AIR FORCE SMALL BUSINESS INNOVATIVE RESEARCH PROGRAM

I. INTRODUCTION AND GENERAL INFORMATION

1. The purpose of the Air Force's portion of Small Business Innovative Research Program is to stimulate technological innovation.

2. This portion of the brochure is organized to facilitate timely submission of proposals by small business directly to the laboratory or product division which will ultimately evaluate the proposal. Listed in the next section are the addresses to which proposals should be submitted. In section III are the topics that the Air Force is interested in investigating through the Small Business Innovative Research Program.

II. PROPOSAL SUBMISSION

Proposals for SBID Air Force topics should be addressed to:

Topic 1:

AFOSR/XOT
Bolling Air Force Base
Washington, DC 20332

Topic 2:

AFHRL/TSMM
Brooks Air Force Base
Texas 78235

Topic 3:

AFRPL/TSPR
Edwards Air Force Base
California 93523

Topic 4 and 5:

AMD/RDO
Brooks Air Force Base
Texas 78235

Topic 6:

AFGL/XOP
Hanscom Air Force Base
Massachusetts 01731

Topic 7:

AD/DLOU
Eglin Air Force Base
Florida 32542

Topic 8:

AFWL/PRP
Kirtland Air Force Base
New Mexico 87117

Topic 9:

RADC/DORP
Giffiss Air Force Base
New York 13441

Topic 10:

AFWAL/XRPF
Wright-Patterson Air Force Base
Ohio 45433

Topic 11:

AFWAL/XRPM
Wright-Patterson Air Force Base
Ohio 45433

Topic 12:

AFWAL/XRPA
Wright-Patterson Air Force Base
Ohio 45433

Topic 13:

AFWAL/XRP-PO
Wright-Patterson Air Force Base
Ohio 45433

Topic 14:

SD/YLXT
PO Box 92960
Worldway Postal Center
Los Angeles, CA 90009

Topic 15:

ESD/TOE
Hanscom Air Force Base
Massachusetts 01731

Topic 16:

AEDC/DOT
Arnold Air Force Base
Tennessee 37893

Topic 17:

AD/CZO
Englin Air Force Base
Florida 32542

Topic 18:

BMO/PMX
Norton Air Force Base
California 92409

Topic 19:

ASD/XRU
Wright-Patterson Air Force Base
Ohio 45433

III. TOPICS

AF83-001 TITLE: General Science and Engineering.

DESCRIPTION: The Air Force Office of Scientific Research (AFOSR) exercises Air Force executive management responsibility for Air Force basic research. It awards grants and contracts for research in the new and innovative ideas which are involved in the search for new knowledge and ideas which are involved in the search for new knowledge and expansion of scientific entific principles. For FY83, AFOSR has special interest in multi-disciplinary initiatives in the following areas related to space.

a. This initiative will include programs for research to provide fundamental information on new materials, structures, and structural dynamics leading to improved stable spacecraft with extended life. Chemistry and materials research will focus on new ceramic, polymeric, and carbon-carbon concepts for dimensionally stable, environmentally resistant space composites; vibration damping materials; and non-welded, in-place joining and space processing of multiple composite units. Structural dynamics research will address active distributed control concepts and modeling for shape control, orbital transfer dynamics, and damping enhancement, and nonlinear large motion dynamic modeling for slewing and attitude control. AFOSR/NC

b. The objective of this program is to advance fundamental techniques for automatic analysis of images collected from space based sensors. The desired techniques should be able to provide timely, intelligent, semantic descriptions of the content of the image. The scope of this program is intended to address many topics and involve several disciplines. Valid topics for investigation include image-processing algorithms (such as image encoding, image models and representation, 3-demensional analysis, neurophysical fundamentals, image registration, analysis of time-varying images, such multospectral analysis of images and novel architectures (digital, optical, or hybrid). Efforts based on neurosciences, mathematics, computer science, artificial intelligence, or electronics approaches are sought. Integrated efforts addressing several topics and involving multiple investigators and disciplines are encouraged. AFOSR/NM

c. This initiative will provide fundamental information on new materials for performing hey roes in preventing enemy engagement of and reducing damage to next generation spacecraft. Research will focus on absorbing and obscuring materials including smokes, laser resistant materials, processes of evaporation/condensation and dissipation in space, radiation damage, and storage properties of potential materials systems. AFOSR/NM

AF83-002 TITLE: Human Engineering and Training.

DESCRIPTION: The Air Force Human Resources Laboratory (AFHRL) manages and conducts research and development programs in simulation, education, training, and personnel use technology. AFHRL has interest in any new and innovative ideas which include these areas. For FY83, AFHRL is interested in furthering research and development of teaching and training techniques.

a. An effective method is needed for identifying and applying relevant aspects of newly emerging microelectronics technologies to initial phases of aircrew training. A procedure is needed to determine least-cost electronics media options for training many academic and early phase aircrew procedural cognitive tasks. At least three major variables interact in such determinations: (1) task variables, the parameters which define human behaviors associated with procedural/cognitive task accomplishment; (2) electronic media capabilities, the hardware/software system characteristics applicable to training requirements; and (3) instructional variables, the pedaogogical specifications required for optimal training interaction between learner, median, and task. A system should be developed by which the elements within each of the three categories can be related and matched in order to determine the essential characteristics of least-cost training systems required for given tasks. The outcome of the concept development would be a demonstration in which the derived classification/analysis system was applied to a major training problem in order to produce the specifications for a least-cost, optimal capability training system to teach specified tasks. AFHRL/NM

b. The operational readiness of tactical C^2 elements is attenuated by the difficulty of teaching complex skills and the lack of opportunity to practice them. The problem requires a two-part solution: (1) the educational technology to teach complex situation assessment and decision making skills, and (2) the application of low-cost micro-computer technology appropriate to impart, measure, and maintain these skills. The feasibility assessment phase of this effort requires that the successful offeror identify and evaluate critical situation assessment and decision making requirements within selected elements of tactical Air Force command and control systems. Once critical training requirements are identified, they shall be matched and evaluated against both current educational and existing micro-computer based technologies to determine whether the development of complex skills trainers are with the current state-of-the-art. If determined feasible, the documentation shall include a functional description of the configuration and cost requirements for developing such a trainer. These specifications shall include precious for automated skill assessment and for the maintenance of skills once critical behaviors have been acquired. The successful completion of this study shall require that the winning offeror work closely with the potential user (to be selected jointly be the contractor and the AFOM) to: (1) identify critical behaviors, (2) determine user requirements, (3) facilitate the eventual implementation process, (4) insure that the product is responsive to dynamic user needs, and (5) insure the acceptance and usability of the assessment measures for improving training and performance. The recommendation and documentation that result from this feasibility study shall fully consider the requirements and constraints of a subsequent goal of combining individual trainers into a multi-station team training configuration that addresses critical team training issues.

AF83-003 TITLE: Rocket Propulsion technology.

DESCRIPTION: The Air Force Rocket Propulsion Laboratory (AFRPL) plans and conducts research and development to provide timely rocket propulsion technology options for Air Force systems. The AFRPL program comprises over half of the national investment in rocket propulsion technology. AFRPL has interest in any new and innovative ideas in rocket propulsion technology. For FY 83, AFRPL is interested in techniques for fabricating large inflatable reflectors.

This acquisition is for an applied research program to demonstrate that inflatable reflectors can be made with surface accuracy to within 0.1 mm rms for diameters of 10-30 meters. A three task effort is anticipated as follows: Task 1: Determine the cost and schedules associated with these materials. Investigate methods for forming films in special or controlled configurations. Determine minimum thickness that have been used. (NOTE: The goal here is not to develop a new technology but to determine the cost of applying current techniques to the large reflector.) Task 2: Investigate alternate seam configurations, including the use of different materials for the seam and the gore. Experiment with the additional bonding agents (heat activate, glue, tape). Determine the effect of various seam widths on structural integrity and ease of assembly. Seaming configurations to be studied shall include: (1) An all seam layup (fully overlapped gores), (2) tapered wedge-shaped butt joints and (3) material removal at seams which are then joined with thin tape. Task 3: Construct two 3-meter paraboloids using the best of the above techniques. Measure actual surface contours under pressure and the rms deviation from the desired shape. AFRPL/DYA

AF83-004 TITLE: Biotechnology.

DESCRIPTION: The Air Force Aeromedical Research Laboratory (AFAMRL) specializes in theoretical and experimental biotechnology research and development in biodynamics, human engineering, combined aerospace stress effects, and toxic hazards. It is a center of excellence for noise research. AFAMRL had interest in any new and innovative ideas which are involved in these areas. For FY83, AFAMRL is interested in techniques to develop injection molded visors.

The purpose of the effort will be to assess the feasibility of developing new injection molding techniques for producing optical quality parabolic and toroidally-shaped visors for use in helmet-mounted sights and displays. The technique must allow the mass production of these visors at a low cost using acrylic and polycarbonate materials. Suitable techniques for assessing the quality of the visors are also needed. Specific contours for the visors will be provided by the Air Force. AFAMRL/TSQ

AF83-005 TITLE: Aerospace Medicine.

DESCRIPTION: The United States Air Force School of Aerospace Medicine (USAFSAM) conducts biotechnology research and development, medical evaluation and education, consultation, and aeromedical support for the USAF. Investigations encompass laboratory and clinical studies in all areas of physicallogical, environmental, and dynamic conditions which may affect the health and performance of Air Force personnel under a variety of operational circumstances. USAFSAM is interested in prosthesis technology.

Technology in prosthesis engineering has advanced remarkably in the past decade and offers a foundation for closer coupling of man and machine (pilot and aircraft). This contractor will prepare a stat-or-the-art assessment of this technology, perform a critical analysis of potential USAF application, and conduct preliminary design studies for systems to couple pilot and aircraft. USAFSAM/TSQ

AF83-006 TITLE: Geophysics.

DESCRIPTION: The Air Force Geographics Laboratory (AFGL) is the center for research and development in geographics and conducts research in missile geograpjics, upper atmosphere and stratospheric operations, ionospheric effects, the optical/infrared environment, meteorology and the space environment. AFGL has interest in any new and innovative ideas involving these areas. For FY83, AFGL is interested in technology for measurement of water vapor.

The initial effort will consist of developing models simulating water vapor profiles to determine the response of a multi-frequency microwave radiometer to a realistic range of variables encountered in the atmosphere. The results of this effort will be used to design and prepare the specifications for a satellite borne multi-frequency microwave radiometer capable of obtaining water vapor profiles in clear and cloudy atmospheres. AFGL/XOP

AF83-007 TITLE: Munition Technology.

DESCRIPTION: The Air Force Armament Laboratory (AFATL) is the principal Air Force laboratory performing research and development of free fall and guided non-nuclear munitions and airborne targets and scorers. These include chemical and fuel-air explosives energy sources and conversions, electronic and mechanical devices, bomb, dispensers, fuzes, flares, guns and ammunition. AFATL has interest in any new and innovative ideas in munition technology. For FY83, AFATL is interested in shaped charge, self forging fragment, and solid state slapper detonator development.

a. The objective of this program is to evaluate the importance of linear microstructure to warhead design by comparing the performance of a material with a nominally superplastic microstructure and identical alloy, but which has microstructural characteristics more in line with current volume production methods. AFATL/DLJW

b. The objective of this program is to determine the feasibility and applicability of batch produced slapper detonators and hi-voltage switches utilizing micro-electronics and micro-electronics and micro-machining technology. Feasibility is defined as actual construction and firing of a sample detonator and switch. AFATL/DLJF

AF83-008 TITLE: High Power Technology.

DESCRIPTION: The Air Force Weapons Laboratory (AFWL) conducts research and development programs in laser and particle beam technology, nuclear weapons effects and safety, and nuclear survivability and vulnerability. AFWL has interest in any new and innovative ideas in directed energy and nuclear technology. For FY83, AFWL is interested in high power technology.

a. A microwave device is needed which would have applications in high power, high resolution radar, plasma heating, linear accelerator drivers, ground to space power transmission, military electronic countermeasures, etc. Such a device must be compact (Smaller than 30 cubic meters, excluding prime power source), tunable over a factor of 10 in the GHZ portion of the spectrum, capable of narrow and broadband emission, and having the power output in the tens of GW, single pulse, one microsecond per pulse. AFWL/NTYP

b. A high current, high voltage opening switch is needed for a variety of pulse power applications, including flash x-ray generation, charged particle acceleration, mass drivers, etc. The need for single shot as well as repetitive switches. For single shot devices, and opening switch capable of handling 50 megamps for five microseconds, opening in times less than 200 nanoseconds is desired. For reprating, a switch is needed to direct one megamp, opening time 20 nsec, reprate 1-10 kilohertz. AFWL/NTYP

c. There is an Air Force requirement for a repeated explosively or magnerohydrodynamic (MHD) driven power source. Current research in magnetoflux compression generator (MCG) technology aims at designing efficient single shot devices. Present MHD devices can operate CW at modest levels. A need exists for a transportable power source having an electrical output of 0.5 megajoule per pulse, 10pulses/sec, pulsewidth of 10 microseconds, 100 pulses run time. AFWL/NTYP

AF83-009 TITLE: Electronic Component Reliability.

DESCRIPTION: Rome Air Development Center (RADC) is the practical organization charged with Air Force research and development programs related to command, control, communications, and intelligence. RADC is responsible for advancing this technology and also demonstrating selected systems subsystems in the areas of intelligence, reconnaissance, mapping and charting, and command, control and communication. RADC has interest in any new and innovative ideas in the above areas. For FY83, RADC is interested in the following areas:

a. The technology for Monolithic Microwave Integrated Circuits (MMIC) has advanced to the point that they are being considered for system applications that may require as many as 1,000,000 MMICs. The MMIC approach has the potential for low cost in production. Projections to date show that the testing of MMICs will be a substantial portion (>25%) of the total circuit cost. New innovative solutions to the testing of MMICs will be required if their full cost benefit is to be realized. MMIC transmit/receive modules for phased arrays are recommended as a vehicle for this study. RADC/OCTP

b. Sources are sought to develop a software cost estimation model capable of accurately predicting costs in the conceptualization/formulation stages of embedded systems acquisition. The model must be vendor independent, since it is DoD's policy to make competitive awards wherever possible. RADC/COE

c. There is a pressing need for vitreous optical materials which are continuously transparent from the ultraviolet to the mid infrared region of the spectrum. Applications for such glassy materials include, but are not limited to, multispectral optical components such as lenses, windows, solid slate lasers, and Faraday rotators for optical switching and IR domes as well as low radiation-hard optical waveguides operating in the 2-8 micron regime. The recent discovery (1977) of new families of non-oxide halide glassy based, for example, on the fluorides of various heavy metals, offers a glassy material transparent in the 0.1-10 micron region. R&D sources are sought for an interactive research program on the preparation of heavy metal fluoride glass samples of large sizes (10 cm dia x 1-1/2 cm thick). The contractor should be capable of preparing fluoride glasses of various compositions. The work will include development of techniques to yield reproducible glasses with low water and impurity content. Also the contractor should be able to prepare heavy metal fluoride in different shapes. The contractor shall characterize glasses developed in the course of this program in terms of their optical, thermal, and mechanical properties. RADC/ES

d. The Air Force has a requirement to identify/characteristics ground and airborne tactical targets at remote distances. Preliminary research has indicated that it may be feasible to derive signatures of transmitting targets by reflections from obstructions on the target. A signal and its perturbations caused by reflections from obstructions on the target. A signal processing technique (Cepstrum Analysis) which enables

separation of a signal and its echoes has been considered for this application. The application of Cepstrum Analysis and/or other processing techniques to the identification/characterization problem requires further investigation. Areas which must be addressed include determination of appropriate processing technology and its application to the development of unique signatures for various classes of targets. RADC/IRAE

e. The development of the read/write optical disk for mass storage systems logically leads toward the need to update and upgrade stored information. The ability to selectively erase and rewrite information would greatly reduce the cost of the optical disk. Future proliferation of the optical disk in mass storage systems couples with increasing data rates and storage requirements will necessitate using a reusable optical disk instead of a non-erasable optical disk in reat-time mass storage systems. RADC/IRAP

f. The pattern of recognition efforts in automatic feature extraction of digital imagery, multi-dimensional image processing and multi-imagery exploitation system (MIES) are addressing image processing and artificial intelligence applications within existing processing system and are not adaptable in AI problem situations more complicated than a simple neighborhood situation. The objective of the effort is to define the target detection and pattern recognition problem in terms of artificial intelligence rules and develop a plan for application to the imagery hierarchy and develop a knowledge base for the most difficult of image pattern recognition problems. Define the process of pattern recognition (target detection and identification) such that a computer con suggests. Develop a plan that will determine how the AI techniques should be best applied to the imagery hierarchy. Based on the plan and process defined, develop a knowledge base that represents the image patterns to be recognized including the most difficult of image pattern recognition problems including CC&D targets, seasonal changes and ambiguities representative of all imagery types. This program will provide a pattern recognition and target detection knowledge base and rules for global pattern recognition in a digital image. RADC/IRRE

g. As a result of exploratory development effort during FY82 and FY83, the technical feasibility of applying decision analytic (DA) artificial intelligence (AI) and operations research (OR) techniques to the planning of discrete portions of the offensive Counter Air Mission planning process has been demonstrated. The discrete decision aids currently addresses the problem of the target prioritization/selection, mission planning (nomination of aircraft from known assets) and route planning. The decisions were developed independently using a variety of hardware and software tools. In order to demonstrate and exploit the full potential of the DA, AI, and OR based decision aids for Tactical Air Force (TAF) application, the feasibility of interrogating these aids into an advanced development model is required. The vertically Integragated decision aide suit will be developed within a scenario of TAF operations beginning with the Commander's apportionment decision and carrying through to individual pilots selecting ingress and egress routes from targets. The first phase will address the feasibility of Integragating this technically adverse set of aids into a vertically integragated set of addresses the functional requirements of Offensive Counter Air Mission planning from target nomination to pilot route planning. Contingent upon successful feasibility study results a second phase will be undertaken to integrate the decision aids into an advanced development model for demonstration and evaluation. The aids will be made as uniform as possible with respect to man-machine interactions and will operate on common data set in a single thread scenario. Evaluations are to operate on a common data set in a single thread scenario. Evaluations are to be performed from technical and operational Tactical Air Force perspectives. RADC/COAD

h. The technology for Monolithic Microwave Integrated circuits (MMIC) has advanced to the point that they are being considered for system applications that may require as many as 1,000,000 MMICs. The MMIC approach has the potential for low cost in production. Projections to date show that the testing of MMICs will be a substantial portion (>25%) of the total circuit cost. New innovative solutions to the testing of MMICs will be required if their full cost benefit is to be realized. MMIC transmit/receive modules for phased arrays are recommended as a vehicle for this study. RADC/OCTP

i. There is a pressing need in DoD for highly durable optical fibers both for high strength applications such as well as high reliability application of a strategic of tactical nature. Moreover, increased durability of optical fibers date no single method has a proven capability for long lifetime without a decrease in dynamic fiber strength and/or fiber transmission characteristics. An interactive research program on the preparation of optical fibers hermetically coated to be used in long-line communication systems under severe

environmental conditions is contemplated. The contractor should be capable of depositing under vacuum, metal and diamond-like carbon coatings on long length, low loss, high bandwidth, state-of-the-art graded index optical fiber drawn from CVN performs producted by the contractor. The coating applied by plasma ion deposition techniques, should be in-line and non-conducting. Also the contractor should be able to conduct strain-rate analysis and detailed fatigue testing on the coated fibers.

AF83-010 TITLE: Flight Vehicle Technology.

DESCRIPTION: The flight Dynamics Laboratory (AFWAL/FI)
develops technology for design and fabrication of future aerospace weapons systems. The laboratory also conducts configuration research of advanced vehicles, performs engineering simulation, and develops experimental flight vehicles to demonstrate new technologies. The laboratory is the Air Force focal point for non-nuclear survivability and vulnerability and atmospheric electrical hazards study. The laboratory has interest in any new and innovative ideas which include these areas. For Fy83, the laboratory is interested in the following areas:

a. Reductions on aircraft life cycle costs be achieved by achieved by reducing maintenance costs and extending structural life. This is accomplished through development of design and repair methods to improve structural element durability and damage tolerance. Research efforts are needed to provide improved understanding of and predictive methods for the failure process in structures and engineering materials, including the identification, characterization and analytical modeling of critical parameters. The failure process include property degradation (residual strength), fatigue damage accumulation, crack iniation and propagation, and fracture. Critical parameters including and environmental factors such as temperature, moisture, vacuum and electromagnetic radiation. Specific research in durability should focus on metallic alloys and super-alloys for high temperature applications and advanced composite materials using polymeric resins or metallic matrices. AFWAL/FIBE

b. Spacecraft systems developments in the Air Force are moving in the direction of large spacecraft structures with distributed electronics and sensors. Integrated with these systems are concepts including power systems and cryogenic refrigeration subsystems which must perform reliably and demonstrate efficient energy management techniques. Fundamental technical challenges will arise from implementing advanced spacecraft analysis and design efforts which include processing megawatts of energy and waste heat. Therefore, technological advancements are required for the development of spacecraft thermal management techniques in which waste energy from power sources, cryogenic refrigeration devices, and electronics is effectively managed and utilized for power generation and environmental control of heat transfer by radiation. Approaches currently being considered include analysis of heat powered refrigeration cycles for spacecraft thermal control and the establishment of space energy and waste heat generated in future spacecraft systems. AFWAL/FIEE

c. The effective and efficient interface between human (Pilot) and machine (Aeronautical/Aerospace Vehicle) is critical to mission success. Research and development efforts are required to develop and effectively integrate new technologies directed at minimizing crew workload. One specific area is the development of mathematical models of the dynamic interaction between the human pilot and the flight control system which involves internal processing and decision making as well as discrete and continuous control inputs. Adequate mathematical models of these dynamic interactions are needed in all piloted system design studies and developments to insure flight qualities and response characteristics of the piloted system. Current mathematical models require extensions to permit analytical consideration of realistic flying tasks characterized by large amplitude motions with time-varying or non-linear dynamic behavior. AFWAL/FIGC

AF83-011 TITLE: Materials Technology.

DESCRIPTION: The materials Laboratory (AFWAL/ML) manages Air Force research and development in materials and manufacturing technology programs. It also plans and conducts specific programs in materials research designed to reduce cost, improve reliability and performance of aircraft, missiles, spacecraft, and support

equipment. The requirements of advanced generations of weapons system will not be met without significant advances in materials technology and the kind of farsighted materials research programs which will make advances possible. AFWAL/ML has interest in any new and innovative idea in materials technology. For FY 83, the laboratory is interested in the following materials technology research areas.

a. In Air Force systems today, materials are operating at or near their capacity with regard to stress, temperature and environment. Yet, it is necessary to prolong use of current systems, and to envision new ones which will demand lighterweight structures of extreme reliability and with resistance to corrosive attack or sudden failure. A rational basis for creating or improving material systems (such as alloys, polymers, glasses, ceramics, and composites) is required and should be obtainable through understanding of the principals that govern properties and behavior as a function of microstructural features composition, and processing parameters. This should lead to a methodology to obtain families of new or improved materials without the expensive and time-consuming- trial-and-error approach which characterizes current state-of-the-art. In order to reach beyond the present limitation, understanding of the factors that control material properties and behavior is required. Specific needs encompass concepts for reliable high strength iron base alloys (240-260 ksi), aluminum alloys for aircraft structures applications, metal matrix composites with high strength and high modulus to density ratios, and alloys specifically formulated for power metallurgical fabrication of high structural efficiency and high temperature components. The need for analytical modeling is particularly acute in the field of thermally-protective materials. Such materials are typically composites in which the fibers are oriented in two or more directions. ADWAL/MLL

b. Fundamental knowledge is needed for polymer characterization to confirm molecular structure and determine physical and chemical property correlations. These are needed as guidance to the synthesis of monomers, oligomers, prepolymers, polmers, and resin systems which offer desirable balances in properties, namely with respect to environmental stability, processability, mechanical behavior and costs to fulfill current and future requirements. Fundamental structure-property correlations are needed to interrelate physical and mechanical properties with molecular and super-molecular structures. this elucidation and application of fundamental polymer structure-property correlations is essential for the development of synthesis and processing chemistry needed to generate new resign systems. Further, a technical basis must be provided for the reliable prediction of the use properties from the polymer structure and properties of candidate materials for advanced matrix resins, adhesives and molecular composites. AFWAL/MLBP

c. Approaches are needed to the synthesis and characteristics of polymeric materials specifically tailored in molecular structure for new, improved matrix resins and adhesives. Included are (a) high molecular weight processable polymers exhibiting high thermal stability which by virtue of chemical additions, cycloadditions or rearrangements can be cured to high strength materials, (b) polymers containing a high degree of chain rigidity which can be ordered (and/or oriented) and processes to high strength materials, (c) reactive oligomers capable of being converted to environmentally resistant, high molecular weight, high glass transition temperature materials by controlled chemical addition reactions and/or molecular rearrangements, and (d) low polymers or propolmers which can, without the production of by-products, be chemically cross-links to high polymer networks with excellent resistance to thermochemical and mechanical and mechanical environments and stresses. This also includes research to provide improved new polumer forming reactions and approaches to the synthesis of specifically structured chemical intermediated, multifunctional monomers and cross-linking agents required to product the above polymeric materials.

d. New approaches leading to higher temperature performance of nickel, aluminum, and titanium alloys and ceramics are required.

- Nickel Alloys. Research is required to identify thermodynamically stable oxidation-resistant turbine engine blade and vane materials possessing high melting points and significantly improved stress rupture and fatigue properties. An improved basic understanding of rapidly solidified power metallurgy is especially important in view of its potential for producing alloys with superior properties.

- Titanium Alloys. Research is required to identify approaches leading to the formation of new titanium alloy systems capable of sustained operation at temperature up to 1600 °F are needed for advanced propulsion system critical components such as blades and disks.

- Aluminum Alloys. Research to identify approaches leading to aluminum alloy systems capable of sustaining repeated high stresses in the 450° to 650° temperature range are required for advanced aircraft critical components.

- Ceramics. Research to identify new families of ceramic materials capable of economical consolidation and possessing improved creep, thermal stress, and static fatigue resistance is needed to extend the limits of future generation high temperature turbine engine components. An improved understanding of the design, fabrication, and properties of ceramic matrix composites is especially important.

- Metal Matrix Composites. Research to identify approaches leading to the development of metal matrix composites with high impact resistance for use in turbine engine blades and vanes. AFWAL/MLLM

e. Predictability of the effects of corrosion on the loadbearing capability of structure requires fundamental knowledge of chemical, electrochemical, mechanical and metallurgical influences, and their interaction. Durability, which has direct impact and life-cycle cost of Air Force systems, is severely limited by hostile environments. Because the degradation of structural integrity by corrosion is a highly coupled phenomenon, sophisticated analythic and experimental skills from diversified fields will be needed to address the problem. AFWAL/MLSA

f. Cumulative damage models for metals and composites due to timevarying loading and environments are required as a basic building block for life predictions. This model should be derived for laboratory-size specimens with and without stress concentrations. Effects of mean stress, positive and negative stress ratios, combined stresses, overloads, rate and frequency of loading, hold time, load sequencing and damping need to be investigated. Materials can then be designed to a required reliability. AFWAL/MLLN

g. The performance, reliability and durability, and aerospace systems depend directly on the availability of improved functional fluids and lubricants. Currently used functional fluids are highly flammable and lack intrinsic oxidative and thermal stability at high temperatures. There are also significant needs of wider temperature range lubricants and higher temperature greases. Synthesis approaches to new high molecular weight, low vapor pressure chemical systems molecular weight, low vapor pressure chemical systems molecularly tailored to lower flam abilities, increased stabilities and broadened fluid ranges are needed. The syntheses and characterization of new synthetic fluids, for example alfa olefins, silahydrocarbons, and polyalkybenzenes, and associated additives to improve their chemical and physical properties are required to replace petroleum-based fluids which may be increasingly more limited in availability in the future. Fundamental studies aimed at improved understanding of the molecular structure-property relationships of these fluids and lubricants and improved understanding of the mechanisms of their thermal and chemical degradation under use environments, for example in the presence of metallic species, oxidizing agents or other substances capable of enhancing degradation, are required to guide future synthesis efforts and to permit prediction of the behavior of theses materials in service. AFWAL/MLBP

h. 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 components, subassemblies, and entire systems during of following manufacture, throughout their service lives, and as part of any maintenance and repair procedures. The items to be inspected, their service conditions, and their requirements or definitions of acceptability are thus tremendously, varied. Research in this area includes the study of mechanisms underlying these phenomena to permit the extraction of quantitative information about the nature of any defects or flaws in materials and coatings of interest, including metals, ceramics, organics, composites and various electromagnetic devices and systems. For example, research is needed on electromagnetic, ultrasonic, and new or improved methods of detecting both bulk and surface cracks or other defects arising from manufacturing operations, fatigue, corrosion, impact, or radiation damage. Also,

the interrelationships between defects on both microscopic and macroscopic levels and the behavior and the quality of materials or components must be determined. This information will guide the development of NDE techniques by defining the nature, size and distribution of the defects or flaws that must be detected and characterized, and will thus contribute to an improved basis for the development of rational accept/reject criteria. Research on the factors which influence the reliability and accuracy of NDE measurements is needed to maximize the probability of detecting defective materials or parts while at the same time minimizing the likelihood of costly rejections of satisfactory ones. AFWAL/MLLP

i. The design and management of manufacturing functions and methods have in the past been largely ignored by scientific and technical communities. As a result, the process and practices currently in use have largely involved through trial and error and the timely solution on a case-by-case basis of specific manufacturing problems. The current emphasis on productivity enhancement, resource conservation and quality improvement, coupled with the technological opportunities that are now emerging, particularly as a result of the tremendous reduction in cost and increase need for interdisciplinary manufacturing science research efforts.

In the area of intelligent manufacturing task automation, research is needed on improved models to describe the tasks to be performed, the economic and other productivity implications of the process to be used, and the means of acquiring, storing and accessing the data to be used in process planning and control; sensors for visual f other means of part recognition and spatial location, for force, torque or tactical information acquisition, and for the determination of geometric and internal material characteristics are needed to provide information for in-process quality assurance and process control; simulation equipment for modeling manufacturing process and material behavior under conditions of processing; and control theory, adaptive learning, artificial intelligence and other branches of computer science related to the problem of acquiring and rapidly processing the huge volumes of manufacturing process information that would be available are required for intelligent, self optimizing, closed-loop adaptive control of flexible, automated manufacturing processes, of advanced robots, and of complex manufacturing tasks such as aerospace system assembly. AFWAL/MLBE

AF83-012 TITLE: Electronic Technology.

DESCRIPTION: The Avionics Laboratory (AFWAL/AA0 develops electronic technologies for airborne systems. Research is centered around reconnaissance, weapon delivery, navigation, electronic components, communications, electronic warfare, and software. This technology is used to develop radar and electro-optic sensors, fire control computers, precision ineterial reference systems, miniaturized digital memories, signal processing warning receivers, adaptive jammers, and information possessing systems. AFWAL/AA has interest in any new and innovative ideas which include advances in electronic technologies. For FY 83, the laboratory is interested in the following avionics technologies.

a. Gallium Arsenide memories may well have access times of less that a nanosecond. There are two aspects that require study. First, what does this increased access speed mean to the throughout of signal processors and how is both logic and memory on the some integrated circuit chop. Perhaps, this integrated logic-memory approach is mandatory if the access speed of the memory is to be preserved and not lost in driving on and off memory and logic chips. Simulation to verify the analysis is preferred. AFWAL/AADE

b. The metal ceramic helix is a promising candidate for RF circuit applications in traveling wave tubes. It consists of a helically wound metal ribbon with an outside cladding of a congruent thick ceramic layer. The complete RF circuit is composed of a tubular outer barrel into which the composite helix is tightly fitted. Until now, the lack of quantitative knowledge on the RF circuit impractical traveling wave tube designs. Rational design engineering approaches require information on the frequency dependence for (a) the phase velocity, (b) the characteristic impendence, and (c) the longitudinal coupling impedance on axis). These quantities are needed as a function of the essential parameters such as relative ceramic shape and thickness and helix pitch as depending on the frequency. It is the objective of this study to develop these data through a theoretical study. AFWAL/AADM

c. Several attempts have been made to vapor deposit aluminum nitride on copper substrates. Thickness of up to eight mils have been obtained before erratic growth. Anistropic pyrolythic boron nitride (APBM) is thought to have a higher figure of merit (ratio of thermal conductivity to dielectric constant) than aluminum nitride. It is proposed that an effort be initiated to deposit samples of boron nitride on to copper substances at thickness up to 0.68 meters. AFWAL/AADM

d. The use of composite materials in the fabrication of wave-guides for airborne applications is a promising area for investigation. Materials such as graphite and/or Kevlar can be used to fabricate lightweight, high strength, dimensionally stable structures with mechanical and electrical properties nearly equivalent to standard aluminum wavelengths. It is desired that several sections of x-band wave guide be fabricated such as straight sections, bends, and a directional coupler. These sections must exhibit the insertion loss, conductivity, VSWR, power handling capability, temperature response, and coupling of standard aluminum waveguides. The most critical area of composite waveguide is the inner conductive wall of silver or aluminum which must be approximately three to six miles thick with less than one ohm per cm^2 resistively across the surface. The conductive lining must adhere to the composite while being uniform, parallel, a perfectly smooth with no bare spots, surface pits, scratches, or nicks. The finished lining imperfections must not constitute more than one percent of the total coated surface and not be concentrated in one local area. Flanges made of composite material must also be attached to the waveguide to provide coupling to other sections without sacrificing electrical performance. In general, it is desired to fabricate lightweight composite waveguides with the characteristics of standard aluminum waveguides. AFWAL/AADM

e. Research in the electromagnetic theory and information processing area is required to develop methods of extracting target information from its far field pattern directly. This information could then be utilized for target identification and also providing phase information related to motion characteristics of either the target itself of the illuminating platform. This research would consist of two primary sequential components: (1) Electromagnetics (E-M) theory research concerning far field representation of target phenomena, and (2) Artificial intelligence implementation which would develop the E-M theory "expert" with associated adaptive processing. The first application of this technology is seen to be in the synthetic aperture radar (SAR) area since SAR in essence reconstructs, through elaborate phase compensation, the far-field pattern over a limited aperture and frequency regime of the target during the imaging process. AFWAL/AARM

AF83-013 TITLE: Aero-Propulsion Technology.

DESCRIPTION: The Aero-Propulsion Laboratory (AFWAL/PO) plans and conducts research and development in air-breathing propulsion, flight vehicle power, fuel, lubricants, and fire protection. AFWAL/PO has interest in any new and innovative ideas which include the above areas. For FY83, the laboratory is interested in advances in the following areas.

a. Air Force requirements in energy storage and power generation devices cover a wide range of research areas including electrochemistry, superconductivity, plasma physics, advanced optical measurement techniques and thermal energy conversion, control, storage, and heat transfer. Specific research will be conducted in non-aqueous electrolyte batteries and new electrode/electrolyte combinations that could provide vast improvements in energy density, low temperature operation, power density and cycle/storage life. Research in superconductors will aim at approaches toward understanding and reducing losses in Type II superconductors due to time-dependant fields. Optical techniques such as laser Induced Fluorescence, Coherent Anti-Stokes Raman Spectroscopy and Photo-Acoustic Spectroscopy will be studied along with fast optical detectors and absorption spectroscopy using pulsed tunable diode and dye lasers. Plasma studies will include nonequilibrium plasmas, electron collision cross sections, plasmas chemistry and lifetime improvements for closed cycle lasers, power conditioning and high voltage switching, advanced diagnostics for temporally and spatially resolved phenomena and plasma chemistry studies in rf discharges. Thermal studies will be conducted to investigate phase change materials, liquid metal heat pipes. The distributed evaporator, liquid pump enhanced heat pipe concept, and thermal energy concepts for pulse power loads will also be investigated. AFWAL/POO

b. Turbomachinery of low aspect ratio and high stage loading will be investigated with the goal of reducing the manufacturing and maintenance costs and improving the mechanical integrity of aircraft turbine engines. Analytical methods will be upgraded to include three-dimensional the time-unsteady effects. Controlled experiments and advanced instrumentation will be used to obtain a better definition of three-dimensional and time-unsteady features of the turbomachinery gas path. Design innovations such as leading-edge sweep, variable fillet geometry and unconventional airfoil optimization techniques will be evaluated experimentally. AFWAL/POTX

c. The objective of this research task is to increase understanding and utilization of the technical disciplines encompassed by solid mechanics of structural systems as they relate to the optimum design and performance of aircbreathing propulsion systems. Advanced theoretical and experimental methods will be developed for the analysis and evaluation of the structural behavior of turbine engine components will be investigated using state-of-the-art structural analysis techniques. Problems of current Air Force importance in this area include transient and steady state structural mechanical response of turbine engine blading and discs. Efforts will investigate bladed-disk structural response using image-derived holographic interferometry. Research will be carried out to study the phenomena of damping and blade mistuning with regard to their effect on modal response of the bladed-disk system. Dynamic structural behavior disc systems will be studied under stimulated and actual turbine engine operating environments. AFWAL/POTC

d. The objective of this program is to conduct analytical and experimental studies of the fluid dynamics, chemical knetics and combustion dynamics relevant to the development to the development of advanced supersonic and hypersonic ramjet propulsion systems for strategic and tactical missiles. Representative test configurations, involving the turbulent mixing and combustion of high-speed heterogeneous fuel air streams, will be investigated under conditions representative of those encountered in integral rocket-ramjet propulsion systems. Extensive experimental effort will be undertaken to develop a broad base of flow field measurements using gas sampling, laser velocimetry, and flow field visualization techniques. AFWAL/PORT

e. The objective of this research is to expand the technology base in the areas of combustion dynamics, fuels combustion, as well as fire and explosion protection for Air Force weapon systems. The emphasis of the work in combustion dynamics is experimental investigation of combustors of varying complexity. Measurements obtained from laboratory experiments will be used to validate and improve mathematical models of combustion under fluid flow conditions encounter red in aviation gas turbine combustors and afterburners. In the area of fuels combustion, effort will concentrate on the formulation of a mathematical fuel combustion model that includes the effects of the chemical and physical properties of hydrocarbon fuels. In fire and explosion protection, effort will focus on formulating a mathematical model for the hot surface ignition of fuels, lubrications and hydraulic fluids. Experimental effort will be performed to provide data needed to formulate and validate the mode. AFWAL/POSF

AF83-014 TITLE: Space Systems Technology.

DESCRIPTION: Space Division (SD) manages all system programs to acquire space systems/subsystems, support equipment, and related hardware and software. SD also performs advanced development technology on programs which support future space mission needs. In this latter capacity, SD is interested for FY83 in any new and innovative ideas in the following areas:

a. COSMIC Ray Interference. The objectives are: (1) Investigate material to shield digital/space equipment to protect against cosmic rays interference to accurate equipment operation. (2) Establish LSI process/design constraints to minimize hazard.

System Program Offices (SPO) have reported loss of information in their digital computer(s). The loss has, so far, been other problems which have not been detected and may be more serious in long term effects.

Guidelines for material or equipment configuration to protect against cosmic interference are the technology product desired. SD/ALT

b. Gallium Aresenide (GaAs) Processor Technology. The objective is to study and develop GaAs technology to support the future design and development of full baseband signal processing. GaAs offers high speed, low power consumption, and radiation hardness. By extending the current MSI/LSI GaAs integrated circuit complexity into the VLSI and eventually VHSIC regions, a number of signal processing functions can be combined into, and performed by, a dingle chip. This extension of GaAs IC technology could lead to substantial increases in processing capability and greatly enhance autonomy and survivability of future MILSTCOM systems.

Present MILSATCOM systems suffer from insufficient processing capability due to large weight and power associated with today's processing technology. Additional problems include limitations on speed and radiation hardness. GaAs technology has the potential to solve all of these problems. Before the advantages of GaAs can be exploited, however, we must develop IC's of greater complexity. Once VLSI and VHSIC GaAs IC's evolve, full baseband processors operating at very high speeds and requiring very little power will be possible.

To extend the development of GaAs technology into useful VLSI and VHSIC, the government should take several steps. First, we should track current GaAs development efforts. From this ongoing study, we should form a development and use of GaAs VLSI and VHSIC chips in full baseband signal processors. The government labs should take the lead in pushing the technology to meet the development schedule. They can accomplish this through device design and modeling, development of practical multichip circuits, applications tests in subsystem breadboards, and reliability life testing. By tracking industry, and coordinating government efforts, we can expediently and efficiently drive the current MSI/LSI level GaAs IC's into the realms of VLSI and VHSIC, and begin development of a VHSIC GaAs full baseband processor.

Technology product desired is the development of GaAs IC's to support a future baseband signal processor program. SD/YKX

c. V-Band Crosslink Amplifier (60 GHz). The objective of this effort is to develop and demonstrate a space-qualified, millimeter-wave (60-63 GHz) , solid-state power amplifier for crosslink (satellite-to-satellite) communications application. Performance goals include a power level of 5-10 watts, 10% efficiency and a 10 year operational life.

Crosslink communication requirements impose high reliability and long life constraints on the amplifier. The communications capacity requirements make a 5-10 watt amplifier a desirable size. At 60 GHz, present devices cannot provide this power level. In addition, the reliability of the most promising circuit design is also necessary before this technology can be considered sufficiently low risk for a space-borne application.

That a prototype amplifier he developed for anticipated space use is a suggested approach. Design and initial testing should anticipate the requirements of the space environment and specifications and standards tailored accordingly. Emphasis should be placed on IMPATT diode optimization and development of a breadband combiner/ amplifier configuration.

Technology product desired is space qualifible 60-63 GHz Solid State 5-10 W Amplifier. SD/YKX

d. 60 GHz Crosslink Antenna Subsystem. The objective is to develop a transmit/ receive steerable-beam antenna subsystem with acquisition and tracking capability. This subsystems design must be compatible with the requirements of the cross-link (satellite-to-satellite) communications system. We project the following design goals:

EIRP	60 dBw
G/T	25 dB/°K
Bandwidth	1 GHz
HPBW	0.35 degrees
Acquisition Angle	Hemispheric Coverage
Pointing Error	+ 0.02 degrees
Beam Pointing	150°/second
Acquisition Time	6 second
Acquisition and Tracking	±0.8 degrees/within 6 seconds
DC Power	Minimum

Satellite-to-satellite data links will be an essential part of future C^3 systems. To be successful, cross-links must have very high EIRP and very narrow half power beamwidths (HPBW). These requirements demand that acquisition and tracking modes be extremely precise. To achieve the high EIRP, narrow HPBW, and extreme accuracy required of future cross-link antenna systems, development is needed in several technologies.

Suggested approach is to develop cross-link antenna technology, develop, study and tradeoff several acquisition and tracking techniques including monopulse and conical lobe methods. Also, study several types of reflector configurations which present alternate antenna designs. Identify any high risk technology and components necessary for a 60 GHz cross-link subsystem, and begin appropriate hardware development.

Technology product desired is a 6 GHz Crosslink antenna subsystem study which makes tradeoffs, recommends a design, and identifies high risk areas. Hardware development of critical high risk technology and components. SD/YKX

e. 44 GHz Low Noise Receiver Front End. The objective of this task is to study the development of a highly reliable, space qualifible, 44 GHz low noise front end receiver for space-borne applications.

Currently, the three possible candidates for use in a 44 GHz low noise front end are cooled and uncooled preamps, use of image rejection mixer diodes for down conversion followed by an intermediate frequency (IF) high gain receive amplifier, and low noise FETs followed by amplification used directly at 44 GHz. Preamps, especially cooled systems, add unnecessary size, weight, power drain, and overall assembly complexity and are unacceptable for space-borne applications. Image rejection mixer technology is preferred over the use of low noise FETs above 30 GHz. This is because the noise figure associated with low noise FETs increases proportionately to the square of the frequency. At 44 GHz, noise figure associated with low noise FETs is currently unacceptable. Novel new design approaches and greater control of manufacturing processes are needed to reduce the noise figure and increase the gain of low noise FETs at 44 GHz the advantage of using low noise FETs, if the noise figure can be reduced, is that they provide initial amplification which reduces application noise in the high section that follows. Image rejection mixer diodes, while providing virtually no amplification, have very low noise figures and allow down conversion to frequencies where amplification can occur with less noise. Both low noise FET mixer diode approaches should be studied for new ways to reduce noise with increased amplification.

Initially, a study should be implemented to compare the 44 GHz low noise FET approach to the image rejection mixer diode approach. Emphasis should be placed on marking novel improvements to these approaches such as the use of III-V heterojunction materials for the low noise FET's, or use of different IF frequencies and high gain amplifier configurations after the mixer diodes. Some development work may be required as part of this study. Consideration should be given to following this with an advanced development hardware effort using a preferred approach from the study.

Technology products desired are 44 GHz Low Noise Front End receiver study with recommendation of a preferred approach. SD/YKX

f. FHF Downlink Solid State Amplifier (20 GHz)

The objective is to develop a space-qualified EHF solid state amplified for on-board space system implementation. Solid state offers the potentialfor a considerable imcrease in reliability and operational life, as well as lower weight than TWT's for similar applications. The following characteristics are design goals:

1. 20 watt RF output
2. 20.5-21.5 GHz.
3. 15% DC to RF conversion efficiency
4. 30 db gain
5. 10 years useful life

Space-borne applications for EHF amplifiers require efficient, reliable designs. The communications requirements result in a minimum practical output power of about 20 watts. Traveling wave tubes offer one solution to meet these requirements but have reliability shortcomings which are being addresses elsewhere. Several approaches exist for the use of solid state technology in transmit amplifiers. Gallium aresenide (GaAs) IMPATT (Impact Avalanche Transmit Time) diodes or GaAs FET's (Field Effect Transistors) con be used in a circuit combined approach with small size and weight, but with relatively large combining losses and low power. Alternatively, GaAs FET's con be used in far fields combining approach (i.e., active aperture antenna) which able power, but which places severe size and weight constraints on the spacecraft. There are significant problems remaining to be solved in the areas of device doping profiles, packing resonance's and thermal resistance, device efficiency, and circuit frequency optimization, reliability and space qualification.

Gallium aresenide IMPATT's and FETs should be investigated. The effort should result in the analysis, test and space-qualification of amplifiers using each type of device.

Technology product desired is space-qualifiable 20 GHz Solid State Amplifier. SD/YKX

g. Spaceborne Mass Storage Devices

The objective is to develop a replacement for tape records to store large amounts of data in a binary format in a spaceborne environment. Storage capabilities in the order of 10^9 bits and continuous operation of seven years with high reliability without external maintenance is required. The memory readout should be non-destructive with positive controls to prevent unauthorized alteration of memory content during all phases of operation. The technology used should be hardened to $5X10^6$ rads (Si) total does as a minimum.

Past orbital failures have demonstrated the need to replace the currently used mechanical–magnetic tape recorders with higher reliability devices.

New memory device technologies, such as magnetic domain tip motion devices (e.g., the magnetic "bubble" devices) and charge-coupled devices are candidate units for replacing magnetic tape recorders. Monolithic, solid state units construed in the form of a large number of circulating memory loops could significantly improve the access time and reliabilities of current massmemories. Also provide high bit storage capacity with significantly reduced access time. Testing and evaluation of candidate replacement units should be conducted under environmental extremes that will be encountered on-orbit.

Technology product desired is space-qualified mass storage devices with a capacity on the order of 10^9 bits. Ideally these devices should be interchangeable with magnetic rape recorders on existing space systems. SD/YDMS

h. Remote Sensing of Meteorological Parameters.

Objective is to develop spaceborne sensors capable of providing data on the meteorological parameters necessary to accomplish the mission of the Defense Meteorological Satellite Program (DMSP). Listed below are meteorological parameters for which an improvement over the present capability of the DMSP sensors is desired. The present DMSP capability and the eventual goals are both listed on the attachment. An improvement of 30-40% or more over present capability in any of the areas listed would be of interest.

PARAMETER	Present/Goal		Present/Goal		Present/Goal		Present/Goal	
Vertical Moisture Profile	None	5nm	None	100-1000Ft	None	1nm	None	±1%
Vertical Temperature Profile	125nm	5nm	5k-15k Ft	100-2000Ft	50nm	1nm	±5°k	±1°k
Visibility (wave Length 0.4-0.7nm)	None	5nm	None	500-1000Ft	None	1nm	None	±.5nm
Winds	None	5nm	None	100-2000Ft	None	1nm	None	±5% nte 2m/s
Surface Temp	None	5nm	N/A	N/A	None	1nm	None	0.5°C
Soil Moisture	12nm	1nm	N/A	N/A	6nm	1nm	None	±10%
Sea State	None	1nm	N/A	N/A	None	1nm	None	±3nm amplitude ± 5% wave-length + 10° direction

While sensors currently in use by DMSP provide much useful data, improvement in the capability of these sensors is desired. The accuracy of data provided by DMSP is a limiting factor in the making of accurate and timely weather forecasts and any improvement in DMSP sensors would permit an improvement of weather forecasts.

Technology products desired are new management techniques of approaches, improvements in critical sensors for use on future DMSP satellites. SD/YDMS

i. Composite Materials. The objective is to develop lightweight, structurally stiff, and thermally, insensitive materials for use on the Defense Meteorological Satellite Program. These materials would find useful application for the satellite precision mounting platforms and are potential candidates for other satellite applications, e.g., adaptors, trusses, etc. These materials must be sufficiently strong to survive in 450nm polar orbits.

The problem is sensitive sensor systems require a highly stable mounting platform to retain stringent pointing requirements. Coefficients of expansion and stability properties of typical spacecraft materials makes sensor alignment difficult. Some composites, especially graphite-epoxy have a virtually zero coefficient of thermal expansion and a high strength to weight ratio. Use of these composites could result in a significant weight savings, simplified thermal control and greater versatility in instrument mounting requirements.

The technology product desired is flight qualified composite materials for use on new generation DMSP satellites. SD/YDMS

AF83-015 TITLE: Electronic Systems Technology.

DESCRIPTION: Electronic Systems Division (ESD) conducts all technology development applied research through acquisition for command, control, communications, and intelligence (C^3 I) systems and ground electronic systems. For FY 83, ESD is interested in any new and innovative ideas in the following areas:

a. The objective of this project is to conduct a study to identify hardware features, capabilities and engineering requirements needed to implement a secure computer system in which the security attributes of the system are resident in the hardware and not the software.

While current and near-term proposed secure systems have emphasized implementing secure operating systems on standard hardware architectures, this study seeks to define an architecture which will satisfy all computer security requirements and greatly reduce the need for independent verification and validation of systems and applications software o obtain security certification.

This is a new task proposed to provide computer security standards needed to satisfy Air Force requirements for secure computers. ESD/TOEE

b. The objective of this project is to conduct a study of computer network security and define hardware and systems software requirements for making the computer components of networks secure. The computers at the nodes of communications links have not been evaluated and the hardware security features and requirements defined well enough to establish standards or develop prototypes. This project will develop requirements and specifications and then acquire, integrate and test a network.

This is a new task proposed to satisfy urgent requirements identifies by the major air commands to provide definitive guidance for development of secure computer networks. The motivating force behind this project is the great proliferation of computer systems serving major air commands/separate operating agencies management, command and control, and logistical support requirements via dedicated local area and commercial communications networks.

These requirements dealing with digital communications security are well enough defined, through numerous studies conducted by the Services and NSA, that a definition of the computer requirements (hardware features, operating and communications software, applications software) mist now be addresses. Essentially, the technology for secure communications between computers is relatively well defined, and in some instances the systems are being developed. However, the computers at the nodes of communications links have not been evaluated and the hardware security features and requirements defined well enough to establish standards and develop prototypes. ESD/TOEE

c. The objective of this task is to develop a system for computer security threat data collection, analysis, and modeling in support of the Air Force Computer Security Program.

The Air Force Computer Security Program Office has been directed to:

Distribute historical hazard/threat information, analyses, and predictive data. Consolidate threat information to formulate an overall computer security threat model.

Provide ADP threat analysis information to MAJCOM/SOA ADP Program Single Managers, Designated Approving Authorities (DAAs), and/or Program Management Offices (PMOs). Further, provide a database of ADP security case study threat analysis data which will be used to assist in risk analysis, assistance visits, and requirements reviews.

Review, analyze for relevance, and publish a non-attribute summary of criminal cases relating to computers on a semi-annual basis. The primary source foe this review will be closed AFOSI investigations. The intent is to show how and by whom computer systems are being exploited and, based upon the type of threat, aid in the development of countermeasures.

Consolidate threat information to formulate an overall ADP threat model.

Development and maintenance of the ADP Security Hazards Analysis and Reporting System is a requirement levied on the Air Force Computer Security Program Office. An extensive market survey indicates that the type and complexity of modeling required to satisfy this requirement is not available commercially. It may be available from academic or industry sources, but will require development to become a workable system that will satisfy Air Force requirements. ESD/TOEE

d. The objective of this project is to develop an Air Force military specifications for a physically small, stand-alone, secure computer system which will support base-and-command-level requirements for classified and sensitive data processing. Hardware prototypes will be developed and at least two of them will be integrated and tested with security software.

The Air Force Computer Security Program Survey, completed in Sep 82, identified extensive requirements throughout the Air Force for sensitive and classified data processing. Currently, these requirements are satisfied by using systems that are essentially designated for other uses (management support, logistics, communications, equipment test), most of them non-sensitive or non-classified applications. There is no manufacturer that provides a small computer specifically designed to support sensitive and/or classified industry efforts and will develop the specifications needed to promote industry-wide efforts to provide this needed capability to a wide spectrum of Air Force activities ranging form System Program Offices to labs to Personnel Offices.

This is a new task defined to fulfill an urgent need for providing secure computer resources to accomplish a wide rage of classified and sensitive unclassified processing requirements. The need for this task was identified when an intensive market survey disclosed that there is no manufacturer providing small secure computers for either the commercial or military markets. ESD/TOEE

e. The objectives of this task is to provide acquisition guidelines for specifying computer security at the beginning of the system life cycle by: 1) identifying computer security requirements 2) specifying computer security measures and features, and 3) verifying the design, implementation, and operation of security features.

The purpose of the guidelines is to facilitate inclusion of computer security features at the outset of the system life cycle and to avoid or minimize retrofitting computer security measures at a later point in the system life. Retrofitting has been repeatedly demonstrated to be significantly more extensive and less effective then incorporation of the same measures during acquisition.

Development of the overview of computer security and verification is expected to be completed in early FY83. The remaining phases of the project will satisfy an urgent Air Force need for definitive guidance on specifying computer security requirements during systems acquisition. Air Force Systems Commands Product Divisions will monitor/review this effort to insure the efforts expanded on embedded computer systems are compressive. ESD/TOEE

f. Develop a computer based risk analysis system providing comprehensive procedures and automated tools for use in identifying and evaluating computer security risks and evaluating cost effectiveness of protective measures. The protective measures will be used for safeguarding embedded computer resources and management support facilities to include computer equipment, operating systems, and functional systems software. The system, titled, Comprehensive Risk Analysis System (CRAS) will become a key component of the Air Force computer Security Risk Management Program. After an analysis of current market products is completed, specifications for the systems and supporting computer resources will be developed. Using the specifications a system with computer resources will be procured.

The Air Force Computer Security Program Office has been directed to Develop tools, techniques, and guidelines to assist Air Force elements in assessing and meeting ADP Security Test and Evaluation procedures. Provide for Air Force-wide distribution and use.

Manual risk analysis systems have been shown to be far too cumbersome and expensive for field application. An analysis of current market products for risk analysis is underway. ESD/TOEE

AF83-016 TITLE: Aerospace Ground Testing.

DESCRIPTION: Arnold Engineering Development Center (AEDC) conducts ground test, engineering analyses, and technical evaluations of aerospace systems. For FY 83, AEDC is interested in any new and innovative ideas in the following areas:

a. Existing force measurement transducers used in both rocket and turbine engine thrust measurement systems deflect proportional to the applied load. This deflection (up to 0.03 inches) is undesirable, as it requires a corresponding movement of the thrust mount system and test article with resultant tare and hysteresis problems. A zero-deflection thrust measurement system (for forces up to 30,000 lb) is needed and possibly could be implemented using a feedback force system to maintain the thrust mount system at null condition. An addition benefit could be derived by measuring the restoration force outside of the test cell hostile environment. AEDC/DOT

b. Existing engine fuel flow measurement systems typically require the use of three sizes of flowmeters to corner the flow measurement range. Remotely actuated valves are used to select the proper size flowmeter depending on the flow rate. This technique is not adequate for transient flow measurements (engine access, etc.) Wherein the fuel flow rate varies over a wide range. The large size flowmeters must be selected for these type transients in order to handle the highest anticipated flowrate. As a result, flow measurement at the low flow rates (at the beginning of the accel) ate of extremely poor quality. A flowmeter capable of covering the total measurement uncertainty is needed. AEDC/DOT

c. No suitable instrumentation exists for measurements of heat transfer and erosion rate of diffusers during solid racket motor tests. These data are needed for assessment of water jacket design adequacy and improvement efforts associated with extending service life. Instrumentation compatible with rocket motor burn times from 10 to 120 seconds at heat transfer rates to 200 BTU/ft²- second and erosion rates of .006 inches/minutes for mecal liners is needed. AEDC/DOT

d. Measurement of unsteady pressures in turbine engine and rocket tests can be adversely influenced by the response of the transfucers and associated plumbing. Frequency, amplitude phase, and linearity effects of the transducers and attached tubing must be known when matching data requirements and transducer configurations.

   Currently the ETF has no facilities for dynamic calibration of transducers and associated plumbing. Transducer response is generally based on manufacturers data and the effects of plumbing (0.1" to 100" tubing lengths and .001 in³ volume) based on past experience and calculations. Determining the response by these methods is highly unreliable and causes large data uncertainties. A plan for performing dynamic pressure transducer calibrations from 0.1 to 1.0 psi RMS, 10 Hz to 5 KHz, with flexibility for in-place calibrations, would allow producing more reliable and accurate test data. AEDC/DOT

e. No high quality low range (1and 2 PSID) pressure transducers exist which are suitable for AP measurements in high vibration, high temperature and varying line pressure environments typically encountered in turbojet engine testing. Transducers are needed which van be installed on inlet ducting and provide one percent data for periods up to one year. AEDC/DOT

f. During Air Force missions, aircraft are sometimes subject to icing conditions. In order to accomplish the missions, aircraft designers need an understanding of the ice shedding phenomenon. The object would be to develop a computer code that would analyze ice shapes accreted on aircraft structures. Experimental verification/calibration of the ice-shedding model could be accomplished in the icing research test cell at the Engine Test Facility at AEDC. AEDC/DOT

g. A liquid droplet dynamics study capability yon a lab scale is needed to reduce energy intensive testing presently required to produce gross effects data. This requires the development of a laboratory based droplet dynamics facility capable of characterizing shear, impingement, and vaporization mechanism. AEDC/DOT

AF83-017 TITLE: Armament Technology.

DESCRIPTION: The Armament Development and Test Center (ADTC) develops, tests, and acquires all air armament, aerial targets, range instrumentation, electronic warfare threat simulators, and electromagnetic warfare systems. For FY83, ADTC is interested in any new and innovative ideas in the following areas:

a. Spread Spectrum Receiver for Missile Applications. The objective of this program is to review the Soviet development of threat spread spectrum systems and to examine current and future US technology for missile receivers to be used in anti-radiation homing missiles. The output of this effort would be used to structure future studies and technology programs for ARH missile application. AD/XRCS

b. Missile Guidance Law. For a boost glide type missile, a guidance law will be developed to steer a missile from point A to point B with three sigma limits placed upon x, y, z, and t and point B specified for min-max value (relative to point A). AD/XRCS

c. Air-to-space Intercept Guidance Laws. Guidance will be designed to intercept switches that solve two point boundary value problems as formulated by the Pontryagain Maximum Principle. Applications will address optimal energy management problems of air-launched missiles. The codes will be compatible with the VAX II computer and use PLAT 10 graphics for interactive use. AD/XRCD

AF83-018 TITLE: The Ballistic Missile Office (BMO).

DESCRIPTION: The BMO is responsible for formulation and management of all strategic missile programs and projects, in various stages of including basing options, research and exploratory, advanced and engineering development. The BMO is interested in any new and innovative ideas. In particular for FY83, the BMO is interested in the ideas in the following areas:

a. Advanced Antenna Window Application. Some advanced vehicles currently being defined by Advanced Strategic Missile Systems require microwave antenna windows. These windows have requirements outside the domain of windows developed for Ballistic Reentry Vehicles (BRV). An example of two vehicles with divergent requirements which would use the advanced windows are defense suppression weapon (DSW) and an advantage air-to-air ballistic intercept missile (BIM).

The DSW is a small maneuvering vehicle which improves the penetration of BRV's by causing the expenditures of anti-BRV weapons. To promote the expanding of these weapons, the DSW has the capability of destroying key defensive radars by non-nuclear methods. The DSW is guided to these radar targets by the target signal. The DSW uses only received signals. No guidance transmitter is onboard the DSW. Unsynmetric window ablation during reentry introduces large errors which effect the desired CEP. Special receive only antenna windows are needed to preserve the CEP

The BIM is a maneuvering vehicle to destroy aircraft beyond the range of available fighter aircraft. The ballistic capability is used to reduce the time to target. To accomplish this mission the BIM must acquire and close on the aircraft during reentry. This engagement results in ling time reentry relative to BRV's (minutes for BIM as compared o seconds for BRV). This long flight time, combined with the severity of reentry, results in internal heat conduction problems not encountered in BRV's. Additionally, the large number of windows required for the precision tracking results in structural and microwave interaction problems. Special windows to resolve these unique problems are needed.

Phase 1: The program will define the special antenna window requirements of the BIM and DSW in conjunction with BIM and DSW guidance contractors. Based upon the requirements, concepts to improve the antenna window will be developed and coordinated with the guidance contractors.

Phase 2: The most viable concepts developed for each vehicle will be fabricated and subjected to ground tests to validate all critical aspects (meets the requirements). BMO/SYMS

b. Solid Particle Measurement in a Rocket Exhaust. The current state-of-the-art of rocket engine design involves the formation of solid of liquid particulate in the expansion section of the nozzle. The particulate is derived from certain gaseous species (e.g.., $A1_2\ 0_3$) that are formed during the normal high temperature (6500°F) combustion process. After burning, these gases flow through the nozzle expansion section where the gas temperature characteristically drops to or well below 2600°F depending on the final nozzle expansion ratio (i.e., is 1^{st}, 2^{nd}or 3^{rd} stage). Sometime in this expansion process, the subject gases condense into a liquid (boiling temperature of $A1_20_3$-6300°F) or further to a solid (fusion temperature of $A1_203$-3600°F). This affects the system design in two ways. First, the condensing particles produce a "hole" in the expanding gases; that is, potential expanding gases are eliminated from the expansion process which reduces the potential deliverable thrust of the engine. Not only is this undesirable effect present, but the newly formed particle, through drag on the non-ducing gases, acts to further retard the expansion of these thrust producing gaseous components. The amount of this "flow drag" depends on the number and size of these particles. Second, the density of the condensed particle is much greater than that of the "carrier" gas so they do not move with the gas streamlines, but rather tend to remain on the velocity path they had at the time of formation. If the formed particles are small, they are small, they are more inclined to follow the gas; if large, they will generally continue their original trajectory. This is particularly true at low expansion pressures so this effect is more prevalent in 2^{nd} and 3^{rd} stages. The first effect reduces the overall thrust of a given engine which, since the mass flow is fixed, reduces the I_{SP} of the engine. Estimates by Air Force Rocket Propulsion laboratory (and corroborated by Aerojet) indicate that up to 15 seconds of I_{SP} could be recovered if this effect were eliminated. The second effect is less important and results in nozzle erosion. In the case of Peacemaker 2^{nd} stage, the erosion process actually removed some of the later expansion sections of the nozzle.

Thus a knowledge of the particulate size and velocity distributions are important to the research to effect propellant and expansion performance and to the nozzle designer to ensure structural integrity. Yet there currently exists no proven way of measuring these particulates during nozzle operation. In prior programs, Advanced Strategic Missile Systems has breadboarded and tested, in arc driven nozzles, a laser device designed to measure particulate in a flowing stream. The contractor that performed that work has been contacted and is in a position to try to make such a measurement. Since the devise works using scattered laser radiation, the major feasibility issue is associated with the background radiation of the rocket exhaust gases in the rocket exhaust. That is, the device will have to detect the scattered light pulses derived radiation. His has been characteristically done in other radiation environments, but not in this environment, which will probably contain large amounts of radiation in select wavelengths. BMO/SYMS

AF83-019 TITLE: Aeronautical Systems Technology.

DESCRIPTION: The Aeronautical Systems Division (ASD) has the overall responsibility for the acquisition of all aeronautical systems/subsystems and associated equipment. ASD exercises responsibility for development, test, and evaluation of all of this program. For FY83, ASD is interested in any new and innovative ideas in the following areas:

a. Head Up Display Proliferation of Symbology and Terms.

Modern Head Up Displays (HUDs) are being designed to be used for low altitude, terrain following operations in less than optimal visibility conditions. As such, symbology on the HUD provides some basic information for instrument flight and navigation (no forward visibility) while the outside visual or FLIR scene provides the "real world" input the pilot needs for mission flexibility, display system correlation and target verification. Essentially what we are doing is instrumenting visual flight. In this context, and as we continue to press toward the goal of a night adverse weather delivery capability, extreme care must be taken in the selection of information to be displayed, symbols used to display that information and the way these symbols

are mechanized. Of equal importance is the terminology used to describe the systems(s) and convey to the pilot procedures and techniques that will assure safe and efficient use.

Unfortunately, the HUD is suffering from lack of standardization and a proliferation of terms used to describe the same display feature. For example, the –0- symbol is referred to as the Total Velocity Vector (TVV), Flight Path Marker (FPM) and Velocity Vector (VV) in different applications. HUD features providing steering commands (pitch and bank steering bars in the heads down flight director system) are referred to as Course Command, Horizontal and Vertical bars, Flight Director, etc.

This variety of descriptors complicates use of these systems from the design stage through the systems integration process to cockpit application. The solution of these problems will require a carefully structured set of development tests that insure that the fundamental information requirements for safe and precise instrument flight are provided in a usable format. In subsequent steps to include navigation information (vertical and lateral) and target symbology we must insure that the added symbols do not reduce the pilots ability to control the aircraft safely. Finnaly, system monitoring, fault detection and failure annunciation must be approached carefully to insure that the pilot is advised of any display problems.

One fundamental initial need, if the effort is to succeed, is to establish a common language to be used by display designers, systems integrators, evaluators and users alike. The function of a variety of new HUD symbols is not intuitively obvious and we need, in one document (perhaps a data base) an accepted name for each display element, a description of how the element works (in a language that can be understood by the user) and recommended procedures for using each feature_. AS/ENASI

b. Develop Cost Analysis software for Contract Administration Organizations (CAOs). The underlying Learning Curve approach received recognition as the most outstanding research in cost and price analysis in 1982 at the Federal Acquisition Research Symposium. This project would develop user friendly software to perform the cost tracking function at the CAO utilizing the Underlying Learning Curve approach. This would enable the approach to be utilized throughout the Department of Defense as efficiently as possible without creating an undue training load. ASD/YZD