relative position of each individual fiber would be maintained at each end of the bundle. The optical bundle would link the sensor's optics with the sensor's detector/dewar assembly. The sensor could be a scanning or staring system. Optical transmission of the fibers would have to be in the 3-5 micron or 8-12 micron region to be consistent with present day imaging systems.

AF86-119. TITLE: Gallium Arsenide (GaAs) Device

DESCRIPTION: Research is needed to understand better the physics of GaAs devices and circuit operation. These devises and circuits are needed for avionics, missile, and space applications. Such devices provide ultra high speed digital data rates; recently, clock rates of 10.0 gigahertz at 77^{o}K have been observed. Higher speed circuits allow fabrication of radar systems with improved performance characteristics. The purpose of this research is to supplement and enhance the development of GaAs technology. Of prime interest is work on modulation doped field effect transistor (FET), since this represents a new and extremely promising technology. Other areas of interest are insulated-gate GaAs field effect transistor technology, bipolar heterojunction transistor technology, and metal silicon FET technology. Theoretical, analytical, or device and circuit fabrication efforts are of interest to further develop the above indicated technologies. Theoretical research may include two-dimensional device modeling, evaluation of ballistic effect, velocity overshoot effects, Gunn

domain formation, and circuit simulation. Analytical work may include materials evaluation by Auger spectroscopy, Rutherford backscattering, etc. Finally, transistors and circuits could be designed, fabricated, and tested. The above description maps out a wide area of interest and the anticipated program would attack a small segment of this above described area. Proposals addressing individual areas are encouraged.

AF86-120. TITLE: Impact of Material Characteristics on Compound Semiconductor Performance

DESCRIPTION: Thin layers of semiconducting material with very sharp interfaces have been shown to have a number of properties that are very interesting to the Air Force. Specific device concepts employing these structures are under development, and basic research to support those developments is underway. Primary interest at this time is in the GaAs/AlGaAs system, but other materials will become of interest as they show significant advantages. At the present time, molecular beam epitaxy and metal organic chemical vapor deposition are the primary methods used to grow the thin structures, and there is interest in programs to improve these two techniques or in other techniques that might be better. New physical principles govern the performance of the new class of devices that are evolving and new measurement techniques or variations of established techniques are needed to understand the materials properties that control that performance. Research to show the connection between the material characteristics and device performance is also of interest. Examples of research that would be of interest are: (1) development of experimental techniques to measure interface sharpness between layers of GaAs and AlGaAs to within a half of a lattice constant; (2) development of ways of determining carrier concentration profiles within 100A^{O}of an interface; (3) development of measurement techniques that would give impurity and defect profiles close to interfaces for both residual and doping concentrations; and (4) research of unique characteristics that would have a significant impact on present or new device concepts. Theoretical research to develop models of the materials properties of thin structures and devices fabricated from those structures is also of interest.

AF86-121. TITLE: A Natural Language for System Avionics Software

DESCRIPTION: The objective is to analyze the feasibility of designing a natural language as input to a software development environment typical of system avionics. A survey of existing and/or proposed environments facilitates the structuring of typical programmers' jargons and styles onto a requirement hypergraph. The long range objective is an expert system for automated software development. Provisions are to be made for:

a. A generalized vocabulary minimally dependent on HOL constructs (such as Ada, Pascal, FORTRAN, LISP, etc.).

b. "Navigation" throughout the discourse of the avionics tree (functional and integral avionics) without disrupting language integrity.

c. Expert system's introspection for:

(1) Adaptation and learning from user supplied knowledge, and

(2) Feedback to users on the system's decisions and reasoning strategies.

The intended goal of this research is an intelligent interface bounded by the discourse of system avionics. Driven by an interactive parser, this interface will process the given description (design requirements) and generate partially predefined data structures. These may be organized as sub-graphs, within the discourse hypergraph, upon which an interpreter is activated, triggering a two-way exchange of both user-supplied and knowledge-based facts. Initial results should suggest a very high order, user friendly dictionary with language constructs for the purpose of supporting a dialogue between the user and the expert system.

AF86-122. TITLE: Design Automation Alternatives to AND/OR Trees

DESCRIPTION: In current second-generation silicon compilers, design optimizations are performed on a small scale using the artificial intelligence approach of AND/OR search trees, a quasi-random process for "discovering" designs satisfying requirements specifications. AND/OR tree searches are used because no current analytical design models are available to support formal mathematical "derivation" of designs for requirements specifications. In the future, design optimization problems (which are currently small in scale and soluable with the tree search approach) will become larger and more complex. Their successful solution will then depend partly on having design optimization approaches available which complement AND/OR tree searching by formally deriving, rather than discovering, optimal designs. For example, having only one tree-search-complementary approach available would more that triple the number of available design optimization methods, because the new approach could be used in clever combination with AND/OR tree searching, as well as separately.

The required research, therefore, entails identification and feasibility study of a new approach to design optimization that supports formal derivation (in the mathematical sense) of optimal designs, and is complimentary to AND/OR tree searching. The first part of the effort involves identification of second-generation silicon compilers with AND/OR search trees that are available for performing experiments, and location of whatever raw data (such as integrated circuit process parameters) are required for the new design optimization approach. The second part of the effort is a feasibility study of the new approach adequate to justify (if successful) a potential follow-on detailed performance evaluation and prototyping effort involving the new optimization approach.

AF86-123. TITLE: Storage Techniques for Digital Terrain Data

DESCRIPTION: Changing threat situations and mission requirements have

resulted in greater emphasis on high speed low level flight for enhanced aircraft survivability in the modern battlefield. This mode of flight places great demands on the map reading ability of the pilot in a single seat aircraft. Currently, the Air Force is using paper and film map systems which are proving inadequate in this new situation. Research and development programs seeking to overcome the limitations of paper and film maps have resulted in rapid advances in digital terrain map systems (DTMS). These systems can present terrain, cultural features, and threat data in a variety of formats at the press of a button. Additionally, the accuracy of these systems is approaching that necessary for passive terrain following/terrain avoidance/threat avoidance. A major problem area right now is how to effectively store all the appropriate data so that a DTMS can access them for retrieval and updating in real time, while providing different components of the data to multiple simultaneous users. Current approaches to storage place undue limits on map area and system access time, as well as requiring excessive volume and power.

AF86-124. TITLE: Fastener/Joining Methods for Carbon/Carbon Structures

DESCRIPTION: The Air Force has a documented need for advanced high performance missiles that fly at hypersonic speeds. These missiles will require high temperature airframes that are capable of operating at temperatures in excess of 2500^{0}F. At the present time, a carbon/carbon primary structure appears to be the lightest weight, most attractive structural concept. In addition to the development of the material, one of the more challenging technical problems will be the development of fasteners and/or joining methods for these carbon-carbon structures. The initial effort should be directed toward assessment of feasible structural joining methods with a follow-on potential for the design, fabrication, and testing of representative structural joints.

AF86-125. TITLE: Vapor Content in Fuel Tank Ullage Spaces

DESCRIPTION: Fuel fires and explosions from hits into the ullage space in aircraft fuel tanks are a major cause of aircraft losses. Many approaches are available to prevent fires and explosion in the ullage and many more are either in development or will be in the future. Each new concept or technique requires extensive ballistic testing with elaborate fuel tank specimens to insure that the new concept is functional and reliable. These tests are expensive and a rapid means of determining if the desired ullage conditions present is needed.

Innovative concepts or techniques are sought which would provide test engineers with a rapid and accurate means of determining the ullage composition of fueled aircraft tank specimens such that the desired condition can be obtained prior to testing. An effective system would prevent misfires, lost test time, needless specimen repairs and would improve test efficiency. The ullage environment of jet fuel temperature, pressure, and device location must be design considerations.

AF86-126. TITLE: Use of Transmission Holograms to Reduce the Size, Weight, and Cost of Aircraft Head Up Displays

DESCRIPTION: One major obstacle to reducing the size, weight, and cost of aircraft head up displays has been the need for large, heavy, and expensive glass relay lens optic systems. With the increased use of narrower bandwidth cathode ray tubes in combination with holographic beamsplitters to improve field of view, it is time to consider replacing the relay lens systems with transmission holograms. The purpose of this effort will be (1) to use computer techniques to design transmission holograms to replace the relay lens systems in head up displays, (2) to build a transmission hologram lens system to replace the relay lens system on the F-16 C/D Wide Angle Conventional Head Up Display for Air Force flight test evaluation, and (3) to document the results of the design and construction of the transmission hologram lens system in a technical paper.

AF86-127. TITLE: Low Density Flow Effects for Hypervelocity Vehicles

DESCRIPTION: Concepts and ideas are solicited for the development of accurate aerodynamic prediction/design methods to account for viscous interactions within the limits of continuum aerodynamics. The approach must account for transverse and streamwise variations in edge conditions and be verified by a representative sample of the experimental data base. Skin friction and heat transfer coefficient are the major characteristics to be determined, although displacement thickness and momentum thickness are also desired. Generation of a complete bibliography of theoretical and experimental work will be a required preliminary step in any new development.

AF86-128. TITLE: Structural Joining Methods for Dissimiliar Metal Airframes /Tankage

DESCRIPTION: The Air Force is actively pursuing the development of manned, reuseable hypervelocity vehicles for orbital and suborbital missions. The airframes for these vehicles will, at least partially, be built out of materials that have, heretofore, never been used as primary flight vehicle structure. These vehicles will also contain cryogenic fuels and be required to achieve structural mass fractions that are lower than any that have been achieved before in aircraft structure. This effort would look at potential joining methods for dissimilar metallic materials such as titanium-to-superalloy materials. It should consider at least various types of welding and brazing that would provide both structurally efficient, as well as leak free joints for the containment of cryogenic propellants (LOX & LH2). The follow-on potential is the design fabrication and test of small but representative structural test specimens that would be thermally tested through repeated cycles from liquid hydrogen temperatures (-423^{0}F) to reentry temperatures (1600^{o}-1800^{o}F).

AF86-129. TITLE: The Effect of Pyrolysis/Electrolysis Techniques Upon Chemical/Biological Agents

DESCRIPTION: The purpose of this effort is to define and evaluate the potential feasibility and practicability of using pyrolysis and electrolysis techniques to avoid and/or protect internal portions of an aircraft (crew compartment, avionics bays, etc.) from any contamination in a chemical and biological threat environment. The concept of pyrolysis reflects the technique where the chemical/biological agent is destroyed via the application of heat or a burning process. The application of a microwave energy device integrated with the environmental control system is one possible choice for this study. The use of ultraviolet and/or alpha rays and/or radio frequency bombardment are electrolysis concepts which should be considered. The program should cover the ability of electrolysis devices to neutralize or destroy chemical/biological agents while keeping radiation levels for the crew and equipment within safe limits.

AF86-130. TITLE: Flying Qualities Requirements for Nonlinear Flight Maneuvers

DESCRIPTION: Innovative analysis methods and criteria are needed to define general flying qualities requirements that consider the nonlinearities which may dominate characteristics of aircraft during large amplitude motions and maneuvers near the boundaries of the flight envelope - possibly a greatly extended envelope. Aircraft with high authority stability and control augmentation systems can be particularly unforgiving in these extreme operating conditions if their design margins do not adequately consider both aerodynamic/inertial and flight control system nonlinearities. One must also consider the pilot's capabilities and limitations to insure the combined system will have flying qualities appropriate for its mission or tasks. The pilot's information requirements and essential cue are key elements of this flying qualities issue. Efforts are solicited to develop analysis methods useable to define the pilots information needs during flight at unusual attitudes in order to assure his awareness not only of "where he is" but "margins remaining" as well. A second research goal is to develop design methods and criteria that insure consistency among displayed information, motion cues, and other sensory inputs to the pilot.

AF86-131. TITLE: An Investigation of Non-Catalytic Materials and Coatings Applicable to Hypersonic Lifting Entry Systems

DESCRIPTION: Hypersonic lifting entry systems create a disassociated and slightly ionized plasma sheath caused by their induced shock envelope. The energy tied up in this process is, potentially, unavailable to heat the configuration. The amount of that energy which heats the configuration is a direct result of the ease with which the disassociated plasma recombines at the surface. The recombination process is controlled by the catalytic behavior of the vehicle surface. The purpose of this study is to screen practical materials and coating systems according to their

ability to resist recombination of low density, high temperature plasmas and to produce a report which will focus research into the development of promising material systems with the desired characteristics.

AF86-132. TITLE: Modelling Techniques for Composites Subjected to Rapid Thermal Loading

DESCRIPTION: The effect of cyclic mechanical loading on delaminations in composites has been investigated for some time. However, the effects of rapid thermal pulse loading on delaminated composites have not been studied. Modelling techniques need to be developed in order to understand the overall effect of thermal pulses on delaminated composites.

AF86-133. TITLE: Electrical/Electronic Signal Tester

DESCRIPTION: Aircraft Battle Damage Repair (ABDR) techniques for repairing damaged wiring in combat damaged aircraft vary depending upon the characteristics of the particular wire being repaired. With the growing application of systems that employ fiber optics and ribbon wiring with extremely low signal power or voltages, it becomes imperative that a test procedure be developed. The purpose of this proposal is to develop an electrical/electronic signal tester that will possess the following capabilities; be able to measure voltage, frequency, and current across the repair and be able to generate any type of signal to be sent across the repair to allow measurements of signal degradation. The tester must be able to reproduce the signal generated by any onboard aircraft system. The F-16 aircraft will be used as a test case aircraft. The tester must be compatible with the Air Force's concept of operations of ABDR.

AF86-134. TITLE: Air Data Sensors for Extended Flight Envelope

DESCRIPTION: Extension of fighter aircraft flight envelopes is the subject of a current Air Force program. The primary purpose of this program is to allow improved mission effectiveness by use of controlled flight at high angles of attack (70-80 degrees) or other penetrations of other existing "boundaries". Flight into these areas involves potential control departures in high pilot workload environments and will almost certainly require significant flight control system (FCS) use. In order for the FCS to operate, proper air data are necessary either for direct feedback or gain scheduling. Efforts are solicited to develop means of generating high quality measurements or estimates of angles of attack and sideslip, their rates, and total velocity while outside the conventional flight envelope. Excursions into this regime are expected to be short term (less than 10 seconds) but of a highly dynamic nature (40-50 degrees/second).

AF86-135. TITLE: Wake Turbulence Model

DESCRIPTION: In many of today's state of the art computer simulations of complex visco s fluid flows, a great deal of attention is given to regions of turbulence in these areas. The long-term solution for turbulent flow

will be accomplished from first principles, but at present, this method is impractical because of the storage and computational requirements. High order closure turbulence models have been successful to a certain degree, but in general are used for an overly broad range of problems.

A focused approach is therefore proposed to study available turbulence data, primarily in terms of the mixing and decay properties of turbulent flow for engineering applications. It is desirable to differentiate between the large oscillatory structure in the wake as opposed to the broad band high frequency, small scale motion. In addition, a quantitative definition of the interaction between large scale, low frequency and small scale, high frequency components of turbulent flow should be developed. The energy cascade and interaction between overlapping areas where the Strouhal number varies about a value of 1.0 should be resolved. In summary, a quantitative wake turbulence formulation is desired for general use in numerical simulations of turbulent flow problems.

AF86-136. TITLE: Stress Intensity Factors for Cracking Metal Structures Under Rapid Thermal Loading

DESCRIPTION: Studies have been conducted to determine the behavior of structures subjected to rapid thermal pulses. However, the effects of rapid thermal pulses on cracked structures have not been evaluated.

The purpose of this program is to develop analytical techniques for predicting stress intensity factors of cracked metallic structures subjected to rapid thermal pulses. The end product would be a computer program capable of predicting stress intensity factors for cracks with general geometries and time-temperature profiles as input.

AF86-137. TITLE: Crew Escape Capsule to Airframe Latch/Disconnect Mechanisms

DESCRIPTION: Future combat fighter aircraft may have a separable crew escape capsule incorporating seating structure, partial instrument panels, and the windscreen canopy. The F-111 fighter/bomber aircraft is the only current operational aircraft with a separable crew compartment escape system. This system depends upon detonating cord and pyrotechnic powered guillotine cutters to sever necessary structure and control system connections during emergency escape. The F-111 capsule cannot be removed for inspection or maintenance. The need exists for unique latching mechanisms and associated system disconnects that will allow for future escape modules to be mated to the airframe as an independent structure. This requirement will allow for simpler assembly of aircraft, improved maintenance, and significantly reduced life cycle cost of future capsule escape systems and airframes. The successful implementation of this requirement depends upon the development of a highly efficient structural latching mechanism and control system disconnects that can be operated manually or by automatic command to release the escape system during all possible combinations of aerodynamic loads and maneuvering load factor accelerations. This program should result in one or more preferred concepts along with supporting analysis and rationale. Simplicity, reliability and

ease of operation should be heavily weighed in determining the preferred conceptual design. The successful development of the latching and disconnect mechanisms would have additional benefit toward solving pilot ingress and egress under chemical defense conditions on the flight line should the sealed cockpit, containing the crew, be mated to aircraft via robot systems immediately prior to sortie launch. Additionally, the Air Force interest in modular fighters with detachable components, i.e., fuel cells, avionics, weapons, engines, etc., as contained in conformal fuselage units, would require efficient high strength latches and disconnect mechanisms not unlike those required for the crew escape system.

AF86-138. TITLE: Stability and Control of Hypervelocity Vehicles

DESCRIPTION: Research on lifting hypervelocity vehicles began about 30 years ago and has included analytical studies, wind tunnel testing, and flight testing. This class of vehicle includes X-15, Dyna-soar, ASSET, and Space Shuttle to name a few. Although many lessons have been learned about the stability and control of this class of vehicle, much must be done to develop advanced configurations for military applications.

The purpose of this research is to develop analysis methods and design criteria for lifting hypervelocity vehicle stability and control. Reviewing past results, collecting lessons learned, and identifying gaps and deficiencies would lead to recommendations of design approaches. These approaches could be contrasted with current and proposed military design techniques. Methods and criteria could include disturbance phenomena and models (anticipated and encountered), interference flow-field control limitations, control power requirements, critical inputs and input limitations, stability limits, control of configurations with reduced static stability, transient propulsion effects, etc. Such an effort would lead to development of rational stability and control design approaches for future hypervelocity vehicles.

AF86-139. TITLE: Vortex Flow Control

DESCRIPTION: Vortex flow technology research and development has recently been devoted to investigating the control of forebody and wing leading edge vortices. Present inviscid analytical tools and an empirical wind tunnel data base allow for the initial design of wing leading edge vortex flow control flaps. However, viscous effects tend to degrade the predicted performance benefits substantially.

Research is solicited to investigate the viscous flow impact, including the secondary vortex effect, on the leading edge vortex of advanced moderately swept (45^{o}-60^{o}) fighter wings incorporating vortex flap leading edge devices. The interaction of forebody vortices with the wing leading edge vortex system should also be addressed. Developing an accurate vortex flap design tool, which includes the effect of viscosity, is the ultimate goal of this research effort.

AF86-140. TITLE: Inspection Methods for Subtle Thermal Damage in Composite Airframe Structures

DESCRIPTION: Organic matrix composites are in major USAF use and are projected for even more extensive application on airframes and space structures. Thermal damage to these materials can range from gross charring and blistering to nonvisible or subtle damage which may affect durability and damage tolerance. In addition, the extent of subtle damage beyond visible damage zones is of importance to structural repair. This program will initially assess test methods, including nondestructive evaluation, that can detect subtle forms of damage. The second phase would apply the methods to assess threshold thermal levels (temperature and heating rates) on epoxy, bismaleimide, and thermoplastic structural elements.

AF86-141. TITLE: Fluid Filled Transparencies

DESCRIPTION: Aircraft transparency systems must survive in an increasingly hostile flight environment. Threats to the transparency system include:

a. Aerodynamic heating at high mach number.

b. High cockpit temperatures when the canopy is closed in a hot, sunny ground environment.

c. Condensation on the inside of the transparency when warm cabin air contacts cold-soaked transparencies.

d. Flash blindness resulting from a nuclear flash during night operations.

e. High temperature burn through or frosting due to an engagement with a high or medium energy laser.

New transparent materials to counter the above threats will not be available in the forseeable future, consequently innovative concepts are needed to develop survivable transparencies using today's materials. The purpose of this effort is to explore the feasibility of introducing a temperature, photochromic, and color conditioned fluid between channeled layers of a laminated transparency system to evaluate the degree to which the threats identified above can be nullified. It is envisioned that light and dark fluids would be mixed in a proportion to yield the desired light and heat rejection for the transparency. Photochromic elements would then be introduced into the fluid to provide the desired response to light stimuli. Next the fluid would pass through a temperature conditioner to cool or heat the fluid depending upon sensor inputs reporting on the environmental conditions in the transparency. The final step would be the introduction of the fully conditioned fluid into the appropriate channeled gap between the laminates. The fluid flow rates and delta temperatures would be determined by the heat transfer balance of the system. An

analysis of the heating and cooling requirements for the fluids would be performed for an assumed windshield design and several critical points in the flight envelope. A simple mockup of the system consisting of two sheets of plastic separated by a gap would be fabricated to explore the optical qualities and the response of the photochromic elements to light, and to validate predicted heating/cooling requirements. Several different fluids would be demonstrated to determine the impact of this variable on the system performance. The successful demonstration of the fluid-filled transparency concept could have a significant impact on the design of survivable transparencies for future tactical aircraft.

AF86-142. TITLE: Supermaneuver Definition and Measure of Merit Development

DESCRIPTION: Maneuvers, that include at least transient excursions into the regions beyond the conventional and combat flight envelope, are being defined as supermaneuvers. The intent is to allow a more rapid firing solution, whether as a result of pointing the weapon system or maneuvering the velocity vector. The direct enabling technology comes from increases in force and moment generation plus eliminating or overcoming the causes of departure from controlled flight. Current means for comparing performance, such as specific excess power, do not account for the benefits available from this type of maneuvering. Efforts are solicited which address the definition of specific maneuvers to be considered and metrics that are capable of showing their worth.

AF86-143. TITLE: Noncontacting Linear Displacement Sensor

DESCRIPTION: The purpose of this research is to develop a noncontacting sensor capable of sensing the distance between two objects within a range of 0 to 1 inch with a measuring accuracy of `.001 inch. The sensor must be able to operate in a Mach 6 flow at a temperature of $1100^{0}R$. The purpose of such a sensor is to accurately determine the location of a boundary layer probe relative to the model surface during wind tunnel experimental investigations.

AF86-144. TITLE: Parachute Landing Impact Attentuation

DESCRIPTION: Analysis of noncombat USAF aircraft ejection statistics shows that parachute landing impact is a frequent source of major injury during an ejection. Approximately 20% of the ejectees sustain some sort of major injury, with ground impact injuries accounting for approximately one-third of these. Crew members ejecting under emergency conditions from a disabled aircraft are at a much higher risk of parachute landing impact injuries than sport parachutists or paratroopers. The sport parachutist or paratrooper can plan the landing conditions in terms of terrain, wind conditions, and visibility. The ejectee must accept the conditions that exist at the time of abandoning the aircraft. In addition, the ejectee may have received relatively little training in parachute landings and could conceivably be injured during the ejection from the aircraft. These facts lead to the need for some form of ground impact attenuation for the ejectee other than his or her legs. Innovative concepts for reducing the

ground impact loads on the ejectee are solicited. The concepts could include inflatable impact attenuation systems tailored to human acceleration tolerances. This could include repositioning the crew member before impact to reduce the accelerations along the more critical axes. An inflatable exo-skeleton system for redistributing impact loads to the body coupled with an impact attenuation system is another example of a possible system. The descent rate of the parachute should be assumed to be 20 feet per second. Uneven terrain and the resultant translational velocity resulting from wind drift and parachute oscillation should be considered in the analyses. New concepts in parachute design or employment are beyond the scope of this effort. Successful development of an impact system could significantly reduce the number of major injuries during ejection. It could also provide the opportunity for reducing the parachute size and the acceptance of higher descent rates. This program should result in one or more preferred concepts along with supporting analyses and rationale. Simplicity, reliability, and ease of operation should be heavily weighed in arriving at the preferred concepts.

AF86-145. TITLE: Fasteners for Above 500^{O}F Aluminum Airframe Structures

DESCRIPTION: Elevated temperature aluminum alloys (e.g., the AL-Fe-X family) are becoming viable structural materials for critical, minimum weight USAF structural applications at temperatures above 500^{O}F. However, mechanical fastening of aluminum structural elements operating over large temperature ranges is not state of the art. Conventional steel or titanium elevated temperature fasteners (e.g., A-286 and Ti-6Al-4V) have much smaller coefficients of thermal expansion than exhibited by aluminum, thus contributing to reduced fatigue performance of the airframe. This program will initially assess mechanical fastening methods using high temperature aluminum and other expansion compatible alloys for two-side installation. A subsequent program phase will optimize the concepts and provide a broad fatigue data base. In addition, concepts for blind installation will be developed.

AF86-146. TITLE: Landing Gear Pin Bushing with Soft Wear Surface

DESCRIPTION: Landing gear designs have always relied upon the traditional hard pin/soft bushing joints in linkage attachment. In these designs, the brushings provide the wear surface and, thus, need to be replaced on a regular basis. Such bushing replacements normally require that the landing gear be removed and disassembled, the bushings forced out, the holes cleaned and reprotected, and a new bushing pressed in. Often, the inner surfaces of the holes have to be burnished or re-bored because of galling, corrosion, etc. In some cases, there is insufficient wall thickness remaining in the lug for such refinishing and the part has to be discarded and replaced.

Ideas/approaches are being sought to determine the feasibility of reversing this design tradition: e.g., investigate the possibility of designing the points wherein the pins/bolts can be made with a "soft" wear surface and the bushings provide the hard, non-sacrificial surface. If

this could be accomplished, then the worn pins could easily be replaced as needed leaving the bushings permanently installed. Cost savings in maintenance would be impressive.

AF86-147. TITLE: 4,000°F Composite Constituent Materials and Processing for Turbine Engines

DESCRIPTION: Because of their tailorability, low density, and potential for high temperature properties, there is a need for the development of structural composites for long term use in an oxidizing media. Ceramic and carbon-carbon composites development for use at 4,000°F in an oxidizing environment require constituent materials and processing techniques to maintain composite structural properties for long periods of time. The specific needs shall be the development of: (1) ceramic fibers and oxidation protected carbon fiber and fabrics that maintain high strength and are stable at high temperatures;(2) matrix development; and (3) integrated composite systems that include fiber, matrix, coating and processing that result in high temperature, oxidation resistant, structural composites.

AF86-148. TITLE: Two-Phase Elastomer Toughening of Bismaleimide Resins

DESCRIPTION: The use of carboxy terminated butadiene nitrile (CTBN) elastomers with epoxy resins to create a precipitated phase of CTBN particles in an epoxy continuum has been demonstrated to provide effective toughening with only minor reduction in elevated temperature mechanical properties. In this program, the concept of toughening bismaleimide resins with second-phase elastomers will be investigated. The goal is good room temperature toughness with good structural performance in the 350°-450°F range. Toughening approaches will be evaluated using neat resin specimens and laboratory scale graphite fiber plastic composites.

AF86-149. TITLE: Tough, Heat Resistant Coatings for Graphite Fiber Reinforcements for Composites

DESCRIPTION: Plastic composites, made with graphite fibers that have been coated with tough, high elongation resins such as adhesives or elastomers, have higher toughness (e.g., impact resistance) than conventional composites. However, the coatings evaluated to date have limited elevated temperature capability. In this program, coatings having temperature capability in the 350°-450°F range shall be investigated. Composites shall be fabricated with coated graphite fibers and bismaleimide laminating resins and evaluated for toughness and in-plane mechanical properties.

AF86-150. TITLE: Fabrication of Microelectronic Packaging Materials

DESCRIPTION: Approaches are needed to solve microelectronic problem areas and to model and develop new packaging approaches, reliable solder materials, optimized printed wiring boards and materials with required properties, such as specified thermal expansion coefficient and low dielectric constant. Approaches are also required in the areas of materials and

process development for microwave circuits packaging. Another general area of interest associated with the manufacturing of packaging materials is the area of process control (i.e., electrochemical plating and etching).

AF86-151. TITLE: Impact of Material Characteristics on Infrared Detector Performance

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance requirements with the emphasis being on long wavelength detection. New concepts such as heterostructures and superlattice detectors are desired for long term applications. Detector arrays are being driven to mosaic formats of 103 to 106 elements which places increased emphasis on needs for material uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

AF86-152. TITLE: Fabrication of Microwave Device Materials

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide material that is used for device substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers. The latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance. Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

AF86-153. TITLE: Paint Removal from Carbon Fiber Reinforced Epoxy Resin Composites

DESCRIPTION: New and novel non-chemical paint removal techniques are required for use in the removal of polyurethane base paints from epoxy resin base fiber reinforced composites. Techniques must be environmentally compatible, non-hazardous to workers, and cause no degradation to the mechanical, chemical, or physical properties of the composite material.

AF86-154. TITLE: Photoelectron Emission Techniques for Pre Bond Field Inspection

DESCRIPTION: Nondestructive techniques are required for use in the field

as well as in the depot for the pre bonding inspection of prepared surfaces to insure that durable adhesive bonds will be formed. The use of photoelectron emission techniques as well as various other nondestructive approaches shall be evaluated in order to demonstrate the feasibility of developing a portable, field usable surface examination technique.

AF86-155. TITLE: Nondestructive Determination of Resin & Moisture Content

DESCRIPTION: Techniques are required to nondestructively determine the carbon fiber/resin ratio in uncured prepreg as well as in cured composite components. In addition, a nondestructive method for the determination of the amount of water absorbed by a composite, that has seen environmental exposure, is needed.

AF86-156. TITLE: Reliable High Temperature Materials for Advanced Gas Turbines

DESCRIPTION: In Air Force turbine engines, materials are operating at or near their capacity with regard to stress, temperature, and environment. Yet, it is necessary to extend the life of current systems. New systems are envisioned that will demand lighter-weight structures of extreme reliability and resistance to environmental attack of catastrophic failures. A rational basis for developing improved material systems (high temperature and refractory alloys, ceramics, or refractory composites) is required through understanding of the principles that govern properties and behavior as functions of microstructural features, composition, and processing. New approaches leading to increased performance of high temperature alloys, ceramics, or refractory composites are required as follows:

a. High Temperature Alloys - Approaches to thermodynamically stable oxidation-resistant turbine engine blade, vane, and disk alloys which offer significantly improved creep, fatigue, and oxidation properties.

b. Ceramics - Research to identify new families of high performance ceramics or composite materials capable of economical consolidation, reproducible processing, and improved thermal stress and fracture reliability is needed to extend the limits of future generation high temperature turbine engine components.

c. Composites - Approaches to improved oxidation resistant carbon-carbon and ceramic composites for use above 3000°F are required.

AF86-157. TITLE: Practical Manufacturing Techniques for Metal Matrix Composites

DESCRIPTION: Graphite-magnesium and graphite-aluminum metal matrix composites offer significant potential for high performance lightweight spacecraft structures because of their stiffness and dimensional stability. However, practical manufacturing techniques for forming materials

and structures are lacking. Innovative ideas are needed in the areas of processing concepts for making tape or sheet and of fabrication of large components.

AF86-158. TITLE: High Performance Aluminum, Titanium, and Magnesium Alloys

DESCRIPTION: New approaches leading to improved rapid solidification technology (RST) for aluminum, titanium, and magnesium alloys are needed. Current Air Force interest in aluminum alloys centers around three families of alloys: namely, high strength/corrosion resistant alloys, high modulus/low density alloys, and elevated temperature aluminum alloys. Included is the response of these alloys to various types of processing: e.g., consolidation, forging, extrusion, and rolling. A new initiative in this area is directed for development of ultra-high temperature aluminum alloys to replace titanium in engine and aircraft applications to temperatures of 900^{0}F. Titanium alloy requirements through RST are directed to the development of alloys with improvements in three areas: temperature stability to 1400^{0}F, strength to 210 ksi, and higher modulus/density ratio to use in advanced engine and airframe applications. Approaches are needed in alloy development, powder making, and powder compaction. A new initiative in this area will pursue the development of ultra-high temperature titanium alloys designed to replace superalloys to 1800^{0}F. Because of good specific strength and stiffness, magnesium alloys are potentially attractive for many aerospace applications. Research is now needed to explore property improvements, especially in the corrosion resistance of these alloys that may be obtained using RST. In addition, improvements in strength, stiffness, and even a reduction in density may be possible using increased levels of conventional additions and/or novel alloying additions. Approaches are needed in the following areas: development of a rapid solidification process suitable for Mg alloys, Mg alloy development, low cost consolidation techniques, and evaluation of mechanical properties.

AF86-159. TITLE: Improved Nondestructive Evaluation

DESCRIPTION: Nondestructive evaluation plays a major role in the production, operational safety, and maintenance of Air Force systems. Current emphasis has largely been on the inspection of airframe and engine components, sub-assemblies, and entire systems during manufacture and throughout their service lives as a major element of maintenance and repair procedures. The tremendous variations encountered in the articles to be inspected, in matters such as geometry, material composition, service conditions, and defect detection and characterization requirements, has led to the study of many physical, chemical, and mechanical phenomena that can be used as nondestructive inspection and evaluation (NDI/E) techniques. Advanced, innovative approaches are needed for improved NDI/E techniques for the detection and characterization of flaws in airframe and engine materials including metals, composites, and ceramics, in electronic device materials and components, and also for the real time monitoring and control of manufacturing processes. In particular, research is needed on electro-magnetic, ultrasonic, radiographic, and new and improved methods

for the detection of bulk and surface defects in metals and composites, examination of surfaces prior to adhesive bonding, as well as determination of resin and moisture content in advanced composites, imperfections in material coating, and corrosion. Furthermore, advanced NDE signal processing concepts and methods, including that necessary for decision making, are sought. Of particular interest are those efforts that give an improvement in the reliability of the NDI/E process that allow the quantitative characterization of the flaws. Furthermore, proposed methods should have the potential to be useful in a manufacturing or in-service environment as appropriate.

AF86-160. TITLE: Polymer Precursors for Ceramic Matrices in Composites

DESCRIPTION: Dramatic progress is being made in synthesizing novel polymeric materials, that yield oxidation resistant ceramic substrates upon pyrolysis. These materials exhibit great potential for extending the oxidation resistance of carbonaceous substrates and composites. Liquid infiltration of inhibitors into composites using organometallic polymers is an attractive approach for developing high temperature oxidation resistant matrices. Silicon carbide, boron carbide, silicon nitride, and other materials including mixtures can be deposited in a controlled manner at relatively low processing temperatures within the composite and, thereby, avoid deleterious effects such as attack of the reinforcement which occurs with high temperature pyrolysis. Controlled levels of inhibitors can be introduced throughout the fabrication process of carbon-carbon composites from prepregging to late stages of composite densification because of the attractive rheological properties of these precursor resins. Viscosities of polymer mixtures can be tailored to infiltrate even the fine pores of a highly densified composite. The work envisioned for this program is to experimentally infiltrate polymeric precursors into a carbon or ceramic matrix composite substrates at various points in the processing cycle. Important considerations are the selection of polymer inhibitors for achieving oxidation resistance in composites exposed to cyclic temperature environments with peak temperatures ranging from 2,500°F up to 4,000°F, the anticipated weight pick-up of the composite, the degree of oxidation resistance achieved, and the retention of mechanical property integrity following processing and oxidation testing.

AF86-161---TITLE: Processing of Organic Resin Matrix Composites

DESCRIPTION: The Air Force is interested in approaches towards controlling the processing of organic resin matrix composites. This research and development can include the following areas:

a. Characterization of the processing behavior of resins as a function of critical materials and process parameters.

b. Modelling of the critical materials - processing interactions.

c. Development of novel sensing technology to provide in-situ

feedbacks during processing to facilitate real-time control of critical parameters (e.g., resin flow, void formation).

d. Validation of results through preparation of materials and processing into material forms and composites.

AF86-162. TITLE: Processing Techniques for High Performance Thermoplastic Composites

DESCRIPTION: The Air Force is interested in new approaches for processing thermoplastic matrix composites. This research is to focus on the new generation of high performance thermoplastic resins such as polyetheretherketone from Imperial Chemical Industries and KII polyimide from DuPont. The research can include the use of novel product forms such as spun thermoplastic matrix fibers and the development of processing technology for utilizing these product forms. The processing research and development can also include techniques for modelling the processing response of these novel product forms during processing, as well as unique approaches to in-process monitoring and control of the consolidation and crystallization or cure (whichever is appropriate to the matrix material being utilized) of the composite. The research should include validation of the results via preparation of materials followed by processing into coupon-type specimens and subsequent mechanical testing.

AF86-163. TITLE: In-Situ Sensing of Thermoplastic Matrix Composites Response

DESCRIPTION: The Air Force is interested in research to develop "sensors" or other approaches to monitoring in-situ the response of thermoplastic matrix composites to both in-processing and in-service stimuli. This is to include both the dynamic response of the matrix materials during processing, as well as the response of the resulting composite during in-service exposure to environmental conditions and mechanical stresses. Key material parameters such as viscosity, percent crystallinity or percent cure, residual strain, and instantaneous in-situ strain response are examples of the type of data desired from the "sensors". The research is to include methods that will allow the "sensors" to be left in place without degrading the properties of the laminate globally. The goal of the program would be the development of sensing approaches that would not affect the local behavior response of the laminates. The "sensors" would have to be capable of operating at temperatures up to 800^{o}F and in a humid environment.

AF86-164. TITLE: Advanced Antenna Window Concepts

DESCRIPTION: Current antenna window materials and designs fail to provide an adequate balance of performance features for meeting potential future requirements. Critical materials limitations are well-known, and occur in such areas as ablative recession, hot electrical transmission, structural capability, and processing restrictions on window size. The primary objective of this innovative research is to identify new and advanced materials, constructions, duplex layers, or assemblies providing a signif-

icantly improved balance of properties. The general technical approach and specific antenna window concepts will be at the discretion of the contractor.

AF86-165. TITLE: High Temperature Composite (HTC) Physicochemical Interactions to 4,000°F

DESCRIPTION: A new effort is underway to develop structural composites for potential application up to 4,000°F in an oxidizing environment. This effort will require the formulation of a variety of advanced materials and systems in defeating this hostile environment. The primary objective of this innovative research is to review, assess, and advocate appropriate simplified laboratory and analytical techniques for the rapid and relatively economical cataloging of critical materials interactions. The large investment in the processing and characterization of numerous specimens simulating, in varying degrees of realism, the cross-section of the HTC, justifies an alternate and more fundamental approach. The two-fold intent of this research is to: (1) aid future materials developers in using appropriate techniques for guiding HTC R and D, and (2) initiate the evolution of the techniques to a more sound, quantitative, and broad-base technology. The contractor should conduct a limited number of baseline and indicative experiments for selected techniques and reference materials to demonstrate feasibility.

AF86-166. TITLE: Synthesis, Characterization and Processing of New High Temperature Stable, High Performance Polymer Systems

DESCRIPTION: Improved approaches are sought for the synthesis and characterization of thermooxidatively stable polymeric materials specifically tailored in molecular structure for structural applications; i.e., new, improved matrix resins for composites, thermoplastics, adhesives, and molecular composites. Included are approaches to: (1) high molecular weight, processable polymers which will exhibit use temperatures in the region of 700°F or higher and be based on the chemistry of additions reactions, cycloadditions, or chemical rearrangements such that they can be cured to high strength materials without the unmanageable evolution of deleterious volatiles, and (2) polymers, prepolymers, or oligomers that can undergo low energy cures without the production of deleterious by-products to be chemically cross-linked to high polymer networks with excellent resistance to thermochemical and mechanical environments and stresses. Approaches to probe network structure and other morphological features are sought to improve fundamental understanding of such polymeric systems. Characterization to determine physical and chemical properties from which to derive fundamental structure-property correlations and correlations with morphology are needed to guide synthesis research and to interrelate polymer (neat resin) physical and mechanical properties with engineering properties for developing processing chemistry. The generation of new polymeric materials for structural applications with more desirable balances between environmental stability, processability, mechanical behavior and costs are needed. Processing approaches for obtaining high temperature molecular composite compositions with superior

performance characteristics are sought. Firm theoretical basis needs to be generated for predicting use properties from the molecular structures and morphologies of potential candidate polymers, classes of polymers and/or various types of polymeric compositions.

AF86-167. TITLE: Synthetic Liquid Space Lubricants
DESCRIPTION: Research is needed to develop candidate liquid space lubricants based on synthetic hydrocarbon or synthetic hydrocarbon-like classes of fluids. Examples of these include: hydrogenated polyalphaolefins, alkyl benzene, and silahydrocarbons. Important properties that should be optimized are low vapor pressure/volatility, high viscosity index, kinematic viscosity at 40°C in the range of 90-150 cs, and good compatibility with normal bearing materials. The research shall consist of the synthesis and characterization of candidate liquid lubricants. The volatility/vapor pressure characteristics of candidate lubricants should be superior to (i.e., lower than) Apiezon C, a mineral oil based hydrocarbon space lubricant.

AF86-168. TITLE: High Temperature Engineering Plastic Sealing Materials

DESCRIPTION: Advanced technology is needed to broaden the temperature range of engineering plastics for chemical, thermal, and fluid aging stability of sealing materials in the 0°C to 400°C temperature range. Novel approaches are needed for the high strength reinforcement of engineering plastics and for the synthesis and polymerization of engineering plastics with 400°C thermal stability for use in advanced gas turbine engine fuel controls and hydraulic sealing systems. Initial considerations will not be limited by cost, but processability of the new or modified engineering plastics will be a factor.

AF86-169. TITLE: High Temperature Ceramic Coatings

DESCRIPTION: The Air Force is interested in developing new ceramic coatings that have: improved bonding to the substrate, the ability to be applied to large areas economically (i.e., an aircraft structure), and the tailorability of optical properties. Innovative approaches are needed to improve attachment methods while compensating for the thermal expansion mismatch between the substrate and the coating. New techniques are required to tailor the ceramic coatings' optical properties, such as varying the composition of the ceramics using the sol-gel process. The coatings' optical properties are to be optimized for applications in spacecraft thermal control and aircraft camouflage.

AF86-170. TITLE: High Temperature Space-Based Adhesives

DESCRIPTIONS: The Air Force has requirements for optically and ultraviolet transparent space stable adhesives that can withstand high temperatures for short periods. These adhesives should be able to withstand temperature limits of -150°C for at least an hour, + 600°C for approximately ten minutes, and maintain their mechanical, optical, and adhesive ability. The adhesives must be low outgassing over this range of applica-

tion with space stability lifetimes of 7-10 years. The adhesive must be stable in vacuum, electron, proton, and ultraviolet irradiation at intensities normally present in space environments.

AF86-171. TITLE: Applications of Biotechnology to Materials Requirements

DESCRIPTION: The Air Force is interested in research and development directed toward applications of biotechnology to materials requirements.

This activity can include the following areas:

a. Biosynthetic methods to provide state of the art materials for Air Force structural, fluid, or electronic applications, utilizing resources that can be domestically produced.

b. Novel materials obtained from biological sources with properties that may satisfy current or future Air Force needs.

c. Biodegradation techniques appropriate to applications such as paint stripping or integrated circuit etching.

AF86-172. TITLE: Avionics Integrity: Integrated Environmentally Engineered Electronics

DESCRIPTION: The objective of this program is to establish very general life prediction equations for integrated circuits and multilayer printed wiring boards that are stressed by thermal cycling, humidity changes and vibrations. The life prediction equations should include all failure modes (cracked, solder joints, cracked plated through holes, corrosion, lifted wire bond, and others) experienced by the electronic devices under the applied stresses. The life prediction equations will be developed and verified by applying the three stresses given above to a number of selected integrated circuits and printed wiring boards. All failure modes must be established so that they will be included in these equations. The life prediction equations must be general enough so that they can be successfully applied to arbitrary electronic systems. A successful demonstration on a selected electronic system must be accomplished.

AF86-173. TITLE: High Power for Space Applications

DESCRIPTION: Development of one or more of the following technologies is needed in the area of high power for space:

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than 10 kilovolts, response time less than 10 nanoseconds, and the lifetimes of greater than 1.0 million pulses per device.

b. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 microseconds, and an

indefinitely long lifetime.

c. Repetitive opening and closing switches for pulse power output of between 10 and 100 kilovolts and 0.1 to 2.0 million amps. Response time must be less than or equal to 100 nanoseconds and the lifetime must exceed one million events.

d. High power, high voltage, high current density pulse conductors that are lightweight, high-strength, and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed, as well as continuous high power without conductor failure. Intercalated graphite conductors must be lighter weight and higher strength than copper and aluminum. Also, assembled intercalated graphite filaments must be able to transmit pulsed, as well as continuous high power without conductor failure. Superconducting conductors must be able to continuously carry 150 kiloamps per square centimeter at an operating temperature above 7.0 degrees Kelvin without going normal. Dielectric insulation for these conductors must be lightweight, thermally and chemically stable for the space environment, and have a voltage withstand of 20 kilovolts per mil of thickness.

e. High power and energy density rechargeable and nonrechargeable electrochemical power sources. These power sources should not produce effluents during storage and/or operation. A calendar lifetime of at least 10 years is desired with an active lifetime of 0.3 hours under random intermittent load conditions over the 10 year lifetime. Instant on-instant off capability is desired. Peak power density goal is 0.1 lb/kWh including all reactant, case, seal, terminal, connector, structure, and auxiliary weights. The power source must not produce any torque, thrust, moments, gyroscopic effects, or vibration external to itself.

AF86-174. TITLE: Turbine Engine Bearing Concepts

DESCRIPTION: In order to meet thrust-to-weight ratio goals of advanced engines, it is predicted that rotor speeds will need to increase in the order of 20% over current state of the art production military engines. Innovative approaches are needed for the design of rolling element bearings to obtain the life of current engine systems while operating at these higher speeds. Previous approaches have included: Series-Hybrid Thrust Bearings, Dual Diameter Roller Bearings, hollow rolling elements and high-speed tapered roller bearings. Additional innovative concepts should be developed and analyzed in this research effort for their application to, and suitability for, turbine engine mainshaft support.

AF86-175. TITLE: Fiber Weaving for Composite Components

DESCRIPTION: Fiber reinforced composite materials offer a design alternative that will enable the designer of gas turbine engine components the ability to develop lightweight, low cost, high performance engine components. The purpose of this effort is to reduce the fabrication costs and inherent flaws associated with components made from composite reinforced

materials using angle ply, hand layups, and woved filament mats. Critical to efforts, such as utilizing metal matrix composite materials in a gas turbine engine low-pressure spool shaft application, are uniformly spaced woven filament mats at fiber orientations in the warp direction ranging from zero to 45 degrees depending on the structural requirements of the shaft. The desired fiber weaving effort shall address the costs of the angle weaving process and will compare this to current fiber weaving methods and layup operations. An assessment will be made to determine if the angular weaving process will provide a reduction in fabrication costs. It will be determined if an increased capability to fabricate components from composite materials is obtained and whether any limitations are imposed by the fiber on the weaving process.

AF86-176. TITLE: Liquid Ramjet Fuel Systems

DESCRIPTION: Fuel systems for liquid fuel ramjets must be capable of long term storage and acceptable operation over the entire temperature range specified for Air Force missile systems. In addition, the packaging of the fuel in the missile should maximize the use of the available volume. The objective of this program is to conduct analytical and experimental studies to develop unique approaches for the storage, packaging, and expulsion of liquid ramjet fuels. Areas of particular interest include the use of fuel to cool missile electronics, co-storage of fuel and missile internal components to maximize use of available volume, atomization of slurry fuels, simple expulsion methods for slurry fuels at low temperatures.

AF86-177. TITLE: Semiconductor and Batteries for Aircraft and Missile Power Systems

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aircraft and missile power systems:

a. High temperature power semiconductor device with a maximum junction temperature of 300 degrees centigrade, low power dissipation, and the ability to switch 10 amps at 2.5 KW per device.

b. Advanced electrochemical power source concepts are sought that offer revolutionary improvements in energy and/or power density. Batteries are needed with the following performance characteristics:

(1) Rechargeable batteries that provide a gravimetric energy density of 100 watt-hours/pound, volumetric energy density of 8 watt-hours/cubic inch, power density of 300 watts/pound, 15-year life, 1,000 charge/discharge cycles, energy efficiency of at least 80 percent, and a self-discharge rate of 10,000 hours or slower. The size range of interest is from 2 through 5,000 ampere-hours.

(2) Active primary batteries for survival avionics that deliver 30 or more watt-hours/cubic inch and at least 100 watt-hours/pound at the 10-hour discharge rate with pulses at the 20-minute rate near end

of life. The batteries must operate over the temperature range from -65 to +210 degrees Fahrenheit. The size range of interest is from 0.5 to 30 ampere-hours.

(3) Active primary batteries for ground and mobile power applications that provide over 400 watt-hours/pound, over 25 watt-hours/cubic inch, 100-hour or slower discharges, and a 15-year shelf life.

(4) High power density primary reserve batteries for airborne applications that can provide peak power densities of at least 10,000 watts/ pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with a shelf life of 25 years and no degradation. Other parameters of interest are: activation within 1 second or less by an electrical pulse, airborne environments, operation over the temperature range from -65 to +165 degrees Fahrenheit without any external heat source, gravimetric energy of 50 or more watt-hours/pound, and volumetric energy density of 1 or more watt-hours/cubic inch.

AF86-178. TITLE: Air Separation Module (ASM) for Aircraft Fuel Tank Protection

DESCRIPTION: On-Board inert gas generator system (OBIGGS) is a promising new technique for protecting aircraft fuel tanks from explosion hazards. It processes engine bleed air into a nitrogen enriched product that is used to inert the fuel tank ullage. The air separation module separates the incoming air into nitrogen and oxygen enriched substreams. Presently, there are two concepts for separating air. The molecular sieve ASM uses an adsorption principle while the permeable membrane ASM operates using selective diffusion.

There is a need to improve the performance of the present air separation concepts or introduce a new approach having improved performance characteristics. Presently, it takes about 25 pounds of sieve material to produce one pound per minute (ppm) of 8% oxygen. Likewise, it takes about 28 pounds of fibers to produce one ppm of 9% oxygen. The USAF is seeking an order of magnitude improvement in these figures. A successful program would mean a substantial OBIGGS weight savings that would greatly enhance its applicability to future USAF aircraft.

AF86-179. TITLE: Turbine Engine Test Instrumentation Techniques

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 instrumentation 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 commonly 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 temperatures in excess of 1500° for at least 50 hours of engine test while detecting strain with at least 5% accuracy and/or temperature with at least 1% accuracy. Additionally, proposed techniques should have minimal influence on blade parameters and gas flow path.

AF86-180. TITLE: Long Life, Multi Megwatt Space Power Systems

DESCRIPTION: Military satellite space power systems at present utilize silicon solar cell arrays, battery or fuel cell energy storage and power distribution, and conditioning in the 28 volt range and at .5 to 5 kW power levels. Near term power system requirements are anticipated to be in the 10 to 50 kW range with peak requirements up by a factor of 10 or greater. Future power requirements are anticipated to be multi megawatts. Survivability and long life are required for all future missions. Technology needed to meet these requirements includes system and component technology in the 200 to 300 VDC range and all that implies in terms of interacting with the space environment and threats in all orbits. Enabling technology is needed to improve system performance, reduce weight and cost, and increase life to a minimum of 10 years. The following developments are needed:

a. Research and development of high power solar cell array technology is needed to enhance the survivability of the array and improve end-of-life efficiency and performance. Performance degradation can come from trapped particulate radiation, leakage, and arcing associated with high voltage solar arrays exposure to the space environment, thermal cycling causing fatigue of the cell to cell interconnects, and exposure to hostile weapon environments. Techniques are sought to improve solar cell and array efficiency and provide protection from hostile environments. Future solar power systems should also be less dependent on the ground station control and techniques are needed to provide autonomous operation of the solar array as part of a power system on a spacecraft.

b. Fully packaged rechargeable satellite batteries are needed with the following characteristics: (1) a usable specific energy of 100 watt-hours per pound under the following conditions: charge-discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, charge times of 5.25 to 22.8 hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 kW per pound and (2) a usable specific energy of 50 watt-hours per pound under the following conditions: charge-discharge cycle life of 30,000 cycles, calendar life of 5 years or more, charge time of 1 hour, discharge time of 30 minutes, and peak power capability of 1 kW per pound.

c. Spacecraft power system thermal management research is required in the areas of (1) steady and unsteady two phase heat transfer for application to power electronic cooling in the 300-400°K regime; (2)

ultralight expandable radiator concepts and other heat rejection, transport, and storage techniques; (3) flow stability and heat transfer phenomenology related to zero-gravity two phase, unsteady high flux heat transfer processes in cryogenic reactants; and (4) high temperature thermionic devices, high temperature thermal energy storage, and associated heat transfer mechanisms.

AF86-181. TITLE: Solid Fuel Ramjet and Ducted Rocket Propulsion for Missiles

DESCRIPTION: The objective of this research is to conduct analytical and experimental studies of advanced ramjet propulsion systems. These propulsion systems include the solid fuel ramjet and ducted rocket for strategic and tactical missiles. Technology areas of particular interest include efficient combustion of metalized fuels, throttling approaches, non-cylindrical engine designs, non-ejectable port covers and inlet covers, and flow visualization techniques applicable to water tunnel and bare wall combustion tests.

AF86-182. TITLE: Compression System Design Methodology

DESCRIPTION: A major trend in compression system hardware is the increased utilization of low aspect ratio blading, blisks, and three-dimensional design methodology. The primary and secondary flow system design capability must be extended fully into three dimensions to adequately exploit these trends. Therefore, there is interest in any new and innovative ideas addressing the above. Areas of prime importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation, trenching, labyrinth seals, and disc pumping), time unsteady features of the turbomachinery gas path, and secondary flow systems. Additionally, such phenomenological areas as water ingestion, ice ingestion, steam ingestion, dust ingestion, and full face overpressure are of interest. Models accurately describing the effects of external influences, such as these, are of interest.

AF86-183. TITLE: Advanced Fuel Evaluation

DESCRIPTION: The potential of liquid hydrocarbon fuels as energy sources for advanced hypersonic vehicles must be addressed. From laboratory tests, naphthenic hydrocarbons have been demonstrated to have the potential for cooling and supplying energy to high speed aircraft. The availability and potential of these fuels will be evaluated from currently available or near-term refining feedstocks or petrochemical products. In addition, novel processing routes will be assessed as to their potential for producing suitable fuels. Small (pint or less) samples of candidate fuels will be produced and appropriate analyses will be performed to determine the quality of the fuels and the cost of production. Estimates will be projected to determine the availability, cost, and quality of this family of fuels as a function of time. The feasibility of such fuels could provide the Air Force with higher energy liquid hydrocarbons that could cool advanced systems, increase heating value, and produce high

energy gaseous fuels such as acetylene and hydrogen.

AF86-184. TITLE: Fuel Leak Identification and Characterization

DESCRIPTION: Fuel leaks into aircraft equipment bays and other dry bays containing potential ignition sources present a serious threat to the safe operation of aircraft systems. Fuel leaks with a leakage rate as small as a few micro-liters per minute must be repaired in order to prevent a hazardous vapor accumulation within such bays. Current practice for repairing such leaks entail visually locating the leak source and then determining the leakage rate by observing the growth of spot size during a six-minute time period. Depending on the leakage rate, repair action may be required immediately or scheduled at a later date during a normal maintenance cycle.

Because of the high density of equipment installed within dry bays and poor accessibility into such bays, visual identification of the leak source and determination of the leakage rate are extremely difficult and require a considerable amount of time. Therefore, a novel approach, which does not require visual inspection to identify and characterize leak sources, should be investigated. Such an approach could employ a wide variety of detection, electronic, and computational technology. A successful program would result in significant savings in leakage repair costs.

AF86-185. TITLE: Fuels for High Mach Aircraft

DESCRIPTION: Conventional liquid hydrocarbon distillate fuels cannot provide sufficient heat sink capacity to cool other aircraft and engine system components and tend to form deposits within critical portions of engine fuel systems when used at speeds above the Mach 2 to 3 range. Cryogenic fuels such as liquid hydrogen have excellent heat sink capacities but have undesirable low volumetric energy characteristics and storage and handling problems. Special liquid hydrocarbons which undergo catalyzed dehydrogenation reactions and vaporization to provide additional heat sink capacity have been studied in the laboratory but never tested in flight. Long-term coking problems with these "vaporizing-endothermic" fuels are anticipated, based on laboratory tests. New, innovative fuels and fuel systems (e.g., hydride concept) for high Mach aircraft are needed that can provide adequate heat sink capacity, high gravimetric and volumetric energy densities, good combustion characteristics, long-term storage, ease and safety of handling, and costs comparable to present day fuels.

AF86-186. TITLE: Characterization of Carbon Deposits

DESCRIPTION: Synthetic ester-based lubricants used in aircraft turbine engines produce undesirable carbon deposits due to high temperature of some components. These deposits reduce overall system heat transfer efficiency and can result in filter, oil transfer lines and fuel/air/oil cooler blockage. A need exists for small scale techniques that can

produce deposits under conditions similar to the environments found in turbine engine systems. Systematic test procedures are also required to characterize carbon deposits as to their morphology, accumulation rate, chemistry, etc., against the particular environment that produces the type of deposit. These techniques are required in order to more effectively characterize new lubricants' deposition characteristics and reduce lubricant qualification costs.

AF86-187. TITLE: Test Machine to Simulate Ball/Cage Contact for Solid Lubricated Rolling Bearings

DESCRIPTION: Design and fabrication of a test machine is suggested to realistically simulate the ball/cage contact found in solid lubricated rolling element ball bearings. Of particular interest would be the measurement of the friction force and the amount of wear for various solid lubricant materials. Typically, friction and wear measurements have been made in an environment that is greatly different from that which the ball/cage interface is subjected to in real bearing situations. Therefore, an innovative approach will be required to realistically model a ball/cage contact situation. The simulated contact should be able to experience a realistic range of impact frequencies, normal loads, environmental temperatures, and rolling speeds. The data base established by operating such a machine would be very beneficial for the design and analysis of solid lubricated bearings.

AF86-188. TITLE: Antenna Window Instrumentation for RVs

DESCRIPTION: Develop techniques(instrumentation) to measure the antenna window response during a reentry vehicle flight test. Instrumentation is needed to measure thermal, structural and radar responses, among others. Of particular interest is the melt layer formed by the window material and the resulting shape change.

AF86-189. TITLE: Innovative Missions for High L/D Maneuverable Reentry Vehicles

DESCRIPTION: Describe a set of unconventional missions for highly maneuverable reentry vehicles. Develop a means for evaluating this mission set for a group of maneuvering reentry vehicles.

AF86-190. TITLE: Vehicle Trade-off Analysis

DESCRIPTION: Investigate potential advantages and disadvantages of high lift to drag vehicles vs conventional maneuvering reentry vehicles. Technical areas should include energy management, maneuver capability, payload capability, aerothermodynamics, structures, guidance and propulsion systems. Compatibility with ballistic missile delivery system is a must.

AF86-191. TITLE: Kinetic Delivery of High Explosive Warheads

DESCRIPTION: The Department of Defense has considered the use of penetration munitions in a variety of scenarios. The major shortcoming lies in the fuzing mechanism. Insufficient or excessive penetration of the munition can result in

degraded performance. The thrust of this research should deal with accurate depth penetration over a variety of impact angles and ballistic impact velocities.

AF86-192. TITLE: Ballistically Delivered Target-Activated Weapons

DESCRIPTION: In the case of missiles or aircraft which become vulnerable to direct attack only during the initial period of their operation (e.g., missile just launched from a silo or a concealed mobile launcher), it can be advantageous to proliferate target-activated weapons, delivered by ballistic missiles, to the vicinity of the known or potential operating areas of the target weapon. A key to feasibility is the achieving of minimal weight for relatively short range target-activated weapons. Accuracy should also be addressed in the technical analysis.

AF86-193. TITLE: Gasjet Nosetip Flowfield Analysis

DESCRIPTION: Analytical approaches to determine the flowfield structure and heat transfer rates on the reentry vehicle gasjet nosetip/body are needed. The application of fast, large capacity computer systems and innovative (efficient) numerical methods to accomplish computational solutions to this problem are needed. Solution approaches for both axisymmetric and angle of attack cases should be considered.

AF86-194. TITLE: Active Cooled Nosetip Technology

DESCRIPTION: Innovative approaches to actively cool reentry vehicle nosetips using liquid, gas or other techniques are needed. Studies are needed to investigate these techniques, develop performance prediction methods, and computer aided design techniques.

AF86-195. TITLE: Meteorological Considerations for Reentry Vehicle Flight Testing

DESCRIPTION: Reentry vehicle testing requires accurate assessments of weather in the reentry corridor. Current methods of forecasting and measurements can predict cloud masses in the area of interest within a factor of two. Improvements in this capability have been dependent on development of new sensors, such as the airborne cloud radar and reconnaissance aircraft. To make maximum use of this new data, improvements are needed in the display and modeling of cloud data in the reentry corridor. Such improvements might include a numerical model for forecasting cloud motion and particle distribution in an atmospheric volume of 1000 cubic kilometers for a period of one hour.

AF86-196. TITLE: Transpiration Cooled Nosetip Computer Aided Design Techniques

DESCRIPTION: The TCNT is comprised of 100-300 etched stacked platelets which are bonded together to form minute hydraulic passageways within the tip. The design of each platelet is currently performed by hand. Innovative CAD techniques are needed to reduce the time, effort, and cost to create a nosetip.

AF86-197. TITLE: High Temperature Bonds

DESCRIPTION: Many reentry vehicle designs suffer excessive thermal protection system thickness because the bonds lose strength at temperatures in excess of 400°C. Bonds capable of retaining their strength, and which do not outgas at high temperatures would allow heatshield weight savings. Bond interface materials include, but are not limited to, aluminum, carbon composites, and silica composites.

AF86-198. TITLE: Soviet Capabilities for the Weaponization of Directed Energy

DESCRIPTION: Define and project the Soviet capability to build and deploy directed energy weapons, i.e., radio frequency, charged and neutral particle beam, and laser weapons, especially for use in ballistic missile defense. Primary literature sources, open and classified, should be used for the assessment as well as finished estimates.

AF86-199. TITLE: Enhanced Lethality Kinetic Energy Projectiles

DESCRIPTION: Most nonnuclear (conventional) kill systems today employ kinetic energy as a destructive mechanism. A kinetic energy weapon must penetrate and destroy the object for which it is targeted. The lethality of the kinetic energy fragment is a relatively unexplored concept. Studies are needed to address the interaction of the fragment with the target, techniques to enhance lethality, materials, and fragment generation and configuration.

AF86-200. TITLE: Particle Beam Phemonology

DESCRIPTION: Identify effects of particle beam irradiation on missile electronics. Consider techniques to prevent neutral particle beam catastrophic single event upsets (SEU) and multiple event upsets (MEU) in missile guidance and computer electronics. Compare the effects of a nuclear environment to a particle beam environment for US missiles. Consider dose rates, total dose, circumvention levels, and SEU effects. Consider the feasibility of neutron circumvention techniques including detectors and algorithms.

AF86-201. TITLE: Particle Beam Mitigation Algorithms

DESCRIPTION: Develop software algorithms that could prevent catastrophic instruction errors for missile control and guidance update due to a particle beam threat.

AF86-202. TITLE: RF and High-Power Microwave Mitigation

DESCRIPTION: Identify effects of RF and high-power microwaves on missile systems. Address uncertainties and influence levels, and mitigation techniques and possible countermeasures.

AF86-203. TITLE: Universal Missile Kill Concept

DESCRIPTION: Identify universal kill concepts for DEW/missile engagement. Innovative concepts that are not completely design dependent are sought. Consider lasers, particle beams, microwaves and other DEW concepts.

AF86-204. TITLE: Satellite Sensor Spoofing

DESCRIPTION: Define satellite sensor spoofing concepts to establish potential methods for confusing or masking sensor acquisition of missile launch.

AF86-205. TITLE: Innovative Techniques to Avoid Midcourse Defense Concepts

DESCRIPTION: Midcourse defense concepts seek to exploit the long free flight phase of ballistic flight in the vacuum of space to perform discrimination and engage threats with kinetic energy or directed energy weapons. Innovative concepts are sought to evade discrimination and/or vulnerability to midcourse weapon systems.

AF86-206. TITLE: Nuclear Hardened Precision Voltage Reference (PVR)

DESCRIPTION: The inertial instruments in the guidance equipment have electronic components susceptible to nuclear radiation. A precision voltage reference is extremely critical for maintaining accuracy. A nuclear hardened PVR is needed to increase probability of survival of an accurate guidance system.

AF86-207. TITLE: Life Cycle Cost Model

DESCRIPTION: There are no known life cycle cost models for ICBM guidance and control systems. An effort is needed to develop a LCC model to allow evaluation of system options.

AF86-208. TITLE: Electronic Parts Reliability & Nuclear Radiation Screening

DESCRIPTION: Parts screening is currently a costly process. Improvement in technique could greatly reduce costs.

AF86-209. TITLE: Future Trends in Semiconductor Hardening

DESCRIPTION: Evaluate present and future trends in semiconductor industry for nuclear hardening of electronics.

AF86-210. TITLE: Fusing Technology Application

DESCRIPTION: Investigate the application of fusing technology to long conductive line source region electromagnetic pulse (SREMP) protection.

AF86-211. TITLE: Unique Signal Devices

DESCRIPTION: Unique signal devices (USDs) are used to insure the missile and warhead cannot function without receipt of valid command code. Present devices are heavy, slow, expensive, and have hundreds of small moving parts. A reliable USD capable of passing nuclear surety criteria is needed.

AF86-212. TITLE: Guidance Update System (GUS)

DESCRIPTION: GUS is a missile-to-satellite laser ranging guidance update system. A study is required to assess nuclear hardness of the GUS transceiver, identify countermeasures to the GUS. The nuclear hardness portion of the study should include identifying vulnerabilities to the various damage mechanisms, recommended tests and analyses where existing data are insufficient, and areas for specific technology development to improve resistance to nuclear weapons effects. Countermeasures should include those that may be employed to attack dedicated GUS satellites or interfere with GUS in-flight operations. Counter-countermeasures should be investigated for each technique defined.

AF86-213. TITLE: Optical Guidance and Homing Techniques

DESCRIPTION: Development of a guidance system capable of optical image (non-thermal) homing is desired. The system should be capable of locating targets from various orientations and have high course correction rates. Considerations such as size, weight, and power requirements must be included.

AF86-214. TITLE: Small, Hardened, Light Missile Computer Design

DESCRIPTION: Based on VHSIC micro processor technology, develop designs that would support Advanced Missile Concepts requirements and not exceed 10 lbs in weight.

AF86-215. TITLE: MaRV/Booster Integrated Guidance System

DESCRIPTION: A MaRV requires an inertial guidance system to support terminal maneuvers. This task will investigate if such a system can perform the boost guidance function (one inertial guidance system instead of 2) which could result in considerable cost and weight savings.

AF86-216. TITLE: RV Terminal Update

DESCRIPTION: Accurate terminal guidance of RVs is essential to their proper mission performance. Reductions in impact errors are sought. One method considered utilizes a target designation system on the bus. Once targets have been acquired, this designation system would guide the RVs, in the terminal phase, to their respective targets. This research should deal with identifying these guidance techniques and the technologies required.

AF86-217. TITLE: C^3I Technology Survey

DESCRIPTION: Conduct a C^3I technology survey based on a knowledge of the Soviet mobile missile programs and within the context of current and projected shortfalls of C^3I/Battle Management systems.

AF86-218. TITLE: Optical Processing for BMD

DESCRIPTION: Studies concerning the use of optical data processing techniques for Ballistic Missile Defense (BMD) are needed. The following areas should be addressed:

a. Applications of optical processing systems for RV discrimination. Systems which use infrared, visible (reflected laser or natural) light or radar signals as input are of interest.

b. Optimal use of optical data processing in a BMD radar system design. Effective hybrid optical-digital systems for reducing or conditioning radar return signals as well as configurations capable of background and noise suppressions, target feature enhancement and directional filtering are among those of interest. Waveform, architecture and internal implications are to be assessed.

c. Characteristics of a probe or airborne optical BMD system that uses optical data processing. Implications for system architecture and performance are desired.

AF86-219. TITLE: High Altitude Sensor Technology

DESCRIPTION: This effort is to examine the unique and innovative approaches to vehicle sensor technology during the transatmospheric phase (100,000 ft - 500,000 ft) of its mission. The use of extendable/retractable sensor arrays for both electromagnetic as well as electro-optical sensors which permit greater performance in resolution, range, and power requirements than vehicle enclosed systems is an area of interest.

AF86-220. TITLE: High Altitude Synthetic Aperture Radar (SAR) Operations

DESCRIPTION: The use of SAR to support ballistic missile application requires the parametric development of envelop/boundaries for trajectory, altitude and pointing, velocity, and SAR footprints.

AF86-221. TITLE: Exploitation of Tactical Warfare Technology for Strategic Warfare

DESCRIPTION: A broad range of technologies have been developed for advanced tactical weaponry. It could prove quite valuable to explore the application of these technologies to ballistic missile warfare e.g., nonnuclear weaponry, special radars for detecting armored vehicles. The technology should take a ballistic delivery system as the baseline and then expand on the system.

AF86-222. TITLE: Target Assessment Damage by Ballistically Delivered Sensors

DESCRIPTION: Accurate damage assessment is critical for targeting second wave launches. Properly delivered sensors can provide needed information for this purpose. One method worth exploring is the use of an RV to dispense sensors in the target area after the remaining RVs have penetrated.

AF86-223. TITLE: Resolution Requirements for Strategic Targets

DESCRIPTION: In support of BMO activities related to "intelligent" ballistic missile systems, a description of strategic targets in terms of resolution required for detection, identification, classification, recognition, etc. is required. These data, when combined parametrically with the time line associated with typical employment scenarios, could provide both processor size and processing speed requirements.

AF86-224. TITLE: Ground Mobile Target Discrimination Techniques

DESCRIPTION: With the proliferation of ground mobile targets in the recent years, investigate potential discrimination techniques for locating mobile targets from other similar nontargets or ground clutter. Technologies should be compatible with a ballistic missile delivery system.

AF86-225. TITLE: Signal Processing Techniques for Constant False Alarm Rate Detectors in a Dense Target Environment

DESCRIPTION: Radars and infrared systems are examples of modern detection systems that determine the presence of a target by comparing test statistic for a given resolution cell against an adaptive threshold. The BMO is interested in new estimation algorithms that are appropriate to a dense target environment and compares the detection performance in both a uniform noise and multiple target environment to those of existing detectors.

AF86-226. TITLE: Artificial Intelligence and Surveillance

DESCRIPTION: The detection of targets such as mobile systems, for real time targets provides a challenge for sensors and processing. Most surveillance functions, however, are the result of a long term viewing and data reduction history. The question is, can a low resolution, multi-waveband system be trained to detect and track targets of interest. Low resolution provides the advantage of allowing large areas of coverage for the surveillance system. Questions of waveband, resolution, target correlations for training sets, and systems synthesis need to be addressed.

AF86-227. TITLE: Laser Discrimination of Penetration Aids

DESCRIPTION: High power laser systems are being postulated and studied for possible strategic application as weapon systems to attack all phases of ICBM flight. From an energy requirement point of view, it is anticipated that RV discrimination may be a less ambitious yet significant role for lasers. The purpose of this study would be to evaluate mechanisms and system concepts of potential value for the negation of the offensive advantage achieved with current and postulated penetration aids.

AF86-228. TITLE: Implementation of Empty Silo Knowledge (Includes Battle Management Plan and Required Retargeting Capabilities)

DESCRIPTION: Devise an optical C^3 architecture and battle management strategy to implement empty silo knowledge. Assume acquisition and relay of knowledge to single location on the CONUS. Variables to include number and capabilities of management centers.

AF86-229. TITLE: Physical Security Threat to Mobile Missiles

DESCRIPTION: Define current and projected future physical security threats to mobile missile concepts. These include but are not limited to concepts such as hard mobile launcher, wide area mobile, and reloadable low-cost mobile.

AF86-230. TITLE: Intelligence and Force Employment Cycle (INFECT)

DESCRIPTION: Investigate all aspects of the Soviet INFECT for targeting Soviet technology (not mirror imaged US technology) in the areas of reconnaissance, data transmission, target identification, command and control (including C^2 of the reconnaissance system), retargeting and delivery.

AF86-231. TITLE: Responsive Threats to Projected US ICBMs

DESCRIPTION: Examine in detail the technological and production implications of several responsive threats to projected US ballistic missile systems. (Specific threat to be determined by BMO/IN.) Implications may include such technology areas as communications, positive command and control, reconnaissance, reliability, survivability, and accuracy.

AF86-232. TITLE: Assessment of Enemy Ability to Strike US Strategic Systems Without Warning in the 1990s and Beyond

DESCRIPTION: The US Strategic Systems, to one extent or another, depend upon strategic and/or tactical warning in order to operate at full effectiveness. This study will project US surveillance capabilities into the last decade of this century and project enemy capabilities to either circumvent these surveillance capabilities or negate their effectiveness.

AF86-233. TITLE: Missile Basing System Cost Data Base

DESCRIPTION: Develop an automated data base of missile basing system cost data for the various basing alternatives. This basing cost data base could be used in deriving cost estimating relationships (CERs) for support Independent Cost Estimates/Analyses (ICE/ICA).

AF86-234. TITLE: Investigation of Nonnuclear Hard Silo Kill Mechanics

DESCRIPTION: The BMO Hard Silo program is examining ways to harden missile silos against nearly nuclear bursts. However, possible ways of disabling a silo-based missile other than nuclear weapons should also be addressed.

AF86-235. TITLE: Verification of Ground Burst and High Explosive Tests Time Responses

DESCRIPTION: Determining an effective means of verifying state-of-the-art responses from both nuclear ground burst tests (Mini/Misty Jade) and high explosive tests to incorporate the results from initial detonation (early time) to late time response. This effort should result in tieing together the results into an improved state-of-the-art calculational effort to duplicate the complete mechanical nuclear response effects for the complete event.

AF86-236. TITLE: Dust-Induced Loading on a Hard Mobile Launcher

DESCRIPTION: Conduct conceptual dust-induced loading due to airblast studies on a conceptual mobile ICBM launch vehicle. Conduct conceptual designs on dust and debris hitting a mobile launch vehicle. Include particle velocities, densities, and erosion effects on the vehicle.

AF86-237. TITLE: Instrumentation and Soil Structures Media Interaction

DESCRIPTION: Develop new concepts for state-of-the-art instrumentation for measuring ground motions and airblast at extremely high pressure regimes (20,000 to 100,000 psi). Develop concrete and soil structures media interaction. This effort should provide an understanding of shear friction between the soil and a structure (i.e., missile silo).

AF86-238. TITLE: Axisymmetric Surface Test for Soil Material Properties

DESCRIPTION: Develop an axisymmetric surface test using high explosives to provide detailed soil engineering material properties. This effort should result in a cost effective method to characterize soil that survivable missile silos would be placed in.

AF86-239. TITLE: Multiple Airslap Loading on Silos

DESCRIPTION: Study the effects of multiple airslap loading on concrete silos and the surrounding media. Tasks would include study of post-attack conditions and their effects on subsequent loadings.

AF86-240. TITLE: ICBM Deep Basing Shock Isolation System Definition for Missile Transporter/Launcher Storage

DESCRIPTION: Survival of the strategic assets of deep base depend on shock isolation systems capable of withstanding large nuclear weapons effects at base depths. The systems have not been defined or studied in any detail. This effort will define the shock isolation requirements for the missile transporter/launcher while in storage, present a conceptual design and describe a low cost test program to demonstrate proof principle. A SECRET clearance will be required.

AF86-241. TITLE: ICBM Deep Basing Egress Muck Flow Tests

DESCRIPTION: There is no state-of-the-art theoretical method for computing muck flow parameters. Parametric muck flow tests varying mineral composition, water content, and muck chute angle could provide the data required to develop these design equations. Development of a muck flow modeling capability and verification of this model with test data will yield a valuable design tool.

AF86-242. TITLE: ICBM Deep Basing Rapid, Automated, Cost Effective Highly Inclined Blind Raise Tunnel Lining

DESCRIPTION: To meet mission requirements, an automated tunnel lining system is needed which can support an advance rate of 70 linear feet per hour for a highly inclined 15 ft inside diameter shaft. This effort will encourage innovative, cost effective, and reliable solutions to these requirements.

AF86-243. TITLE: ICBM Deep Basing Construction Tunnel Lining System

DESCRIPTION: To meet initial construction requirements for deep basing, a fast, cost effective tunnel lining system must be available. This effort will encourage innovative lining systems capable of 25 linear feet per hour for an 18 ft inside diameter tunnel.

AF86-244. TITLE: ICBM Deep Basing Missile Launch Mid Air Separation Demonstration Concepts

DESCRIPTION: The current deep basing missile launch concept calls for tunnel lining flyout followed by midair separation of the missile from the tunnel lining. This effort will define a low cost experiment/demonstration to be used as proof of principle of midair separation stability.

AF86-245. TITLE: Innovative Kill Mechanism for Attacking Deeply Buried Hard Targets

DESCRIPTION: Develop plan to investigate innovative kill mechanism for attacking deeply buried hard targets. Evaluate these kill mechanisms by order of effectiveness as a function of target characteristics.

AF86-246. TITLE: Analytical Model of Motorcase Strength

DESCRIPTION: Develop analytical model to predict composite motorcase strength after cutting of some layers of the composite fibers.

AF86-247. TITLE: Structural Properties of Solid Propellants

DESCRIPTION: Identify methods of increasing structural strength of solid fuels to provide greater load carrying capacity of the total missile.

AF86-248. TITLE: Fast-Burn Booster Technology

DESCRIPTION: Fast-burn boosters experience higher loads while transitioning the atmosphere than conventional boosters. Previous studies have identified significant problems in areas of staging, stability, control and heating loads. Innovative ideas are being sought for drag reduction techniques and control while in boost-phaze. In addition, the impact of the higher heating and aerodynamic loads on the missile structure and materials needs investigation. This study may include part or all of the areas addressed by this topic. While primary emphasis should be on one (or all) of the previously mentioned areas, it is not limited to them.

AF86-249. TITLE: Effects of Depressed Trajectories on Ballistic Missile Defense

DESCRIPTION: A study to explore the effects of a depressed trajectory missile on a Ballistic Missile Defense. The study should address the possible effects on the defense sensors and its ability to respond.

AF86-250. TITLE: Advanced Concept Design Computer Codes

DESCRIPTION: A series of computer codes are required which allow quick turnaroun[design analyses for ICBMs and related weapon system concepts. These codes would include capabilities for performing booster sizing, plume impingement on deployed objects, simulation of powered flight/free flight and reentry trajectories (3 and 6 degrees of freedom), warhead simulation for Advanced Concept Ballistic Missile (ACBM) utility analysis, nuclear effects on ICBM design and nuclear effects of ICBM warheads on targets, structural and

dynamics analysis for boost design, guidance error analysis and simplified CAD/CAM for ICBM external/internal profiles.

AF86-251. TITLE: Structural and Dynamic Analysis Simulation for ICBM Design

DESCRIPTION: Simplified Structural Analysis and Dynamic Analysis Codes for Missile and Deployed Object Design Analyses. Development of a fast running 1000 node code for buckling, bending, and torsion design analyses and for modal response analyses. Should be to include the capability for environments associated with the high temperatures and pressures expected with the Hot Missile and Slow Missile design concepts. N-Mode design analysis is required to satisfy antisimulation concerns for the dynamic analysis related to exo-atmospheric deployments.

AF86-252. TITLE: CAD/CAM for ICBM Advanced Concept Design Analysis

DESCRIPTION: Development of CAD/CAM Software. This software would be developed to support quick turn-around design analyses and would be used in conjunction with some of the previously mentioned design codes such as the booster sizing, the plume impingement, and the trajectory analysis codes. Outputs would be missile internal/external profiles, subsystem designs and descriptions, sequence of events charts, graphs/plots of missile and trajectory parameters, etc. Nodal graphs and dynamic response graphs would be required.

AF86-253. TITLE: Slow Missile Booster Design Analysis

DESCRIPTION: Slow Missile Booster Analysis with focus on unique approaches for defeating space based sensors and all weapons. The Slow Missile Concept expands the action time of each stage or has coast times between stages to keep the apogee of the total missile below the 80km altitude which was found to be critical for evasion of beamed weapons. A MaRV would then fly within the atmosphere to the target. Suppression of the IR signature and/or evasion maneuvers for land based defenses would also be studied.

AF86-254. TITLE: Unique Design for Boost Deployments

DESCRIPTION: Unique Designs for Boost Deployment of Reentry Vehicles and Penetration Aids. Mechanical concepts for the deployment of many objects from Post-Boost Vehicles with changes in the allowed deployment times ranging from hundreds of seconds for exo-atmospheric deployments down to seconds for endo-atmospheric deployments (Starburst type deployments). Additional concepts would include how to provide necessary velocity and attitude control which could vary from each object having its own mini-bus to having everything deployed from a single bus. Deployments would include trade-offs between Ballistic Reentry Vehicles and MaRVs with full contingents of penetration aids.

AF86-255. TITLE: Innovative Techniques to Avoid Discrimination and/or Vulnerability in the Deployment Phase

DESCRIPTION: Traditionally, deployment of weapons and penetration aids from a ballistic missile has been a methodical, time consuming procedure dependent on accuracy requirements. Defense system operations during this phase could exploit this potential offense vulnerability problem. Impact and requirements on mission objectives have to be considered.

AF86-256. TITLE: Computer Generated Target/Weapon Interaction Graphics

DESCRIPTION: Conventional weapons create complex interactions with their targets in the process of attempting the destruction of the target. The objective of this topic is to investigate the use of computer generated sequential graphics to display dynamic target/weapon interaction.

AF86-257. TITLE: Nuclear vs Conventional Kill Mechanisms

DESCRIPTION: Both nuclear and conventional type munitions are available for use on ballistic missile systems. Evaluate the effectiveness of selected conventional munitions against nuclear weapons performing the same mission.

AF86-258. TITLE: Creation and Maintenance of Long-Range Planning Management Information System

DESCRIPTION: Good long-range planning requires access to large quantities of existing information on program cost, schedule and effectiveness. Most long-range planning is hamstrung by the sheer time and effort required to amass and update this existing data. Definition of a system which makes this information rapidly accessible to planners is required.

AF86-259. TITLE: Conformal Array Antenna Characteristics

DESCRIPTION: Formulate and verify expressive characterizing response of conically conformal antennas. The formulations should enable the evaluation of the impact of varying both geometric and electronic/ parameters of the array. The expressions should be verifiable experimentally and experiments defiened to effect of such a validation.

AF86-260. TITLE: Optical Materials Development

DESCRIPTION: Materials should be examined and developed to effect various responses to reentry heating. Both emissive and reflective materials should be investigated as well as the range of signature variation possible with a given material.

AF86-261. TITLE: Wake Augmentations

DESCRIPTION: Investigate the feasibility of passive wake augmentation/modification concepts for small decoys and reentry objects.

AF86-262. TITLE: Improved Small Batteries

DESCRIPTION: Batteries to proivde high power (100 to 1000 watts) for a time period of 2-5 minutes are required. Weight must be less than one pound. The batteries must be able to survive rocket launch, space, and reentry environments.

AF86-263. TITLE: Optical Countermeasures

DESCRIPTION: Propose and investigate countermeasures to optical threat systems. Frequencies are mainly in the IR range, although visible range may be considered. Approaches may be active or passive. Countermeasures may fool, jam, avoid, or destroy optical sensors. Countermeasures must address optical sensors which scan, track, and discriminate. Novel concepts desired.

AF86-264. TITLE: Space Based Side Lobe Jammers

DESCRIPTION: Design and evaluate a satellite based sidelobe jammer system. Jammer(s) may counter space based and/or land based radar and optical systems. Assess survivability and feasibility.

AF86-265. TITLE: Dual Beta Jammers

DESCRIPTION: An aero design is needed for very small jammers which may be deployed over a radar at a medium to high Beta (aero coefficient), but which must quickly attain a much lower Beta.

AF86-266. TITLE: Nuclear Effects on Penetration Systems Effectiveness

DESCRIPTION: Incorporate existing efforts into assessing total effective blackout on penetration systems effectiveness.

AF86-267. TITLE: Post Boost Vehicle Fractionation as a Penetration Aid

DESCRIPTION: A study to explore the possible benefit of intentional fractionation of a post-boost vehicle as a penetration aid. The study should address the various scenarios that would offer the best effect against a ballistic missile defense.

AF86-268. TITLE: Methods for Ground Testing Optical Properties of Chaff

DESCRIPTION: A reliable technique for ground testing the optical properties of chaff is needed.

AF86-269. TITLE: Optical Signature Simulation/Optical Pen Aid Effectiveness Codes

DESCRIPTION: The research would develop critical input scenarios to the Optical Signature Code (OSC).

AF86-270. TITLE: Anti-Simulation for Penetration Aids

DESCRIPTION: Anti-simulation techniques for exo-endo penetration aids. Mathematical approaches to using multisensors for discrimination against deployed objects using anti-simulation (dissimulation) would be explored. Environmental aspects, materials for deployed objects and tactics should be defined.

AF86-271. TITLE: Radar Scattering Properties of Aerosols

DESCRIPTION: Aerosols are generally considered as optical maskers. Microwave properties will depend on both the particle and bulk properties of the aerosol cloud, as well as the relative wavelength of the incident microwave energy. Characteristics of aerosols ranging from reflective (high conductivity) to absorbing (dielectric) are of interest. Characteristics of scattering properties, supporting data and computer simulation software are of interest.

AF86-272. TITLE: Low Altitude Dispersal Techniques

DESCRIPTION: There has developed a need for a method to disperse up to 1000 small objects of approximately 10 lb total weight from a small reentry vehicle at low altitudes. A study is needed to define various feasible concepts such as explosively expelling the objects from the base region of the vehicle. The study must address the aerothermodynamic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

AF86-273. TITLE: Chemical Warfare Agent Detectors and Alarms

DESCRIPTION: There is need for fieldable technologies for point detection and measuring of chemical agent vapors in air. Specific needs are for (1) sensitive and selective reagent systems for colorimetric, fluorescent, chemiluminescent and other chemical and enzymatic techniques for measuring the nerve and bliste[agents, and (2) reagent packaging systems (such as agent active (a) chemically impregnated film and tapes, (b) coatings for fiber optice (c) coatings for electronic sensors, etc). These systems would be the basis for developing realtime microelectronic chemical agent detectors/monitors, industrual hygiene type dosimeters, and detector sprays.

AF86-274. TITLE: Development of Persistent Chemical Warfare Uptake Simulants

DESCRIPTION: Realistic training in a chemical warfare environment requires the use of a chemical uptake simulant that has chemical properties representative of the particular warfare agent, good detectability, and be safe for humen use. Perfluorinate[aromatic[and highly fluorinated blood substitutes compose a group of chemicals with chemical stability in vivo and are easily detectable in picogram quantities. Chloropentafluorobenzene has been identified as a candidate uptake simulant for non-persistent chemical agents; however, the development of uptake simulants for persistent agents needs to be accomplished. The requirement is for a chemical with good detectability by gas chromatography with electron capture detection, a vapor pressure of approximately 0.001mmHg at 25°c, be absorbed by inhalation and through the skin, and be biologically inert.

AF86-275. TITLE: Automatic Filter Change Indication Analysis

DESCRIPTION: In the event of a chemical warfare attack on an air base, personnel will be required to perform tasks in a vapor contaminated environment. There is no known method that will detect agent breakthrough in mad[filters worn by personnel. Thus, individuals are very dependent on the filter life and scheduled changes of the filters. The objective of this effort is to quantitate MCU-2P filter saturation using theoretical calculations and

verify the quantitative estimates by simulant tests. In addition, the contractor will analyze the current filter change procedures and determine the cost and operational effectiveness of an automatic filter change indicator. The product of the effort will be recommendations for the use of an automatic filter change indicator for personal mask filters.

AF86-276. TITLE: Chemical Warfare Simulants for Don/Doff Experimentation

DESCRIPTION: This work should examine chemical compounds for applicability in don/doff experimentation. The ideal simulant would have the same physical characteristics as any one of the chemical warfare agents. The characteristics of concern are disseminability (viscosity), off gassing (volatility), and the ability to be mechanically transferred and decontaminated (surface tension and chemical activity). In addition, the compound should be detectable in small quantities by standard chemistry practices, and should not be interfered with by commonly occurring environmental conditions. Alternately projects in this area should examine detection methods for simulants currently in use.

AF86-277. TITLE: Application of Cognitive Science to Crew Station Design

DESCRIPTION: Mission requirements for future airborne weapon systems place increasing demands on the system operator, particularly in terms of decision making/problem solving activities. One approach to relieve this problem is to employ the use of artificial intelligence (AI) to accomplish some of the decision making formerly performed by the crew. This approach offers new challenges to the crew station designer, since the interface between new crew and the system must now accommodate the transfer of preprocessed information and decisions from on-board expert subsystems, as well as raw data. It is envisioned that the interface will have to support a high level, abstract dialogue, as well as the current type and level of information exchange. Accordingly, increased attention must be given to the design of the crew station from the perspective of cognitive engineering.

An emerging discipline, known as Cognitive Science, has made significant advances in formulating cognitively based principles of work station design, especially in the area of display format construction. Several of these principles have been applied recently in the analysis and design of work stations in process control industries.

Research and exploratory development is needed to apply and extend the advancements of Cognitive Science into the design of future crew stations. Specifically, the goals of the research are to develop validated design principles and methods from Cognitive Science perspective for use during conceptual design engineering. As a minimum, the methods should consist of (1)+analysis tools to facilitate development of cognitively sound crew station concepts; (2)+evaluation metrics to access the quality of a design in terms of speed/accuracy, problem formulation ability, coordination among AI sources, crew situation awareness attainment, and in general, dialogue quality; and (3)+operator workload and total system performance.

AF86-278. TITLE: Techniques for Bioelectrical and Biomagnetic Sensing from Humans

DESCRIPTION: Electrical activity from humans has a long history of use to measure and body's response to environmental stimuli. Data analysis techniques have greatly improved in the past years while sensor technology has remained essentially the same. There is a need in both laboratory and "real world" environments for sensing techniques that are highly sensitive, reliable and easy to apply. Problems of long duration wearing, skin reactions, subject acceptance and artifact minimization must be overcome in order for a usable new generation of sensors to be made available. New technologies for electrical, ionic, magnetic and any other detection methods should be considered from those techniques currently available. The advantages of new methods over currently available ones would have to be demonstrated in order to convince potential users of their superiority.

AF86-279. TITLE: Improved Neck for Ejection System Testing Manikins

DESCRIPTION: The neck structures of ejection system and crash/impact test manikins have limited human-like biofidelity in their response to vertically and horizontally applied accelerations. Increasing interest in the effects of changes in the stresses transmited through the neck and in head motion due to the encumbering of the head with various life-support, protective and performance-enhancing equipment has resulted in a requirement for the development of an improved mechanical neck structure. This structure must provide proper human-like, three-dimensional kinematics of the head for horizontally and vertically applied accelerations; possess provisions for readily modifying internal resistance to flexion; have integrated, multiaxis force transducers for measurement of transmitted forces; and be designed to be compatible with current state-of-the-art testing manikins. Initial emphasis is on design concepts, methods of mechanical implementation and demonstration of the feasibility of the approach. The program is expected to lead to prototype fabrication; testing for response and compliance with overall testing manikin requirements; and a final refined design suitable for multiproduction purposes.

AF86-280. TITLE: Biofeedback System for the Treatment of Motion Sickness

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on subsystems on or an integrated system for the utilization of biofeedback for the amelioration of motion sickness susceptibility, syncopal susceptibility, vagal/autonomic tone dysfunction, spatial disorientation susceptibility, optokinetic distress. The subsystems which might be addressed are sensors and sensor ensembles to include sensors with some signal processing capability, downstream signal transduction and/or microprocessors, circuitry to deliver appropriately treated data streams to minicomputers, A to D and D to A conversions required for minicomputer analysis and display biofeedback signals on-line in near real time to practitioners and patients, and circuits and hard wire ensembles to record data streams for storage on tape and floppy mediums. Integration should address any combination of the subsystems listed above. Full integration should have the objective of a turn-key package. The scope of this topic description is interdisciplinary.

AF86-281. TITLE: Improved Techniques for Human Tracking of Moving Targets

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on techniques to enhance the speed and accuracy of human tracking of moving targets. The analogue of this task is the tracking of an adversary in an air-to-air engagement by military pilots of high performance aircraft. The effort should address the motor side of sensory-motor function as the primary focus, but may also address the sensory (display) side as the secondary focus. Applications should be targeted on the utility of the technology to identify military pilots with potential for enhanced tracking, the use of the technology as a training tool, and potential for incorporation into future cockpit systems.

AF86-282. TITLE: Pschophsiologic Test Battery for Pilot Selection

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on a battery of measures which will yield psychophysiologic profiles of sufficient sensitivity and specificity to reflect modest and/or subtle individual differences. The intended application of this battery of measures is to identify superior performers in the operation of vehicles in motion requiring high levels of skill in sensory-motor performance and cognitive functioning, and specifically to identify superior military pilots of high performance aircraft. A secondary application is to assess progress during special training programs for enhanced cognitive function, as well as unique training for increased situational awareness. The scope of this topic description is multidisciplinary.

AF86-283. TITLE: Analysis of Chemical Agent Resistant Coatings

DESCRIPTION: Contamination avoidance is probably the best option available when performing duties in a Chemical Warfare agent contaminated environment. Personnel can avoid contamination by knowing what is contaminated or, lacking that information, knowing that surfaces needed to be contacted are already decontaminated. The potential usefulness of chemical agent resistant coatings for air base surfaces and materials is very high because personnel could perform aircraft maintenance and sortie generation in a liquid hazard free environment. The objective of this analysis is to identify surface characteristics on air base equipment, machinery and surfaces involved in sortie generation, identify chemical agent resistent coatings under exploration, and determine the compatibility of the coatings with the air base surfaces. The compatibility criteria to be used include detoxification efficiencey, matreria[effects, application difficulty, and equipment funtional decrement. The product of the effort would be a matrix of each chemical agent resistent coating versus the established criteria. In addition, recommendations on new chemical agent resistant coatings will be made.

AF86-284. TITLE: Modern Training Model Concepts

DESCRIPTION: Much Air Force training rests on principles of learning as they were expounded half a century ago. These Thorndike-era principles were derived more from animal learning than human learning, which makes them largely mechanistic in nature. Resulting training programs focus on objective aspects

of learning and largely ignore the mediational processes that underlie performance. Even so, training is usually fairly successful, but primarily because training developers and instructors go fdar beyond the mechanistic model of learning. The positive results obtained by instructors spring from their personal experience and intuition that a lot more goes on during skill acquisition than the purely observable behaviors that are the primary focus in current application of the Air Force Instruction System Design (ISD) process. With the present high level of interest in the Air Force regarding total training system design, an improved conceptual framework is needed to guide the use and design of aircrew training devices at all levels. Dr William Spears (Seville Training Systems Corporation) recently completed a program with Naval Training and Equipment Center (NTEC) to develop a rationale for the design and use of part-tas[and lot-fidelity training devices (technical report NAVTRAEQUIPCEN+78-C-0113-4). Cognitive and motor skills were analyzed in terms of modern information processing concepts to understand the mediational process involved in performance. The major purpose of this proposed effort would be to lay a foundation for the design of low-cost devices based on functional equivalence rather than on the more traditional concepts of fidelity. Within the context of emphasizing an information processing/cognitive science approach, specific products would be:

a. Guidelines (in a handbook format) for designing training to make effective use of each level of training device in the context of an overall training system.

b. Feasibility assessment of further development for specific levels of training devices.

c. Recommendations concerning (1) research required to fill in gaps in knowledge, (2)+changes in the Air Force ISD process to accomodat[the newer developments referred by Dr Spears in the TR reference[above, and (3)+a potential demonstration of the concepts developed in this effort.

AF86-285. TITLE: Pilot Judgement Skills Test Battery

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development of technology to measure judgement skills and to train for enhanced judgement skills. The target population is the superior military pilot of high performance aircraft. The resulting measurement battery must meet at least 90% specificity and sensitivity, to include demonstration that the cognitive functions being measured are unique to judgement skills, with little overlap with other cognitive skills such as information processing and decision making. The training package must have demonstrated utility (with a small number of subject), and must be amenable to implementation on a microprocessor having CRT display and keypad for responses. Required first generation software should be provided.

AF86-286. TITLE: Preprocessor for Theater Simulation Air Base Resources (TSAR) and Theater Simulation Air Base Resources Using Input from Ada (TSARINA) Logistics Models

DESCRIPTION: TSAR and TSARINA are very detailed Monte Carlo logistics requirements simulation models written in FORTRAN 77. The data bases for these models are difficult to acquire and require many man/computer hours to digitize in form acceptable by the models. A need exists to develop user-friendly methods and procedures to build data bases for these models. The methods/preprocessors need to be developed for use on a VAX-compatible computer/microcomputer in the form of menu-driven, relational data bases to account for interrelationships in the models. The data base must be capable of being updated and self documenting. In addition, menudriven command and communications routines are required to exercise these data bases on VAX 11/780 and NAS 7000 (IBM compatible) mainframes. The command routines should facilitate editing and reiteration of the relational data bases for sensitivity and costing analysis.

AF86-287. TITLE: Graphic Post Processors for TSAR and Dyna-METRIC Logistics Models

DESCRIPTION: The TSAR and Dyna-METRIC models are being used to quantify wartime resource requirements and interactions throughout the logistics community. These models have a significant shortfall for users; both lack user definable graphical representation of output data. This graphical representation would significantly extend the management utility of the models and aid model analysis and interpretation. Both the TSAR and Dyna-METRIC models are now resident on the VAX+11/780 and NAS+7000 (IBM compatible) computers. Estimated effort would require model installation, user surveys, literature searches, software development, demonstration.

AF86-288. TITLE: Icing Monitoring Equipment

DESCRIPTION: The propulsion test units conduct simulated altitude testing of turbine engines with inlet air temperatures ranging down to -80°F. Ice formation on inlet ducting and engine components, with subsequent ingestion by the engine, is a potential hazard at these low temperatures. Instrumentation currently in use to warn of potential or actual icing conditions include pressure drop measurements across the inlet screen, airstream dew point temperature measurements and vibrating reed ice detectors installed directly in the engine inlet. Each of these instrument systems has limitations in either response. reliability or safety. Additional techniques are needed which will reliably provide a warning at the initial onset of icing. These techniques should operate at airstream temperatures of -80°F to +40°F. The air flow velocities are from 0 to 600 FPS at pressures from 2 to 20 PSIA. Operations up to 1000 hours total in vibration environments to 10 g's peak from 20 to 2000 Hz without service are needed. Penetration holes (up to 3" diameter) in the metal ducting immediately in front of the engines are permissible. The engines are installed in an enclosed test cell with space around the inlet ducting limited to approximately 3 feet in all radial directions.

AF86-289. TITLE: Smoke Generator

DESCRIPTION: Flow visualization through the use of smoke injected into an air stream is required to map airflow patterns. Such mapping is needed to understand freejet nozzle flow, exhaust diffuser flow, and test cell secondary flow.

The smoke generator output must be sufficient to make a 1/2-in.-diam stream tube visible to the eye, TV cameras, and film cameras in a 150-ft/sec air stream operated at pressure levels from 14.7 to 35 psia. There should be no deposits as a result of smoke impingement. White smoke is most desirable, but colored smoke would also be acceptable. The smoke generator should be designed to provide periodic volumes of smoke for up to 30 seconds with 10-second delays between discharges, and be capable of continuous discharges up to 5 minutes. Smoke particle sizes between 10^{-4} and 10^{-6} cm in diameter are desirable. The maximum distance the smoke would travel is 10 feet. While it is understood that smoke can be irritating to the eyes and lungs, the smoke should otherwise be harmless and easily filtered with common breathing air masks.

AF86-290. TITLE: Radiant Heating Augmentation System

DESCRIPTION: The requirement for simulation of high heating loads on aerodynamic vehicles has caused AEDC to pursue development of a radiant heating augmentation system for the Aerothermal Tunnel C (Mach = 4). The system should be capable of delivering heating rates in the range of 150 to 700 BTU/ft^2-sec to a conical body of 20 inches in length and seven inches in base diameter for run times of one to three minutes. The heating distribution delivered by the system should be remotely variable along the body. The heater should be capable of operating in the highly turbulent back flow region of the Tunnel C Aerotherm test section and should provide shielding, insulation, etc, to protect the basic facility from the high thermal loads generated by the heater. Aerothermal Tunnel C has a 25 inch nozzle exit diameter supersonic freejet expanded in a 50 inch diameter test section.

AF86-291. TITLE: IR Target Simulator

DESCRIPTION: The IR sensors which are being developed for future surveillance satellites will be capable of tracking and discriminating many objects in their field of view. In order to provide a ground test capability which can simulate an infrared scene of moving objects, there is a need to develop an IR scene generator. One concept is to provide a mosaic array of heater elements which can be selectively addressed. This could be viewed by the surveillance satellite and the tracks of targets could be programmed in the scene generator by sequentially addressing the appropriate heater elements. Because of the need for high resolution, the heater elements must be very small ($>$ 2mils) and closely spaced. Techniques for producing such heater arrays might be found in silicon chip etching and thin film sputter coating technology.

The objective of this project will be to develop the techniques for producing mosaic heater arrays whose elements can operate in the temperature range from 20°K to 600°K. The eventual goal being to provide a large fault free array ($<$ 10^6 elements) of individually addressable heater elements.

AF86-292. TITLE: Boundary Layer Transition Detector

DESCRIPTION: A transition detection device is required whose output is easily interpreted and minimal modification to model or flight vehicle is required for its installation. The ideal candidate is one wherein no cutting or drilling of the model surface is required so that one installation is good for all flow conditions. The presence of the device should not cause boundary layer transition, and the output should give a positive indication that the boundary layer is laminar, transitional, or turbulent without requiring extensive expertise on the part of the user. If available, this device would be used extensively by companies and government agencies involved in wind tunnel and flight testing. These measurements are not made routinely at this time because of the high cost and questionable interpretation of the techniques currently available.

AF86-293. TITLE: Small Particle Generator Development

DESCRIPTION: AEDC has a requirement to develop a system which can generate small particles in the size range of 0.05 to 0.5 microns. Ideally the generator would generate monodisperse 0.1 micron particles. A narrow gaussian distribution would be acceptable. These particles would be introduced into wind tunnel flow, they would acquire the velocity equal to the air velocity surrounding them. These particles may be either solid or liquid. The particle rate of generation should approach an approximate order of magnitude of 10^{12} particles per second or a material mass flow weight an approximate order of magnitude of 10^{-4} grams per second. Evaporation rates in high temperature air may become a factor for some liquids. The maximum air temperature where the liquid droplets would be utilized should be left to be determined as part of the development effort. Wind tunnel conditions with air temperatures as high as $1000^{\circ}F$ are potentially useful where the dwell time for the particles would be of the order of 100 milliseconds or less. Liquid particles may be impossible to use at the higher temperatures in spite of the short dwell time.

Previous experience with seeders using solid particles of aluminum oxide and magnesium oxide has demonstrated that size distributions occur in a way that indicates particle agglomeration is a problem. Experience with liquid seeding using olive oil at AEDC is limited, however better results were obtained with liquid than with solid particles for high flow velocities.

AF86-294. TITLE: Technique For Local Oscillator Laser To Follow Frequency of Transmitter Laser Heterodyne Laser Light Detection and Ranging (LIDAR)

DESCRIPTION: Several heterodyne LIDAR systems use a laser tuned to a particular frequency, as a transmitter, to probe the atmosphere for chemical species. The laser evergy is reflected back into a photovoltaic detector, where it is mixed with local oscillator laser radiation of a differrent frequency (on the order of a 50-megahertz (MHz) offset from the transmitting laser frequency) to generate an intermediate frequency (IF) for final signal processing.

Massachusetts Institute of Technology, Lincoln Laboratory (MIT-LL), has developed a carbon monoxide (CO) transmitter laser which can be rapidly tuned over the entire P-branch of the CO band (on the order of milliseconds (ms)). However, the local oscillator has not been able to change frequencies with the

transmitter to give a stable IF.

The product desired is a technique to have a CO local oscillator laser which automatically tracks a CO-transmitting laser frequency as it is rapidly switched in frequency. The local oscillator laser may be a separate laser, or it can be part of the beam from the transmitter laser. The techniques must be demonstrated on at least a laboratory-bench scale. It must apply to LIDAR systems which use CO laser transmitters, such as the one developed by MIT-LL, or a commercially available laser which can (or can be modified to) change frequencies electronically on the order of milliseconds (ms). A successful technique will solve two problems that exist in current heterodyne LIDAR systems:

1. It will negate the need for two transmitters and two local oscillators for true dial capability.

2. The rapid tuning capability will increase the confidence level in identifying a single chemical species and could also provide a capability to identify multiple species in short measurement time (i.e., seconds).

AF86-295. TITLE: Equivalent Material Properties for Reinforced Concrete

DESCRIPTION: A requirement exists for developing equivalent material properties for reinforced concrete to be used in finite element analytical models. The research effort and approach will apply conservation of strain-energy theoretical concepts to reinforced concrete materials. An equivalent isotropic material model will be developed, using Young's modulus, Poisson's ratio, and the volume percentage of steel reinforcement. Their equivalent material properties will be used in finite element analytical models and compared with existing experimental results from previous tests. These data can be supplied by the Air Force. The effort will include state-of-the-art assessment of applicable literature and research in this area.

AF86-296. TITLE: Dynamic Soil Analysis By Intergranular Association

DESCRIPTION: Dynamic soil analysis from vibrations, explosions, or earthquakes involves constitutive properties (i.e., stress-strain relationships) as inputs to analytical models. Existing constitutive properties are semiequipped, at best, as one good technique now exists to develop dynamic constitutive properties. This effort will develop a soil dynamic response (i.e., deformations, consolidation, liquification, etc.) model based on intergranular movement during excitation, tracking each partical (or particles--i.e., grants of soil) during the dynamic period of interest. This technique has never been done, nor suggested in the literature.

AF86-297. TITLE: Biodegradation of Jet Fuel in Groundwater

DESCRIPTION: Shallow aquifers, typical of the military bases in coastal regions, have been contaminated by fuel spills and leaks from tank farms, pipelines, and service stations. Cleanup of these aquifers is required, and cost-effective methods are sought. The objective of this research is to investigate the use of in-situ biological treatment to clean up spill sites. Efforts should focus on development of methods used for evaluation of

biological treatability of contaminated groundwater. An Air Force base with an identified spill site can be selected for aquifer material and groundwater collection to determine: (1) the contaminants--floating fuels or soluble components; (2) the microbial community present; and (3) the nutrient additions necessary for biological degradation of the contaminants. Small microcosm studies could be conducted to characterize the activity of the microbial community on the contaminants present. The end-product of this project should describe methods required for preliminary evaluation of contaminated sites for biological treatability.

AF86-298. TITLE: Surfacant Effects on Equilibrium Partitioning of Volatile Organic Contaminants (VOCs)

DESCRIPTION: The Air Force is investigating packed-tower aeration, plus other aeration technologies, to remove volatile organic contaminants (VOCs) from groundwater. The removal efficiency depends, in part, on the degree of air/water contact and the active surface area on the packing media for mass transfer. If the wetted part of the packing, the active area, could be increased by wetting agents, such as surfacants, the removal efficiency could be increased. However, since surfacants are surface-active, they may reduce mass transfer by limiting partitioning of selected VOCs under static (equilibrium) conditions in aqueous solutions. Some VOCs of interest are tetrachlorethylene, trichloroethylene, toluene, benzene, n-pentane, and tetrachlorethane in concentrations of approximately 1+mg/L at ambient temperatures. These data on surfacant effects will help the Air Force determine if surfacant-enhanced aeration is feasible.

AF86-299. TITLE: Crack Growth in Cementitious and Asphaltic Materials

DESCRIPTION: Crack propagation in pavement systems is a major problem for the Air Force, because it increases maintenance and reduces durability. Fracture mechanics provides a means for determining the causes of failure in materials which have been subjected to below-design stresses. These failures begin with existing microscopic cracks in the material. As loads are applied, these become larger, propagating through the structure until fracture occurs. A basic model is needed to explain and predict crack growth. This model, based on projections of crack growth, will help suggest measures for preventing or mitigating such growth.

AF86-300. TITLE: Aeration Techniques for Removing Volatile Organic Contaminants (VOCs)

DESCRIPTION: The Air Force is investigating various aeration techniques, such as packed-tower air stripping, to remove VOCs from groundwater. While these devices are relatively effective, they suffer from several drawbacks: (1)+inefficient use of packing media, where only a fraction of the packing's surface is wetted sufficiently for mass transfer; (2)+high-horsepower blowers to move large quantities of air through the packing and achieve intimate air/water contact; (3)+very dilute exhaust streams which may require additional, expensive pollution controls, and (4)+large buildings or towers which require considerable land area. The research objective is to suggest new, alternate, or innovative ideas on aeration techniques, technology, or procedures. These ideas should address minimizing energy usage while maximizing mass transfer (removal efficiency). Appropriate concepts include

rearrangement of tower internals, redesign on existing hardware, or other new ideas in aeration techniques. These concepts should be bench-scale tested, using relatively volatile and nonvolatile organics, such as tetrachloroethylene and tetrachloroethane, to prove the concept of the idea, but not as performance demonstration. This study will aid the Air Force in investigating new aeration techniques, or modifying existing technologies to remove VOCs from groundwaters.

AF86-301. TITLE: Infrared Inspection Method (NDI) for Flame Spray Coatings

DESCRIPTION: Aircraft engine Technical Orders call for specific coating acceptance on specific parts. Some may be more critical then others and may require extensive testing. Increasing costs and quality requirements are causing timely part production to become more difficult. The objective of this topic is to develop an NDI (nondestructive inspection) method using infrared to eliminate costly destructive methods currently in use. Coating standards such as specified in T.O.2-1-111, Section XIX, should be used. Defects are classified for percentage of porosity, excessive osides, cracking, interface bonding, and excessive grit particles.

AF86-302. TITLE: Metal Processing Using the ND:YAG Laser

DESCRIPTION: An opportunity exists to develop new applications that exploit the particular properties of the ND:YAG laser. These properties include focused energy application, non-contact processing, narrow kerf, minimal heat affected zone, rapid cutting of non-reflective materials, pin-point drilling, fusion welding, welding of dissimilar metals, and localized heat treating. Laboratory tests have shown that the unassisted ND:YAG laser has the capability to cut a hard, tough, high-temperature resistant allow (Hastelloy-x) at the minimum rate of 12 inches per minute (IPM) compared with a 1 IPM cutting speed using conventional numerically controlled 3-axis milling machines. Additional productivity benefits result from the narrow kerf and reuse of the patches that have been cut out. The objective of this topic is to identify specific ND:YAG laser applications for cutting, drilling, welding, and localized heat treating of aeronautical components that require overhaul, to determine process parameters for the ND:YAG laser, and to analyze any residual effects of the laser.

AF86-303. TITLE: Robotics in Propeller Blade Grinding

DESCRIPTION: Procedures employed for current propeller blade grinding create a hazardous and unpleasant environment of aluminum dust, which permeates the surrounding work area. In addition, blades are too heavy to be handled by one man. The objective of this topic is the design and implementation of a mechanized system for grinding propeller blades in rework. Contour following, material removal, and smoothness are critical criteria.

AF86-304. TITLE: Electromagnetic Compatibility Versus Corrosion Control

DESCRIPTION: On many new weapon systems, good corrosion prevention techniques are being eleminated in favor of the ultimate in electrical conductivity between system components. EMI and EMP requirements are often cited as rationale for limiting the extent of corrosion protection. The objective of this topic is to established a method to allow electromagnetic pulse (EMP) and

electromagnetic interference (EMI) protective measures to coexist with corrosion prevention/control measures for aerospace equipment. EMI and EMP requirements need to be examined in order to determin[realistic electrical conductivity requirements followed by the identification, evaluation, and optimization of corrosion prevention materials and processes that can coexist with these realistic EMI and EMP requirements.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submitting Proposals

The responsibility for carrying out the DARPA SBIR Program is vested in the Program Management Office. The DARPA Coordinator and Manager of the program is Dr. John K. Meson.

DARPA invites the small business community to send proposals directly to DARPA under the following address:

Defense Advanced Research Projects Agency
Program Management Office
ATTN: Dr. John K. Meson
1400 Wilson Boulevard
Arlington, VA 22209

The proposals will be processed in the Program Management Office and distributed to appropriate technical offices for evaluation and action.

DARPA identified 22 technical topics to which the small business can respond. A brief description of each topic is included below.

DARPA 86-1 Magnetic Imaging Seeker

Most military targets of interest contain large amounts of magnetic materials. Conventional seeker technology for negating tanks, artillery and other similar weapons relies on exploitation of optical, millimeter wave and infrared signatures for detection of the target in clutter. These seekers concepts require sophisticated electro-optical imaging concepts that degrade in high clutter and certain combinations of target and weather conditions. This Research Task will investigate the feasibility of magnetic imaging concepts as replacement or adjunct to conventional tactical seekers. The investigator will be required to assess the potential for arrays of magnetometers to detect, recognize and isolate tactical targets in clutter at various ranges out to a few kilometers. These arrays should be capable of eventual packaging in small seeker configurations. Consideration will be given to the need for gimbals, auxiliary sensors, strapdown operation, accuracy, influence of the earth's magnetic field and the effects of simple countermeasures. If necessary the investigator will recommend development of miniature magnetometers with properties compatible with the requirements derived during the initial study phase. The second phase of the program will proceed either to the development of a test array or to testing of development magnetometers. Proposals must contain analysis indicating preliminary feasibility assessment. Performer and installation must have Secret clearance.

DARPA 86-2 Advanced Gun Propellants

Current gun propellants are based on formulations containing primarily nitrocellulose, blended with various other ingredients that modify nitrocellulose physical ballistic properties. Despite the success of nitrocellulose based gun propellants two performance areas need improvement: gun bore erosion effects and the need for higher muzzle velocity. To achieve very high muzzle velocities will require a combination of high propellant gas temperatures and very low molecular weight of the propellant gas. For nitrocellulose propellants temperatures of 2700° K are common and propellant gun molecular weight of about 25; limiting velocities for those propellants are about 6500-7500 ft/sec. We are interested in new gas propellant formulations that have the potential of muzzle velocities of 7500-10000 ft/sec at temperatures less than 4000° K with propellant gas molecular weights below 19.

DARPA 86-3 Advanced Explosives and Energetic Binders

Current very energetic explosives and propellants include materials such as RDX and HMX which have very high energy but which are also extremely sensitive. New techniques are needed for introducing nitro groups into aromatic N-heterocyclic compounds. Preparation of nitro aromatic N-heterocyclics is recognized by the explosive and propellant community as highly desirable. Techniques for the synthesis of the caged hexa-N-nitrohexaazaadamantane are also desired.

Low modular weight polymers have the potential to impact a broad range of explosives and propellants. Polymer binds are used to modify all aspects of

performance and properties of explosives and propellants. Synthesis techniques for new types of very low molecular polymers for use with very high energy oxidizers such as RDX, HMX, Nitro N-heterocyclics, and other very high energy compounds are desired.

DARPA 86-4 Novel Concepts for Electromagnetic Accelerators

Electromagnetic launchers have possible applications to a variety of defense needs. Railgun accelerators have received the most attention but some work has been done on alternate accelerators: coilguns, mass driver, and induction accelerators (see IEEE Transactions on Magnetics, Vol. 20. No. 2 March 1984.)

Ideas are being sought for novel accelerators capable of driving small masses (1 to 20 gm.) to velocities in excess of 20 km/sec.

DARPA 86-5 High Power Density Pulsed Electro-Chemical Energy Sources

Many military systems would benefit greatly from electro-chemical power sources that are well beyond the present state-of-the-art in power density and that have one or more other unique properties; e.g., the ability to produce 1 to 100 millisecond pulses. This task seeks innovative concepts which will make possible a substantial advance in the power density of fieldable electro-chemical pulsed power sources. Here an electro-chemical power source can mean a battery or a fuel cell; also, both primary and secondary power sources are of interest. Peak power densities in excess of 20 kw/kg are required a fully packaged power source. While the task goal is stated in terms of power density (watts)/kg), concepts which might lead to other unique attributes (watts/cm3, conformability, etc.) will be considered.

DARPA 86-6 High Power Density Components For Electromagnetic Launchers

Electromagnetic launchers are being considered for a variety of missions including anti-aircraft, armor and ballistic missile defense. Innovative concepts are needed in a variety of technologies relating to the repetitive operation of such devices as practical weapon systems. High current opening switches and acceleration concepts that mitigate or eliminate opening switches are needed. High power density electrical power supplies and pulse forming networks are desired to minimize the total system weight. Techniques for reducing and rejecting the waste heat generated in switches, rails, inductors and other components are desired for both ground and space based systems. Materials and methods for reducing erosion and increasing life of rails and sliding electrical contacts would be valuable. Innovative concepts for applying electrical energy to achieving high projectile velocities with high efficiency are particularly sought.

DARPA 86-7 Application of Adaptive Neural Networks

New approaches and concepts are sought to develop and apply novel computational methods associated with physiological models. Such methods might utilize models of human neurons and networks of neurons to deal with

complex problems such as learning and planning. These networks of neuron models are often found to be adaptive to their environments, and respond to external changes by altering their input gains according to some functional relationship.

The goal is to apply these new techniques to problems associated with tactical air warfare avionics, such as trajectory determination, pattern recognition, and adaptive threat response. Adaptation of computational approaches to utilize new ideas and hardware and software developments in parallel computing architectures is anticipated.

DARPA 86-8 Small Unit Mission Electronic Equipment

New approaches and concepts are sought to develop small, lightweight, waterproof, low probability of intercept and low probability of detection mission electronics equipment for small units. Concepts should be modular (allowing independent or collective operations) with each individual radio transmitter having a common power system and common connectors. The frequency spectrum of interest is low through extremely high frequency. Accommodations of various modems is desired as are built-in antenna matching units which optimize size and weight. A common data message input/output burst device is also desired.

DARPA 86-9 Advanced Technology Batteries for Small Units

New approaches are sought to develop rechargeable and disposable batteries that provide greater energy density and are smaller, lighter, cheaper and safer than current batteries such as the BA-5590/U. It is desired that the battery power or variety of radio transmitters and input/output devices can be stackable to achieve the required voltage for different components. It should accept recharge from a variety of sources and optimize ampere hour capacity per gram of weight and battery life. Finally, the concept should allow for transport on all commercial and military aircraft.

DARPA 86-10 In-Process Sensor Concepts for Intelligent Processing of Materials

The DoD has increasingly stringent materials requirements in order to achieve many of its future systems concepts. These advanced materials will need to be processed, utilizing revolutionary concepts for process control which involved direct, in-situ, real time monitoring of the evolution of intrinsic features of the material such as microstructure, phase change, defect formation, etc. DARPA has interest in research aimed at such sensors for processes including in bulk crystal growth of especially gallium arsenide and for critical steps in the production of advanced carbon-carbon composites. Proposals should address the rationale concerning which aspects of the process are key to successful, reproducible manufacture of such materials and how the specific sensor research proposed addresses the need.

DARPA 86-11 Instrumentation for Semiconductor Material And Device Characterization

Electrical characterization of devices often proves to be the most sensitive measurement for indicating problems in starting materials or processing techniques. Instrumentation is needed that can relate the electrical determinations to elemental impurities and/or stoichiometric variations. The instrumentation programs proposed in this area should focus on either GaAs, HgCdTe or electro-optic materials, and should clearly establish the methodology for relating the electrical or optical properties to the physical measurements.

DARPA 86-12 Military Applications of Conducting Polymers

In the later 1970's, the materials field of conducting and semiconducting organic polymers was opened with discovery of the prototype materials, doped polyacetylene, (CH) x. In broad terms, these materials have conceptual applications as classical semiconductor device structures, lightweight wires, electro-magnetic shielding, transparent conducting coatings, batteries, and perhaps optical fibers. While the stability and other properties of (CH) x initially precluded "real-world" use of conducting (CH) x in these applications, subsequent development of other much more robust conducting polymers (as well as advances in (CH) x itself) suggest that these materials now deserve detailed considerations for applications to military systems and problems. This task seeks to identify and develop specific concepts for the application of conducting polymers in military systems. Proposals must elucidate clearly and concisely the potential advantages of using conducting polymer materials compared to any presently used material, and/or elucidate a unique system capability which will result. Polymers which exhibit electronic or ionic conduction are of interest. Proposals which comprise largely of research and characterization of potential new conducting polymer systems will not be considered in the task.

DARPA 86-13 Electro-Optic Techniques for VLSI Interconnect

A major limitation to achieving significant speed increases in VLSI lies in the metallic interconnects. They are costly, not only from the charge transport standpoint, but also from capacitive loading effects. The Department of Defense, in pursuit of the fifth generation supercomputer, will be investigating alternatives to the VLSI metallic interconnects, especially the use of optical techniques to transport the information, either inter- or intrachip. Interests include such areas as source and detector integration onto a VLSI chip, the optical control of integrated electronic devises, optical switching elements, reconfigurable optical channels, and all-optical generalized cross-bar switching networks.

Guided channels may be considered for intrachip interconnects, but the advantages of unguided optical channels should play a major role in solving interchip and interprocessor communications. Once the electronic signals have been converted to optical signals, optical imaging and holography may be used to guide the optical beam to its destination which would likely be a

photo-detector to another chip. One may go so far as to envision reprogrammable interconnects employing the optical phenomena of four-wave mixing. The bottom line in realizing opto-electronic interconnects is a need for research into nonlinear optics because it is the nonlinear aspect of optics that lies at the root of many of the desired operations - from integrated light sources, through optical switched and reconfigurable channels, to four-wave mixing. Consideration will be given to proposed studies into nonlinear optical materials, new device concepts, optical/electronic integration schemes, and interconnect architecture.

DARPA 86-14 Low Cost Mobile Robot

Intelligence evolved in mobile creatures which had to deal with the complexity and variability of the real world. Researchers differ on whether initial conceptual research on intelligent systems should be performed in a simulated artificial environment, or in a real world setting; however, the proof of a concept in intelligent systems lies in whether or not that concept improves the system's performance in a real-world environment. In particular, a mobile robot offers an excellent platform for evaluating the perceptual and planning capabilities of an intelligent system.

We desire a low-cost ($5k to $50k each in quantities of 100) multi-purpose mobile robot suitable for educational and laboratory use. Just as the proliferation of computer-based work stations has accelerated progress in computer science, so should the ready availability of a suitable mobile robot accelerate the progress in intelligent systems research. This study should trade off possible capabilities of the robot vs. cost and produce an effective design.

Modularity and interfaces are important considerations. Almost all users are expected to need an imaging visual sensor (e.g. TV camera). Many users will require some form of manipulator(s). Other sensors and effectors should be considered. Careful attention should be paid to the mode of mobility. Wheels or tank-tracks are possibilities, an air-bearing would require a specially prepared environment and would therefore probably be too limiting, and legged locomotion is quite general, but may be too expensive. Some on-board local processing will no doubt be required, but users are expected to have substantial processing resources in their laboratories, on which their algorithms already run. Therefore a capable bi-directional tele-communications link will be required.

DARPA 86-15 Chemical Vulnerabilities of Armored Vehicles

Proposals are desired that will assess the vulnerabilities of current and future armored vehicles to chemical warfare. The vulnerabilities may include windows, sensors, rubber and synthetic components, antennae and other communications equipment, lubricants and so on. The intent of such warfare would be to disable or significantly reduce the fighting capability of armored vehicles for a significant period of time - hours to days. Issues of interest include the systems, subsystems and components of armored vehicles that are vulnerable to chemical warfare, the chemistry of such warfare, and the delivery systems appropriate for the chemistry and the target.

DARPA 86-16 Performance Evaluation of Artificial Intelligence Systems

The field of artificial intelligence has advanced to the point where some exciting practical applications are possible. Most of those applications are expert systems, but there is growing work in natural language understanding, speech understanding, and vision or image understanding. Techniques are needed to evaluate the effectiveness and efficiency of such systems, both in order to compare competitive systems, and to measure improvements of such systems over periods of time. Some of those techniques may come from the field of psychological testing or, in the case of expert systems, from software engineering techniques applicable to measuring programmer productivity. Proposals are desired that will explore and evaluate such methods and techniques.

DARPA 86-17 Algorithms and Multiprocessor Architectures

A new generation of multiprocessor supercomputers is being developed that attains high speed by connecting many processors in a network, rather than through the use of ultra-high speed microelectronics. Efficient and effective algorithms for computation on such architectures are quite different than those developed for standard von Newmann computers. Proposals are requested for algorithms in a variety of areas including but not limited to harmonic analysis, linear programming, partial differential equations, computational geometry.

DARPA 86-18 Compact, High Average Power Accelerators

Accelerating charged particles is a relatively recent scientific pursuit that had its beginning in the early 1930's. With the development of the Advanced Test Accelerator by DARPA at the Lawrence Livermore National Laboratory and the Radial Line Accelerator-II by the Air Force and Department of Energy at the Sandia National Laboratory in the early 1980's, the use of accelerators for possible defense applications are being investigated. Applications of electron beam accelerators to radiation processing, driving lasers, generating microwaves, etc. are just beginning to appear.

Both potential defense applications and commercial applications of high average power electron beam accelerators would benefit from innovative ideas on the miniaturization, weight reduction and cost reduction of the accelerators. New developments in accelerator pulsed power drives and the beam handling technology suggest that large improvements can yet be made with minimal levels of effort. Innovative ideas are sought for concepts and designs which can operate at power per unit accelerator weights in excess of 10 Kw/Kg and with accelerating gradients exceeding 20 Mev/m. The offerer should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

DARPA 86-19 Diffractive Optics

Diffraction gratings have been used extensively by the scientific community. The invention of lasers and its application in holography have spawned a number of new scientific, military and commercial applications. Recent developments in

the calculation of resonant electromagnetic fields for deep gratings and the application of computer and VLSI technology to generate the high resolution, high accuracy patterns have created a new class of binary diffractive infrared optics, which are high quality (/100) and have high efficiency (95%). Workers at MIT Lincoln Laboratory have designed and tested various optical components including high-performance laser radar binary telescope and high-efficiency binary phase-grating beam combiner for combining multiple laser beams. It appears that the high quality and high efficiency binary optical components and subsystems can be obtained using low cost materials if some of the basic processes can be further improved.

Innovative ideas and designs are sought. These include the development of lithographic software using a polar or curvilinear coordinate system which are better matched for diffractive optics applications, development of laser beam writers which can provide low-cost, very fast lithographic pattern generators, development of contiguous and noncontiguous programmable scanners which are useful for target acquisition, fire control subsystems, robotics, optical interconnect switching and product labelling as well as other innovative concepts to extend the binary optics technology to shorter, visible wavelengths and to dynamic situations. The offerer should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

DARPA 86-20 Technology for Electron Beam Guiding

High intensity electron beams are finding wide application in the development of tactical and strategic technologies to meet DoD missions. Recent experimental results obtained with the Advance Test Accelerator (ATA) demonstrate that pulsed (50 nsec), high current (10 kiloamp) electron beams can be stably guided by a tenuous plasma column created in benzene gas by two photon ionization with a krypton fluoride laser. This powerful new technique relies on electrostatic focusing of the high energy electron beam by the positive space charge of the ion column which remains after the beam electrons have expelled the background plasma electrons. High current beam instabilities, which had previously limited electron beam currents to less than 5 kiloamps, are totally suppressed by this new technique. The laser guiding concept has substantially expanded DoD capability to generate high energy, high current electron beams.

This task is directed toward the development of new concepts and technologies for guiding high current electron beams in linear induction accelerators such as the ATA. Ideally these concepts would be compatible with beam repetition rates up to 30 kilohertz in burst mode operation (10-20 pulses per burst), efficient extraction of the electron beam from the accelerator and achievement of low beam emittance. The offerer should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

DARPA 86-21 Discharge Pumped CO_2 Laser Technology

Pulsed moderate power CO_2 laser technology is supporting a broad spectrum of current DoD applications. Potential applications range from sensor negation on the tactical battlefield to laser radar for optical imaging and discrimination. During the past decade, substantial progress has been made in

the development of gas discharge pumped CO_2 laser technology. This research has demonstrated that the efficiency, volumetric scalability and pulse length achievable with these lasers depend critically on maintaining discharge stability at the pump power densities required for efficient power extraction. Innovative discharge pumping techniques have been developed to provide pump power densities consistent with high electrical and volumetric efficiency. These methods include the electron beam sustained discharge, pulser-sustainer discharge and UV or X-ray preionized discharged, each of which has been tested successfully but all of which have limitations for DoD applications.

This task will develop alternate pulsed CO_2 laser discharge technologies with the objective of increasing efficiency, increased repetition rate, pulse length and extracted energy per unit volume while reducing laser complexity, size and weight. The offerer should demonstrate his/her innovative concept through analysis, design and a limited demonstration.

DARPA 86-22 Applications of Distributed Computation

Research on distributed computation has produced many interesting distributed software systems and concepts over the past few years. These include distributed data bases, distributed signal processing, distributed AI techniques, and distributed debugging. Applications of these and other similar concepts to selected military areas has already included areas such as distributed sensor nets and distributed communication networks. Other new applications of distributed computing are requested that have direct strategic or tactical defense applications. Proposals in this area should show clearly how distributed systems can improve military capabilities in the field. In each case, the essential computation as well as computational resources should be fully distributed and show a significant advantage over a centralized approach. Applications may cover existing capabilities which can be carried out much more effectively using distributed computation or, preferably, entirely new capabilities not previously possible or practical. Examples that involve only trivial cases of distributed computing (e.g. distributed digitization of sensor data for relaying to a central site) or a single central nodal point are not desired.

SUBMITTTING PROPOSALS ON DEFENSE NUCLEAR AGENCY TOPICS

The Defense Nuclear Agency is seeking Small Business firms with a strong research and development capability and experience in nuclear weapons effects and nuclear weapons phenomenology areas. Proposals should be submitted to:

Headquarters
Defense Nuclear Agency
ATTN: AM/SBIR
Washington, DC 20305

Handcarried proposals should be submitted to:

Headquarters
Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310

Questions concerning the research topics should be submitted to:

Major Thomas M. Loebl
(202) 325-7300

The research categories proposed for study under this program are:

1. Nuclear Weapons Effects.
2. Nuclear Effects Simulation.
3. Instrumentation.
4. Directed Energy Effects.
5. Nuclear Hardening and Survivability.
6. Security of Nuclear Weapons.
7. Operational Planning.

These topics are further explained below.

Additional information beyond that provided herein may be obtained by request from the address given above.

DNA86-1. TITLE: Nuclear Weapon Effects

DESCRIPTION: Exploratory Development: Nuclear weapons effects include air blast, thermal, ground shock, water shock, cratering, personnel, and dynamic loading. Of particular interest is the response of materials, structures, and systems to these nuclear weapons effects. Materials of interest include metals, ceramics and composites. Any new material capable of being used as a structural member is of particular concern for aircraft, missiles, ships (both surface and subsurface) and military vehicles. The response of underground structures, such as missile silos, command and control facilities and communications facilities are especially important. Also of interest are transient and permanent radiation effects on new types of electronics and sensors. Concepts and techniques which will improve the survivability (decrease the response) of systems to these nuclear weapons effects are required.

DNA86-2. TITLE: Nuclear Effects Simulation

DESCRIPTION: Exploratory Development: International treaties preclude the testing of nuclear weapons in the atmosphere and hence we are unable to test military systems in an actual nuclear environment. To compensate for this, other test techniques are used to simulate the effects of the nuclear detonation. Nuclear weapons effects simulation includes: high explosive testing to simulate the mechnanical effects, EMP simulation, thermal radiation simulation, and nuclear radiation simulation. Simulation techniques should be as realistic as possible. relatively inexpensive to perform and comparable to the threat environment. Improvements to nuclear simulations are required to address their possible use in a training and/or operational sense for combat troops. An extensive program currently exists for all areas of simulation and one should become familiar with those to see how they can be improved and/or combined in order to make the total process more realistic and more representative of the actual nuclear weapons effect being studied. Both destructive and non-destructive test methods are desired.

DNA86-3. TITLE: Instrumentation

DESCRIPTION: Exploratory Development: Instrumentation is used for measuring nuclear weapons effects and phenomenology parameters and the response of test items exposed to these weapons effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in an underground nuclear test, a high explosive test, or test involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should, for the most part, be survivable and include recording, data transmission and data analysis capabilities. Concepts are required for new instrumentation utilizing state of the art technology which will result in improved data collection with better accuracy at lower cost.

DNA86-4. TITLE: Directed Energy Effects

DESCRIPTION: Research: The effects of directed energy (e.g., lasers) sources on materials, structures and systems are of interest. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of

materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and mechanisms by which the directed energy effects actually interact with target materials/structures.

DNA86-5. TITLE: Nuclear Hardening and Survivability

DESCRIPTION: Engineering Development: Techniques for nuclear hardening and survivability of systems/structures against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal and nuclear radiation in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required.

DNA86-6. TITLE: Security of Nuclear Weapons

DESCRIPTION: Exploratory Development: Measures to improve the security of nuclear weapons against all possible threats are required. This includes the design of security features both for the actual weapons and for the facilities in which weapons are either stored or transported. These security measures should protect against all known or predicted threats and should be done in such a way as to avoid making the protected item visible as a target.

DNA86-7. TITLE: Operational Planning

DESCRIPTION: Research: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes.

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals

Phase 1 proposals (5 copies) should be prepared for routine US Mail and addressed to:

Strategic Defense Initiative Organization
Attention: IST/SBIR
The Pentagon
Washington, DC 20301-7100

Since no provisions will be made to receive handcarried proposals, bidders should allow ample time for routine delivery of proposals by the US Post Office. The above address can not be used for commercial delivery services, US Post Office Express Mail, or hand carry.

Many of the concepts being addressed by SDIO involve major ground or space based systems which tax the capability of even the largest corporations. While the total systems may be beyond the capability of a small high technology business, many of the subsystems, components, processes, etc fall within the scope of this solicitation. Accordingly, the prospective bidders can interpret the SDIO topics in terms of how they can contribute to the solution of the broader problems and challenges described in this solicitation. In many cases, the thrust of a topic includes establishing feasibility of concepts, enabling major advancements in capability, etc rather than directing attention at production. For example, the deliverable from a successful Phase II effort could be a prototype which becomes an element in a demonstration program; the follow-on Phase III could be further research to perfect the approach following testing or evaluation.

Prospective bidders are advised to interpret the twelve SDIO topics in the context of its present mission, i.e., a research program to provide a sound basis for making future decisions on whether to proceed with development on specific weapons and components.

Although in the original legislation providing for the Federal SBIR Program Congress envisioned Phase 1 awards of approximately $50,000, the Department of Defense is authorized to exceed that amount for specific awards when adequate justification is provided. SDIO anticipates that its nominal Phase I awards will be in the $50,000 to $100,000 range. SDIO is encouraging small high technology businesses to form cooperative arrangements with university researchers by involving university researchers in both the Phase 1 and Phase 2 activities. Also, SDIO is receptive to arrangements whereby a small high technology business proposes to take advantage of the special facilities of other businesses, either large or small. Proposals which provide for such arrangements can include budgets up to 50% greater than the nominal budgets. Prospective bidders are cautioned that nothing in this paragraph is to contradict the instructions in Sections 1 through 7 of this document.

Strategic Defense Initiative Organization FY1986 SBIR Topics

SDIO 86-1. Title: Directed Energy Concepts

DESCRIPTION: Innovative research in the generation and propagation of directed energy will play an important role in the determination of effective ballistic missile defense systems. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, nuclear and non-nuclear driven x-ray lasers, gamma-ray lasers, free electron lasers, neutral and charged particle beams, and plasmoids. Hybrid approaches are also of interest. Interests in the concepts include the full range of embodiments, i.e., light weight spaced based, ground based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, mirror technology, beam propagation through natural and disturbed environments, and countermeasures. Approaches are needed that either extend or improve the present concepts. Approaches that facilitate or support the evaluation of concepts are also appropriate.

SDIO 86-2. Title: Kinetic Energy Weapons

DESCRIPTION: Along similar lines to the topic SDIO 86-1, kinetic energy systems are candidates for ballistic missile defense. Systems being considered include (but are not limited to) electromagnetic rail guns, plasma guns, and other hypervelocity projectile concepts, as well as chemically-propelled interceptors. Included in the kinetic energy weapons area are smart projectiles development, homing devices, launcher designs, engagement tactics, hypervelocity aerocontrol/thermal protection, and countermeasures. Approaches are needed that either extend or improve the present concepts.

SDIO 86-3. Title: Sensors for Surveillance, Acquisition, and Discrimination

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. Both passive and active 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 refrigerators, signal and optical processing, algorithms, optical beam steering, synthetic aperture lidar and radar, passive imaging (IR to UV), interferometry, beam positioning, low-signal gamma-ray detection, and frequency-scanning laser techniques for active discrimination. Approaches are needed that can extend and improve the efficiency of present concepts.

SDIO 86-4. Title: Nuclear Space Power Concepts and Thermal Management

DESCRIPTION: Weapons, sensing, and communications systems under consideration by SDIO have diversified power requirements. Methods and processes are being considered for a wide spectrum of power, power conditioning, and thermal management conditions. Nuclear power concepts and the associated components are of interest for both manned and unmanned spacecraft. The power duty cycles to be considered include: 10's of MW power for pulse applications, sustained MW power for electric propulsion, continuous 10's of kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include: thermoelectric, thermionic, and Brayton cycle. New approaches leading to controlled wide excursions of power and burst mode power are sought. Innovative high power thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainablity, and reliability of space nuclear power systems are sought.

SDIO 86-5. Title: Non-nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO 86-4, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: 10's of MW power for burst applications, sustained 10's of kW power for electric propulsion, continuous 10's of kW power for house keeping, tracking, etc. Specific topics on which proposals are sought include: novel battery concepts, advanced solar collectors and converters, inductive and capacitive stores, MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainablity and reliability of space power systems are sought.

SDIO 86-6. Title: Propulsion

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 payloads in the desired orbit. Both expendable and reusable systems are of interest. Processes, methods, and techniques are sought to support propulsion approaches which include: liquid, solid, transatmospheric air-breathing, electric. In addition, advancements are needed in propulsion related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluents, sensors and controls for autonomous operation.

SDIO 86-7. Title: System Survivability

DESCRIPTION: The survivability of various components of a space-based missile defense system will be a key issue in the effectiveness of such a system. Of interest to the SDIO are products, processes, and techniques for active and passive hardening against directed and kinetic energy devices. Components to be made survivable include sensors, battle managers, power systems, and directed/kinetic energy weapon configurations. Survivable sub-components include large and small optics, electronics, structures for support and fuel

containment, and specific materials critical for shielding, maneuvering, propulsion, and targetting. In addition, to shielding, other well designed and innovative countermeasures are encouraged. Specific examples of areas to be addressed include: thermo-mechanical shock hardening, heat dissipation techniques, protective coatings, baffling techniques, materials conditioning, orientation, or deployment strategies, and insulation methods. Of particular interest is hardening and survivability in the nuclear environment.

SDIO 86-8. Title: Target 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. The key questions that need to be addressed under this topic deal with the quantitative assessment of target lethality. Hence, techniques are needed to acquire, access, and query an extensive data base on the damage to basic materials, electronics, and optics due to various mechanisms. Techniques are needed to quantify laser radiation damage due to ionization, thermal deposition, and impulse shock as a function of wavelength, intensity, and pulse characteristics. This is required in order to direct future research in novel directed energy concepts. Similarly, techniques are needed to investigate and quantify damage mechanisms due to particle beam interaction with targets. In the area of kinetic energy, the effects of hypervelocity projectile impact on structural and hardened materials are of extreme interest. Finally, innovative ideas or concepts for measurement of radiation or particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off, and equation-of-state data are relevant.

SDIO 86-9. Title: Computer Architecture/Very-High-Level Language Design for Battle Management

DESCRIPTION: The battle management requirement for a ballistic missile defense system is an extremely demanding one, requiring order-of-magnitude advances in existing technologies. The system will be required to acquire and track thousands of objects through the use of hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Three areas to be strongly emphasized under this solicitation are:

(1) New computer architectures which are lightweight, compact, fault-tolerant, and hardened to radiation, but allow for the extremely rapid processing of data which will be required. This issue can be addressed via either new designs for computer components (e.g., optical signal processors) or innovative architectures using existing technology.

(2) Very high level language (VHLL) design for both the development and testing of extremely large software systems.

(3) Novel numerical algorithms to enhance the speed of data processing for sensing, discrimination and systems control. Since the computer will likely be a single-purpose design, these may be specifically tailored to a particular architecture suited to the SDIO data processing task.

SDIO 86-10. Title: Supporting Concepts for System Architecture

DESCRIPTION: As part of the Strategic Defense Initiative research program, a number of systems architecture options are presently being studied. This multiple-path approach is necessitated by the large number of missile threat interceptor concepts being considered in the program as well as by the survivability, viability, and affordablity issues associated with defense systems options. While comprehensive systems architecture studies are beyond the scope of a small business, a number of supporting concepts may be investigated under the SBIR program. Examples of these include: secure laser satellite networking of battle managers and sensors, deployment strategies of components in a nuclear environment.

SDIO 86-11. Title: Space Materials and Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures and the materials to be used for their fabrication. The requirements include structures and materials for: prime power systems, antenna, tracking and pointing systems, solar collectors, and pressure vessels. All of which 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, cost effectiveness, and prediction methodology.

Space structures supporting weapons and antennae must accommodate retargetting maneuvers without detrimental jitter from vibrations and thermomechanical 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.

Techniques are need to obtain greatly improved understanding of structure-property relationships for advance carbon/carbon, ceramic-matrix, and metal-matrix composite materials. Specific goals requiring advanced techniques and processes include imparting oxidation resistance and damage tolerance to carbon/carbon 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 establish the thermodynamics and kinetics basis for minimizing fiber-matrix reactions in composites exposed to high operating temperatures. Methods are needed to address the basic mechanics of failure characteristics and fatigue behavior under complex mechanical and thermal loadings.

Consistent with topics SDIO 86-1, -3, and -7, advances are sought in materials for optical systems, electronic components, and radiation hardening.

Proposals involving these, as well as other, space structure and material-related research and innovative technology topics are encouraged.

SDIO 86-12. Title: Space Transportation and Support

The objectives of this activity include encouraging research into the areas of space transportation and support with the primary emphasis on reducing the cost of space operations. Traditionally the cost of space transportation and the operations of the spacecraft have been major factors in determining the life cycle costs of our space based assets. This burden on the deployment of Strategic Defense Systems has been confirmed by the Horse Race Contractors and was originally identified by the Defensive Technologies Study Team as a major cost driver. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems, automatic design, assembly, and control systems; expendable and recoverable components; improved structures and materials; increased propulsion efficiency; and significant reduction in the manpower intensive tasks of production, assembly, checkout, operations, and control. Approaches leading to techniques, processes, and products in support of these objectives are sought.

Reference A

TO: SBIR Proposers

To prepare better informed proposals addressing any of the topics presented in this DoD SBIR Program solicitation, you may request bibliographies of technical reports produced by prior DoD-funded R&D projects related to appropriate topics; bibliographies will include references to other sources of related information. Additionally, you will receive, if available, information about related DoD-funded R&D projects in progress. You may also request a copy of any of the technical reports you select from the bibliographies.

DTIC authorization to provide this service expires January 31, 1986, the DoD SBIR Program Solicitation 86.1 closing date.

Please use the request form below; fold, staple, stamp, and mail it back to us. Type or print legibly complete and accurate information. Be sure to indicate in the space provided that your firm qualifies as discussed in Section 2.0 of this solicitation document.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC'S SERVICES

REQUESTER _____ _____
NAME TITLE/POSITION

ORGANIZATION NAME _____

ADDRESS _____

CITY _____ STATE ZIP CODE Area Code / - TELEPHONE NUMBER

Please send technical report bibliographies and other information on the following DoD SBIR solicitation R&D topics:

DoD COMPONENT	TOPIC NO.		DoD COMPONENT	TOPIC NO.
		PLEASE TYPE		
		OR PRINT		

Company Status: I confirm that the small business concern identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD SBIR Program Solicitation No. 86.1.

_____
Signature of Requester

STAPLE HERE

PLACE
STAMP
HERE

RETURN ADDRESS

Defense Technical Information Center
ATTN: SBIR
Cameron Station
Alexandria, VA 22304

FOLD ON DOTTED LINE

Reference B

TO : (Fill in firm's name and mailing address)

SUBJECT : SBIR Solicitation No. 86.1
(Fill in topic No.) Topic No. _____

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by _____
(Fill in name of

_____
organization to which you will send your proposal.)

_____ _____
(Signature by receiving organization) (Date)

Reference C

Director of Small and Disadvantaged Business Utilization (SADBU) Specialists Assigned at Defense Contract Administration Services Regions (DCASRs) and Defense Contract Administration Services Management Areas (DCASMAs)

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