AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Systems Command Deputy Chief of Staff for Technology. The Air Force SBIR Program Manager is R. Jill Dickman. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of the Air Force
HQ AFSC/XTIP (SBIR Program Manager)
Andrews AFB DC 20334-5000

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

No additional technical information (this includes specifications, recommended approaches, and the like) can or will be made available by the Air Force during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to section 7.1 in this solicitation for further information on DTIC.

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

AF92-001 TITLE: Turbine Soot Emission Monitor

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

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

AF92-002 TITLE: Cryogenic Infrared Source Array

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

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

AF92-003 TITLE: 2400 K Gas Sample Cell

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

DESCRIPTION: A spectrographic gas sample cell containing hydrogen-air combustion products at the temperatures and pressures existing at the exhaust plane of a hydrogen fueled supersonic combustion ramjet engine is needed for the development and calibration of diagnostic instrumentation. Optical access to the sample volume along two perpendicular axes is required to allow operation of laser Raman property measuring instruments. There must be a clear optical path through the sample volume and out the other side on both of the perpendicular axes. Optical view ports (four total) shall have a diameter of one inch or greater. The view port windows shall be of UV grade fused silica. The maximum distance form the sample volume to the access window shall be 24 inches. The sample volume shall have at least one cubic inch. The sample volume temperatures shall be controllable over the range of 1200 to 2400 K and shall be uniform throughout the volume within +/- 20 K. The sample volume pressure must be capable of being controlled over the range 0.5 to 2.0 atmospheres. The cell atmosphere shall be air with up to 20%

by weight of water vapor. Sample gas flow rate shall be 0 to 1.0 standard liters per minute. Phase I will result in a feasibility study of and a laboratory demonstration of a 2400 K gas sample cell. Phase II should result in construction and check out a prototype 2400 K sample cell for delivery to AEDC.

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

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

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

AF92-005 TITLE: Real Time Subsonic Flow Vector Measurement

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

DESCRIPTION: A system is required to make three-dimensional flow vector measurements in close proximity to full scale aircraft inlets in confined or free jet flows. Small sensors or non-intrusive sensors are required to minimize flow disturbances and to provide local measurements. Instruments currently used for similar steady state measurements are generally unacceptable. These include combination total static pressure probes for airspeed and cone or hemisphere probes for flow angles and “flying cruciforms” with an integral force balance which use lift coefficients generated by the cruciform elements to establish local flow angles and Mach numbers. The new instrument should operate over a Mach number range of .3 to .9 at static pressures and total temperatures. Flow angle range is from 60 degrees below horizontal to 20 degrees above horizontal in the vertical plane and +/- 15 degrees about the axial direction in the horizontal plane. Frequency response must be sufficient to display vectors at rates of change of Mach number up to +/- .1 sec and flow angle rates up to 10 degrees per second. The system should measure Mach number to within +/- .02 and flow angle rates during transient operation. Continuous operation up to 12 hours without servicing is required. The output signals must be usable as inputs to a closed loop control system for the vector magnitude and direction. A primary requirement is that the sensor(s) produce minimum disturbance or interference to the inlet flow field. Phase I should demonstrate the concept and Phase II should result in demonstration of a prototype system in a test cell at AEDC.

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

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

DESCRIPTION: Hazardous waste sites contaminated with chlorinated solvents present special problems to remediation activities. The dense organics sink to the bottom of the aquifer as a free phase product. This pool of solvent then slowly leaches into the surrounding aquifer, providing a long term source for contamination. Phase I is the development and proof of concept of a treatment system to remediate a 10 cubic foot test cell contaminated with

trichloroethylene. It will soil analysis down to the parts per million level and water analysis down to the parts per billion level. Phase II, if approved, will be the operation of the treatment system at a contaminated Air Force selected site.

AF92-007 TITLE: Trichloroethylene Aqueous Phase Sensor

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

DESCRIPTION: Accurate detection of minute concentrations of trichloroethylene in ground water are needed for well field control units. The sensor have to detect and transmit an analog signal to a central processor unit. The sensor must be able to detect TCE in the range of 5-1500 parts per billion.
Phase I is the development and proof of concept of operation of a laboratory scale system demonstrating the capabilities of the sensor to detect and quantify TCE in actual groundwater samples. Phase II, if approved, will be the test and evaluation of the sensor system in a well field at an Air Force selected site.

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

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

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

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

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

DESCRIPTION: Air Force environmental personnel lack accessible numerical tools for calculating the environmental impacts of fuel jettisoned by aircraft in flight. A user-friendly microcomputer model is needed that will estimate the location, a real extent, and magnitude of ground contamination resulting from the deposition of jettisoned fuels. The model should consider aircraft type, flight profile, meteorological parameters, and fuel characteristics in determining the fallout “footprint.” Fuel specific behavior, in terms of aerosol drop size distribution, setting velocity, and evaporation rate, should be treated for both JP-4 and JP-8 fuels. The model should facilitate addition of alternative fuels that may be developed in the future. Phase I should accomplish necessary review of previous work in this area, as well as production of a prototype ground contamination model with numerical output. Phase II should refine the model with addition of graphical output depicting aircraft flight path,

wind direction, and ground level contamination contours. The final model should also contain a routine to estimate the time-dependent reduction of ground level concentration due to evaporation. The model should be delivered in both source and executable form, with full documentation to include a user's guide. Phase III could expand the model database to include commercial aircraft and "Jet A" fuel for marketing to the civilian community.

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

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

DESCRIPTION: The existing third generation hardened aircraft shelter doors have a metal superstructure that has a highly visible radar and infrared return signature. This signature makes these shelters detectable from radar sensing devices used by enemy aircraft. To reduce the ability of these shelter doors to be detected by radar and infrared sensors, a method needs to be developed to mask these signatures. This program, in Phase I, seeks the design of such a system to be retrofitted on the existing shelter doors in Europe and the Pacific. Phase II would require the development and testing of such a system. The system should be operationally compatible, meaning it would not interfere with the current operation of the shelter doors. This system would have to be able to meet the performance standards without degradation from years of exposure to the surrounding environment. The preferred system would be passive in nature, not requiring the support of mechanical systems. Finally, the system should not enhance the visibility of these structures to the human eye.

AF92-011 TITLE: Active Firefighter Cooling

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

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

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

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

DESCRIPTION: After attack on an airfield, an autonomous repair vehicle or team of vehicles will be dispatched to rapidly repair the bomb craters. Before these vehicles are sent to work, a topographical map of the damaged airfields will be loaded into the vehicle's memory. Each vehicle will be assigned specific crater to repair. Location and path to these craters will be passed to the vehicle before it starts out. A navigation technique is desired that relies solely on the in memory topographical map and on board sensors. These sensors may be cameras, range fingers, electric compass or any autonomous device. Cost and number of required on board sensors is an important consideration. The vehicle should arrive at its destination within ½ foot and 5 degree heading. While traveling 10 mph a deviation of 1 foot from the path is acceptable. Phase I will identify and define the innovative navigational

system. Analysis and simulation will be required to support specified location and path tolerances. If possible, a demonstration of key concepts is desired. Phase II will center on developing and testing a prototype of the system. Phase III will involve fielding the system.

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

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

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

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

OBJECTIVE: Conduct basic research experiments and modeling to address precombustion chemistry and fluid transport behavior in stored and flowing hydrocarbon fuels at high temperatures and in the supercritical thermodynamic state.

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

AF92-015 TITLE: Space Propulsion

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

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

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

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

DESCRIPTION: Advances in ceramic, glass, and polymeric materials are expected to come via structure control from the molecular level through the ultra structure level to increasingly sophisticated hierarchical levels of structure. For the achievement of such structural sophistication, it is necessary to understand the design and function

of hierarchical structures; to utilize this understanding, together with computational modeling based upon an initial, semi empirical, or intelligent database methods to predict chemistry/structure/property correlations; and to fabricate the newly designed materials through the use of chemical, biological, or biomimetic synthesis and processing methods, together with a functional understanding of the mechanisms associated with the synthesis and processing. Materials of interest include those with nonlinear optical, magnetic, superconducting, and semi conducting properties. Sub-picoseconds, nonresonant, or near resonant nonlinear optical polymers, organics and inorganics, or combinations thereof are specifically required. Also of interest are approaches to properties which afford mechanical and environmental integrity in ceramic, polymeric, ermeric, molecularly reinforced, and carbon-carbon composite materials, such as optimization of strength, stiffness, and thermooxidative stability. Of particular importance are materials which exhibit concurrent combinations of properties, such as structural and electro-optical for multifunctional applications. Device applications should be considered, especially where the material will serve as a self-contained functional entity. Novel chemistry for nonstructural materials is also needed. This includes temperature resistant lubricants and fluids. Chemistry for fuels, such as endothermic fuels and their conversion catalysts, which can serve heat transfer and lubrication functions under supercritical conditions in advanced turbine engines, is also required. Phase I must provide sufficient material and/or concept feasibility for proof-of-principle. Phase II must make available both well characterized material and processing knowledge for high volume production.

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

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

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

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

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

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

AF92-019 TITLE: Advanced Frequency Standards

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

DESCRIPTION: Recent advances in trapping and cooling of neutral atoms or ions in electromagnetic, optical, or other types of traps give promise of leading to better and more stable frequency standards. In such traps atomic resonances can be made free of Doppler shifts, collisions, and other perturbations that broaden resonance lines. Since many atomic resonances are in the optical region, it is needful to develop methods of phase coherent comparison between the optical and microwave regions. In addition to the general subjects of trapped and cooled ions and atoms, the following topics are also in need of attention: confinement, surface interaction, and cooling of hydrogen atoms, cesium fountain experiments, frequency multiplication and division between optical and microwave regions, and high critical temperature superconducting microwave cavities. As this topic addresses a subject at the forefront of modern atomic physics and frequency research, rapid progress may not be possible for Phase I. However, it is expected that Phase I will clearly demonstrate the practicability of the proposed approach and establish a convincing Phase II research program.

AF92-020 TITLE: Human Systems/Subsystems Research

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

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

AF92-021 TITLE: Human Systems Integration Problem Identification Program

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

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

AF92-022 TITLE: Crew Protection Systems

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

DESCRIPTION: Specific areas include the following:

Develop an airborne monitoring system for pilot incapacitation. Numerous subsystems have been developed for physiologically monitoring pilots while they are flying. At least 18 pilots have lost consciousness, crashed their aircraft and died as a result of G-induced loss of consciousness, or G-LOC since 1982. Likewise, over 70 Air Force pilots have been killed during peacetime due to crashes related to spatial disorientation. The system, ideally should be noninvasive, one hundred percent accurate, and lightweight such that it can be retrofitted into aircraft with minimal cost and downtime. In Phase I all work that has been done to date on such incapacitation monitoring systems should be assimilated, investigated, and those that appear the most promising developed. In Phase II the system should be developed, tested on a centrifuge, and then flight tested. The end product will be a prototype airborne physiological monitoring system for pilot incapacitation.

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

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

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

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

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

Fine manipulation using human sized robotic hands requires human sized exoskeletons for intuitive control. Force feedback to these small exoskeletons requires small volume, high efficiency, semi linear, actuator mechanisms. Actuators are needed to provide human range forces to exoskeleton systems used by operators of fine dexterous manipulators. Phase I will explore the feasibility of the concept. Phase II product could be miniaturized actuators; Sensor technology advances now yield exceptionally high resolution measurements. A key element in human controlled robots is to provide quality feedback without overwhelming the operator with excessive detail. The challenge is to define reasonable limits of information feedback to the operator. Successful completion may require reductions in sensor resolution, smaller matrices, or the reduction techniques. Phase I should explore test methods and criteria which need to be developed to verify and validate the Operator-Robot Interface sensory feedback specifications. Phase II product could be an evaluation system which quantifies human sensory feedback efficiency.

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

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

DESCRIPTION: Specific areas include the following:

A requirement exists for development of a photocathode/focal plane array material sensitive to a greater portion of the near-infrared spectrum. Critical parameters include cost, spectral response, sensitivity, resolution, and signal-to-noise ratio. Phase I will investigate approaches that consolidate the fusion of thermal and image intensification. Estimated size, weight, and cost of peripheral support equipment is critical to the advanced photocathode

development strategy. A 25mm diameter cathode design is recommended as optimal. The minimum sensitivity requirement is 1000 micro-amps per lumen, and the minimum resolution must exceed the current Night Vision Goggles (NVG) specification of 36 line paris. The ultimate goal is to incorporate the advanced photocathode as the integral component that can replace the Aviator's Night Vision Imaging System (ANVIS) third generation photocathode. Correct form, fit, and function would be ideal, but not required. A Phase II product would incorporate the advanced photocathode in a helmet-mounted night vision device to give the aviator increased spectral response, sensitivity, field of vision (FOV), and resolution.

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

Design and demonstrate a helmet-mounted virtual image display. A virtual world employs an electronically generated all aspect virtual image display. A VID is similar to the aircraft mounted head-up display but mounted on the helmet so the information displayed is always within the viewer's field of view. By taking into account the viewer's line of sight, the VID becomes an interactive control/display system within a panoramic display. This new virtual interface system concept requires a helmet mounted VID that permits displaying superior graphics and pictorial information. This Phase I effort will design; using innovative hardware/technology, a helmet-mounted VID for supporting virtual Man-Machine Interface (MMI) research activities. Two monochromatic image sources are required in order to display a true 3D world. Whether monochromatic or color image sources are used, achromatized display optics will be required. Initially, the resolution requirements for the VID is video graphics adapter (VGA) compatible; eventually, the virtual environment will include high-resolution engineering workstation Computer Aided Design (CAD) graphics. The proposed VID display approach should have a plug-in capability for future image source improvement products and optics should be free of geometric distortions, pincushion, keystone, etc., so that pre-distortion of the input images is not required. The goal for field of view is 120 degree horizontal by 90 degree vertical with at least 40 degree stereo overlap region: the minimal requirement is 80 by 60 with at least 40 degree stereo overlap region. The system must be lightweight and sufficiently rigid to qualify for centrifuge usage as an out the window scene simulator. The Phase II will assemble three fully functional laboratory breadboards for performance verification.

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

OBJECTIVE: Develop low resistance breathing system components; hypobaric, evolved, gas measurement techniques; and embolism protection garment.

DESCRIPTION: Specific areas include the following:

Flow resistance offered by current USAF aircraft oxygen systems limits the rate at which breathing gas is delivered to the crewmember. High breathing resistance adds work stress, discomfort and distraction to an already high workload, stressful, flight environment. High aspiratory resistance may produce reduced G-tolerance by reducing the effectiveness of anti-G respiratory maneuvers. It may also contribute to episodes of hypoxia and abnormal respiratory gas exchange. Identification of the flow resistance contributed by each of the component parts of currently deployed oxygen systems will enable us to identify the components which are the best candidates for redesign. Current systems fall short of meeting the standards set down by the Air Standardization Coordinating Committee for aircrew breathing systems. Suggested design changes and prototype low resistance components are needed to advance future development of these systems toward meeting these standards. Phase I efforts would identify the flow resistance in each of the components and suggest design changes for the components which are significant contributors to breathing resistance. Phase II would produce a brass board low-resistance breathing system, from the regulator to the coronial mask, for standard aircrew operations.

Operations in both advanced, high altitude aircraft and in space have the potential for accidental human exposure to hypobaric environments in which the ambient pressure is less than the vapor pressure of water. Under such

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

AF92-026 TITLE: Electromagnetic Radiation Effects and Measurement Devices

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

DESCRIPTION: Specific areas include the following:

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

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

AF92-027 TITLE: Hazardous Waste Research

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

DESCRIPTION: Specific areas include the following:

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

application to a field monitoring type utilization. In Phase II further develop this instrumentation into a portable, field type instrument that could be set up at a base well to monitor daily contaminant levels of chlorinated solvents.

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

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

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

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

DESCRIPTION: Specific areas include the following:

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

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

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

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

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

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

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

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

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

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

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

a. Performance metrics which will allow accurate assessment of performance and productivity gain (or loss) from the implementation of CALS technology. A potential metric might be a variant of the Goldratt Theory of Constraints;
b. Modeling and simulation tools which will allow assessment of the impacts of CALS technology on Air Force processes. Such simulations would provide decision makers with data to choose among alternative implementation strategies;
c. A demonstration of the methods, metrics, and tools in an actual ALC or SPO environment.

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

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

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

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

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

DESCRIPTION: Topic centers on increasing the war fighting capabilities of the Tactical Air Force (TAF) in the areas of command, control, communications and intelligence. The area covered in this topic is primarily improvement within the airborne and ground Tactical Air Control System (TACS). Specific areas of interest are interoperability in joint and combined operations, upgrades, and improvements through technology, and application of existing and planned systems into architectures for the future. Proposals may address specific elements, such as the Tactical Air Control Center (TACC) or Air Support Operations Center (ASOC). New concepts can also be explored addressing technology's impact on future systems in terms of operational capability, logistics, mobility, etc. Phase I should accomplish the demonstration or prototype development. AF managers evaluate proposals on their merits and applicability to ESD programs.

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

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

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

a. Evaluate the health of the long-haul communications links, local area networks and automated data processing devices.

b. Provide appropriate error statistics on communication links and fault isolate malfunctioning devices to the lowest replaceable unit.
c. Provide online debug and correction of software problems.

The task should define the functionality, both software and hardware, and provide a system design required to maintain a notional configuration. A notional multi-node configuration should be developed to serve as a background for the design. Communications should include ground-to-air radio, satellite and land link links. The demonstration system should make maximum use of COTS software and hardware. Major consideration should be given to meeting the requirements of Open System Architecture (OSA) standards including the use of ADA for developed software and UNIX based operating systems. In addition, the demonstration workstation/processor should be of the high-end variety to provide sufficient MIPS, a windowing capability and color graphics. Special emphasis should be placed on the user/system interface aspects of the capability such as display presentation of diagnostic information. Phase I will accomplish the design analysis and prototype implementation plan. Phase II will implement the prototype and accomplish the demonstration.

AF92-034 TITLE: Remote Detection of Mobile Missile Launchers

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

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

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

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

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

AF92-036 TITLE: Software Supportability

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

DESCRIPTION: LSA is the selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other integrated logistic support (ILS) objectives through the use of an iterative process of definition, synthesis,

tradeoff, test, and evaluation. A single, uniform approach by the Military Services for conducting those activities is necessary to cause supportability requirements to be an integral part of system requirements and design, define support requirements that are optimally related to the design and to each other, define the required support during the operational phase, and prepare attendant data products. Although MIL STD 1388-1A addresses systems, it is primarily hardware oriented and needs to be expanded to include software supportability. Phase I will develop specific language for MIL STD 1338 1A tasks and subtasks which will: focus on integrating software development processes with hardware designed and produced according to an LSA program, focus on systems integration of new, or modified commercial, hardware and developed software. In addition a Phase II implementation/demonstration plan to develop data elements, output summaries, data item descriptions and other data pertaining to software to be included in MIL STD 1388 2B, DoD Requirements for a Logistic Support Analysis Record, will be described. Phase II will accomplish the implementation and demonstration.

AF92-037 TITLE: Adaptive Integrated Focal Plane Processor

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

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

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

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

DESCRIPTION: Although significant advances have been made for photonic devices at the discrete component level, integration of these same components in a circuit may result in a decrease in performance due to process incompatibilities. This increasing demand for compatible photonic components has necessitated the development of advanced epitaxial materials, device and circuit process techniques in the III-V materials system. In particular, the availability of advanced InP-based technologies is essential for continued development of photonic components for communications systems. The goal of the Phase I of this initiative is the demonstration of heteroepitaxial III-V materials preparation techniques that can support the next generation of advanced photonic components for light wave communications. In particular the program should focus on epitaxial growth techniques that can lead to superior photonic device and circuit integration and improved manufacturability of these materials. Phase II will implement the materials preparation techniques developed in Phase I, develop device fabrication techniques that will complement the materials technologies and begin fabrication and testing of photonic devices and circuits using these

developed techniques. In Phase III, growth and device fabrication processes refined in Phase II will be used to define manufacturable photonic devices for commercial applications. It is expected that both the processes and the device concepts established in Phase I and II will be applicable to commercial and military speed of light communications systems where either optical or electro optical control of data is required.

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

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

DESCRIPTION: A CAD simulator code is needed to determine electromagnetic environmental effects' susceptibilities of multiport T/R modules that use interconnected sets of MMIC and digital circuit chips. Circuit simulators used for contemporary microwave CAD can handle only baseline designs of individual circuit chips, whereas a complete T/R module contains several interconnected and electromagnetically susceptible chip sets. Phase I will investigate ways to combine the CAD circuit models presently used for the constituent chips of a T/R module set. These include both linear and digital circuit functions as well as the associated pads, vias, interconnects, parasitics, and nonlinearities. The challenge is that the desired models should include capability to simulate baseline performance and determine attendant susceptibility. A detailed design plan for developing a simulator code to design a T/R module as a system is requested. Phase II effort will implement and build the selected design in software and will perform the validation testing. Phase III effort envisions tailoring the code to the design of commercial HDTV and satellite communications circuits.

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

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

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

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

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

DESCRIPTION: Recent accomplishments in low and high temperature superconductivity offer the possibility of significant new advances in monolithic antenna technology from microwave to the submillimeter wavelength regimes. Innovative research proposals for the applications of superconductivity include but would not be limited to monolithic microwave, millimeter, and submillimeter integrated circuits for signal generation, reception, control and processing in phased array applications. Examples of components include oscillators, mixers, filters, isolators, circulators and antenna feed structures. Electronically variable ways to control power, amplitude and phase or time delay of large wideband phased arrays are of interest. Innovative wideband, monolithic, phased-array antenna elements are needed which are compatible with thin-film superconducting feeds, are efficient radiators and at the same time provide thermal isolation of the superconductive feed circuits from ambient free-space temperatures.

Research to develop sub-systems such as monolithic integrated receivers and frequency synthesizers is required. A/D converters, shift registers and signal processing circuits operating in the giga-to multi-gigahertz regime are desired to advance state-of-the-art of digital phased-array antenna control. A Phase I contract will involve analysis of theoretical background, and preliminary experiments and tests to clearly demonstrate the technical feasibility of the proposed development concept. A Phase II contract will require the development, test, analysis and conclusive proof of the concept. Under Phase III non-federal capital will be used for commercial application of the technology.

AF92-042 TITLE: Quantum Enhanced Vacuum Tube Technology

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

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

AF92-043 TITLE: Hypsographic Cultural Data Integration

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

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

AF92-044 TITLE: Automated Librarian

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

DESCRIPTION: Subject analysis of free text documentation in large military databases requires must manual effort and is an information processing and correlation bottleneck. The technical innovation is to construct a computer process that can accurately identify, summarize and retrieve the intellectual content of large unconstrained free text documentation collections. The most desirable goal, and a feasible one, is a system that could fully automate the functions of indexing, catalog summarization and natural language queries which presently can only be performed by a librarian. The system should also autonomously generate a knowledge base established by it's own text processing experience. This knowledge base must dynamically adapt to changing natural language patterns facilitating the indexing, cataloging and retrieval of library holdings. The technology for the system should be based on a combination of signature analysis/statistical techniques similar to these found in natural networks and classic knowledge base expert system techniques. The finished system could be used everywhere the correlation and fusion of text information is an overburdening labor intensive task. DoD examples include Intelligence Data Handling,

Logistics, and R&D. Other uses include Law Enforcement, Investment Banking and Libraries. Phase I of this effort will develop a working prototype demonstrating the feasibility of the automated librarian. Phase II will construct an operational version developed specifically for a selected DoD application. Phase III will pursue commercial applications software for generic library use.

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

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

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

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

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

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

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

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

DESCRIPTION: To meet the requirements of many missions, it is necessary to accurately measure the patterns of high gain antennas having extremely low side lobe levels. Antenna test ranges often contain objects that scatter or reflect UHF/SHF waves from the transmitting antenna into the receiving antenna, thereby creating a multipath channel. Very large measurement errors of low side lobe regions can result from this multipath propagation. Development of a system to operate in real time with antennas under test on an azimuthal/elevation pedestal to suppress indirect components and permit accurate pattern measurements is required. The system should utilize a reasonably small bandwidth and be able to suppress multipath by 20dB to 40dB in real time for a 100 wavelength antenna that is mounted on a pedestal rotating at an azimuthal rate of up to 30 degrees per second. This system is to

operate without any additional antennas and without modification to the antenna positioner. It will display and record in real time the time delay and amplitude of each multipath component for every orientation of the antenna under test. Goals for multipath measurement accuracy are plus or minus 1 nanosecond for time delay and 0.2dB for amplitude. The measurement accuracy goal for low side lobe levels is plus or minus 1 dB in the presence of a multipath component 20dB stronger than the direct component at the antenna output. The goal of Phase I is to demonstrate the feasibility of the proposed anti-multipath system. The goal of Phase II is to develop a prototype system to be interfaced with an existing antenna range set-up to demonstrate the proposed anti-multipath capability.

AF92-048 TITLE: High Performance A/D Converter

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

DESCRIPTION: Future radar systems will utilize digital beam forming to meet advanced performance requirements. Here the individual signals received by the array antenna elements will be converted from analog to digital format for further digital processing. A bottleneck is the presently available commercial A/D converters which do not meet the requirements as to sampling rate or dynamic range nor do they offer small size, low power consumption and low cost. Recent engineering developments in a number of solid state technologies offer the promise of improved A/D converter development. For instance, the new Rapid Single Flux Quantum architecture for superconducting circuits is a case in point. Phase I of this effort will investigate techniques to increase the performance of A/D converters and propose a complete design. Phase II will fabricate, test, and deliver a set of two-four prototypes.

AF92-049 TITLE: Neural Network Antenna Controller

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

DESCRIPTION: Current phased-array control techniques are unable to adapt to antenna element degradations and failures to still produce an optimized radiation pattern. A neural network could learn, by observing the effects of different element attenuator and phase-shifter settings on the antenna's radiation pattern, the relationships between the output radiation patterns of the antenna and the input attenuator and phase-shifter settings that combine to cause them. Once this mapping is achieved, it should be possible to use the neural network to form and setter the main beam, place nulls in the pattern at certain angles, and maintain side lobe levels below certain radiation levels. Furthermore, if the network is allowed to continually monitor the antenna's input settings and output radiation and re-train when inconsistencies occur, the neural network should be capable of re-learning the behavior of a degraded antenna and using this new behavior to optimize the antenna's remaining performance capabilities. This would both improve overall performance during missions and increase the antenna's available mission lifetime between major repairs. Phase I of this effort would design, develop, and test one or more software neural networks capable of controlling a provided software model and simulation of a 16 element linear antenna. This antenna model has 11 binary inputs for each element, a variable number of output pattern points, and is capable of both perfect and degraded behavior. Following a successful Phase I demonstration, Phase II would integrate a similar software neural network model into the control software of a test bed phased-array antenna and then train the network on the control of a working linear aperture at an antenna measurement site.

AF92-050 TITLE: Design Approach for High Performance Computing

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

DESCRIPTION: High performance computing is characterized by its great diversity of applications, of hardware architectures, of computation models, of control regimes, and of programming languages. The never-ending quest for greater computer speed leads to processors working in parallel to solve a single computation task. Air Force systems in the 1990's will most likely consist of several novel architectures, networked together. Developing a

large-scale system across several high performance computers will be very risky using today's methods, and the resulting software will be a nightmare to maintain. To make high performance computer technology easier to use, a strong foundation in enabling technologies is needed for dealing with both parallel and sequential software, an integrated set of parallel exploitation tools and methods for designing, coding and testing software. Advanced techniques such as visualization and algorithm animation need to be tapped to help improve the quality of software and make its development more productive. This effort seeks to evaluate and recommend design techniques that are architecture independent, demonstrate the suitability of chosen design approaches for different classes of high performance computers, describe how the design representations will be downloaded to different high performance computers and outline a research plan to develop automated design tools for implementing the best technique. A final report should document the results of this effort and include a development plan for implementing the design approach. For Phase II, the development plan will be refined and implemented. The end product will be a prototype software package which assists in designing software for parallel implementation on target high performance computers.

AF92-051 TITLE: Reusable ADA Software Fault Tolerant Components

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

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

AF92-052 TITLE: Supercomputer Data/Knowledge Bases

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

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

mechanisms for developing large supercomputer data/knowledge bases. Phase II will propose prototype development of a very large data/knowledge base for supercomputer database processing architectures.

AF92-053 TITLE: Ultra-Wideband Elemental Radiators

OBJECTIVE: Develop an elemental radiator with maximized bandwidth, plus maximized gain or minimized scattering cross section.

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

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

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

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

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

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

DESCRIPTION: Adaptive optics systems for wave front control are important for many future systems. They are required in imaging systems to remove distortions caused by the atmosphere. They are required in laser propagation to insure a good quality beam is transmitted through the atmosphere. The design of these systems uses many, perhaps well over a hundred, actuators which dynamically shape a mirror surface to compensate for the atmosphere. These actuators require an equal number of control loops to maintain their position. Further, these control loops are coupled to each other due to the mathematical equations used in the loops and due to the mechanical coupling of the mirror surface. The area of multiple-input-multiple-output control theory is directly applicable to this hardware implementation. The techniques of Singular Value Decomposition (SVD) have been developed to help designers evaluate the design of a MIMO system. The problem is that techniques to systematically test this type of system

have not been developed. The Bode Plot has been the most used tool of single input single output (SISO) control design and testing for the last 40 years. However, this approach is not feasible for testing large MIMO systems for two reasons: it takes too much to implement and run hundreds of simple tests, and the Bode plot does not yield stability measures for coupled MIMO systems. The need is to develop testing techniques and testing hardware that can be used toe valuate an adaptive optics systems. The solution must develop performance measures and stability measures that unambiguously describe MIMO system performance. Phase I will demonstrate that the contractor completely understands the techniques necessary to measure stability and performance of a MIMO system, specifically an adaptive optics system. The contractor will use simulation tools to show that a math model of a system can be tested and evaluated using the contractor's proposed techniques. The contractor should be able to conceptually describe the required testing hardware and demonstrate the performance and stability tools a the end of Phase I. Phase II will build a MIMO system in hardware and built the testing hardware to demonstrate the performance of the system. An adaptive optics system can be reasonably demonstrated with a beam, or plate, to represent the mirror, with small piezoelectric actuators, to represent the mirror actuators, ad with displacement probes, to represent the wave front sensors used in adaptive optics system. The contractor shall then design and build the test hardware to fully characterize this surrogate system. The final product of Phase II will be a report showing the proposed tests and the test hardware to measure stability and performance margins for the systems. Phase III of this effort should be a natural extension of Phase I and II. The techniques of testing MIMO systems should be marketable to persons involved with astronomy, adaptive optics, structural control, aircraft control, and many others. If a good testing approach is developed in Phase I and demonstrated in Phase II the contractor should have a very marketable technical base.

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

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

DESCRIPTION: recently, improvements in GaAs semiconductor diode laser coherent output power and beam quality have been achieved by utilizing advanced diode laser structure. Typically, simply diode lasers are cleaved-facet, edge-emitting devices in which the coherent output power is limited by gain stripe width and catastrophic facet damage. Advanced structures, such as grating surface emitters, both distributed feedback and distributed Bragg reflector on-chip unstable resonators; non-regenerative diodes in external resonant cavities; master oscillator/power amplifier configurations; and antiguided, leaky, wave arrays have led to increased coherent output power by avoiding high intensities on device facets and/or coherently coupling several lower power emitters together into a single, high power beam. Basic diode laser structures are also being developed to emit in the 2-5 micron range utilizing materials. Although excellent results have been achieved, it is readily apparent that the potential utility of these mid-IR sources for Air Force applications will be greatly enhanced via the development of advanced laser structures. Phase I of this effort shall study the implementation of advanced diode laser structures in mid-IR materials. Study of new and innovative structures, in addition to those mentioned above, which address the dual requirements of high power and good beam quality, is highly encouraged. Identification of basic limitations preventing implementation of an advanced structure will be one of the goals of this study. Following the identification of a viable structure, all growth, fabrication, and materials processing requirements necessary to implement the structure's various components will be addressed. Any unique optics necessary to implement the design shall also be identified. Phase II will implement the Phase I design and develop a mid-IR diode laser source. This development will include either growth or purchase of the epitaxial wafers, and the processing, test and characterization of the devices. The test results and mid-IR devices will be deliverable at the end of the Phase II period. The technology development has direct impact on the critical Air Force problems of Strategic Relocatable Targets, Secure optical Communications, and Opto-Electronic Warfare. Other Air Force and commercial applications of this technology include optical communications, heterodyne detection and high resolution molecular spectroscopy.

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

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

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

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

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

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

AF92-059 TITLE: High Speed Data Acquisition System

OBJECTIVE: Develop low cost high speed digitizing board for data acquisition systems used in recording array.

DESCRIPTION: The Phase I effort will be directed towards the development of a low cost detection and data digitization system for the evaluation of fast single event signal pulses. These pulses range from a few millivolts to tens of volts in amplitude, having a rise time of sub nanoseconds to tens of nanoseconds. The time of occurrence of a single event is known to be between 0.3 and 3 microsecond accuracy. An initial application will be observing and measuring 10 to 100 terawatt CX-ray pulses with large arrays of X-ray detectors. At this time, high speed digitizers of greater than 1 are either very expensive or non-existent, but advances in this technology are anticipated in the near future. During Phase I, a prototype digitizing board with the following characteristics will be developed and tested:

The board will be built to VXI bus standards
The sampling will be 4 Gs/s or greater
There will be a hardware/software switch for the variable input impedance
The vertical resolution will be eight bit or better

The data transfer rate will be greater than 1Mbte/second

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

AF92-060 TITLE: Fractal Modeling of Spall Characteristics

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

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

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

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

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

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

OBJECTIVE: Develop and demonstrate an instrumentation system to quantify results due to disintegration of a hypervelocity projectile.

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

AF92-063 TITLE: Hypervelocity Collision Scaling

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

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

AF92-064 TITLE: Wide Bandwidth Diagnostics and Instrumentation

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

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

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

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

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

thermocouples to samples on the Air Force cryogenic interrogation chamber located at Maxwell Laboratories, San Diego, CA. Phase II fabricates and tests candidate designs for ongoing Air Force experiments. Phase III transitions this technology to the Air Force satellite survivability community and to civilian users.

AF92-066 TITLE: Thermal Management for Advanced Electronic

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

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

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

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

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

AF92-068 TITLE: Hyper-Dense Chip Connection Systems

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

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

(1) Very high density chip connection technology
(2) Maximum frequency/minimum power performance due to integrated circuit device enhancements
(3) Packaging which will meet Class S performance levels and yet provide significant input/output bandwidth

In Phase II, the Phase I solution must be refined and demonstrated. A functional system shall be constructed in the phase which will demonstrate the feasibility of the hyper dense chip connection concept. The demonstrated system must be capable of operation under severe thermal, mechanical, and radiation environments. Furthermore, the constructed system shall demonstrate the feasibility of heat removal by simulating the electrical power loading of typical electronic systems and then demonstrating thermal equilibrium of this system in operation. Potential Phase III efforts would consist of development projects for the industry and military needs which would directly benefit by the transition of the concepts developed in the early phases of the effort.

AF92-069 TITLE: Superconducting Wafer Scale Interconnects

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

DESCRIPTION: For space-based electronics systems, size, weight, power, performance, and survivability are important considerations. Fortunately, the tendency in electronics technology development is to provide higher density components, which in turn lead to smaller and lighter weight systems. Even on the systems level, new packaging technologies are being applied to increase component densities. As systems get more complex, the interconnection density increases. In some systems, the connection density requirement is already pressing the limits of conventional materials. Within several years, superconducting materials will be required to support the finer line width geometries necessary to achieve vastly increased connection density capabilities. Phase I will investigate superconducting interconnects, and it will demonstrate the advantage of superconducting interconnections compared to those composed of conventional conductors. The Phase II will fabricate test substrates with multi-layered interconnections. The substrates will demonstrate the geometries required to perform low-loss interconnections with a minimum factor of five improvement over that achieved with conventional conductors. The successful completion of this phase would naturally extend to many promising Phase III opportunities.

AF92-070 TITLE: Pultrusion Processing of Composite Material Hardware for Space Systems

OBJECTIVE: Establish feasibility of innovative manufacturing techniques for fabrication of Air Force space structures.

DESCRIPTION: Most structures in present Air Force spacecraft are derived from machined aluminum components. As a result designers have failed to fully explore the superior material properties that are available using composites. This is due in part to the cost and complexity of conventional composite manufacturing techniques. Greater use of composite materials is needed to enable more ambitious missions to be undertaken, all of which require large, precision-built, space structures. A reduction in overall structural component weight would realize significant launch cost savings in this area. Pultrusion is a low cost automated manufacturing technique capable of producing constant high quality cross-section structures. Commercial pultrusion composite parts manufactured using this process have demonstrated significant cost and performance advantages when compared with conventionally produced composite parts. However, pultruded parts have yet to be significantly applied to space structures because manufacturing techniques need to be improved to produce thin gage components. The purpose of this program is to provide an impetus to use advanced composite materials, utilizing the thin gage thickness concept to achieve reduced weight and volume savings in proposed Air Force space hardware. Feasibility of innovative manufacturing concepts will be established in a Phase I program. The Phase II program will further demonstrate the results of the

Phase I program by fabricating structural components and putting them in a prototype space structure for testing. Successful development of such innovative manufacturing concepts could lead to wide scale commercial benefits involving the application of thin gage composite materials to spacecraft, commercial aircraft as well as marine and automotive equipment.

AF92-071 TITLE: Modular Piezoelectric Damping Elements for Flexible Structures

OBJECTIVE: Integrate recent vibration suppression hardware technology into an innovative modular patch for use wherever it is needed.

DESCRIPTION: This patch would contain sensors, actuators, control hardware, and power conditioning electronics necessary to perform local vibration suppression. The anticipated interface to the host structure would be standard power lines and a data line to monitor and change, if necessary, the control law. The innovation of this program would be the ability to inject vibration suppression technology wherever it is needed. Many proposed and ongoing DOD and SDI space systems for the 1990s and beyond have very precise pointing and shape control requirements. There has been a great deal of success in developing hardware with the necessary sensing and actuation technology to meet these requirements. These efforts have centered around piezoelectric materials as sensors and actuators for active vibration control. These same piezoelectric materials also provide an excellent tunable passive damper when stunted with a tunable resonant LRC circuit. The focus of past efforts has been to prove the technology, and the assumption has generally been made that the technology will be integrated into systems at the design phase. Consequently, there has not been a lot of effort to develop modular, small, lightweight self-contained systems which could retrofit the technology onto a system in need of vibration suppression. The active suppression system could be used for large amplitude vibration suppression, and the passive vibration suppression system could be used either when less vibration suppression is required or in the event of an active system failure. This patch would also have a predictable failure mode. Phase I of the SBIR task would be to develop two competing designs for the piezoelectric patch based on passive and active piezoelectric technologies and to evaluate the merits of each design. Phase II of the SBIR would consist of fabricating the chosen concept prototype and testing the qualifications.

AF92-072 TITLE: Suspension System for Dynamic Testing of Space Structures

OBJECTIVE: Develop a general purpose suspension system for simulating on-orbit boundary conditions in dynamic testing of very low frequency structures.

DESCRIPTION: A system is needed for simulating the unconstrained boundary conditions of orbit in ground vibration testing of a variety of highly flexible structures. Existing approaches introduce undesirable mass, damping and stiffness into the test article suspension device system, reducing the effectiveness and validity of any ground tests. The proposed suspension device or system must be capable of providing vertical rigid body suspension frequencies low enough to isolate highly flexible structures without adding unwanted mass, stiffness or damping. The suspension device or system must also allow unconstrained vertical test article motion in a large enough envelope to perform meaningful vibration tests, and must be able to operate in a vacuum chamber without significant loss of performance. Phase I will include construction and testing of a single point suspension device or system for proof of concept demonstration. Phase II will develop the concept into a full system using multiple devices of the same basic design.

AF92-073 TITLE: Nickel Hydrogen Battery Improvements

OBJECTIVE: Develop Innovative High Performance NIH2 Batteries for Air Force Space Applications.

DESCRIPTION: Air Force satellites will be using NIH2 batteries for the foreseeable futures. Presently NIH2 batteries have energy densities of 20 and 40 Whr/Kg in low earth and geosynchronous orbits, respectively. Improved performance batteries are required to enable envisioned future Air Force space missions. Innovative proposals for improved/advanced NIH2 batteries are therefore solicited. Energy densities twice current state of the art is the desired goal. Other aspects include volumetric energy density, greater depth of discharge, and increased

cycle life. Submitted proposals may address any of the above identified parameters or other significant aspects of NIH2 battery operation. Phase I should produce a complete analysis of the concepts feasibility, a prediction of performance characteristics, and a design of a proof of principle model. Key laboratory level testing which helps substantiate analytical predictions is highly desirable. In Phase II, the model should be fabricated and tested under appropriate conditions to simulate realistic operational performance. During Phase II, flight weight prototype batteries should be designed, fabricated and tested. Testing should include sample life testing.

AF92-074 TITLE: Prototype Storage and Delivery Device for Cryogenic Solid Oxygen Propellants

OBJECTIVE: Develop a cryogenic container capable of storing and delivering cryogenic oxygen solids into a combustion chamber.

DESCRIPTION: Cryogenic solid propellants may provide revolutionary advances in rocket propulsion. Solid oxygen and a mixture of energetic oxidizers with solid oxygen are relatively easy to form and store for long periods of time. If these cryogenic oxidizers are to be useful for rocket propulsion, a storage and delivery device need to be developed that will have the following characteristics:

(1) Capable of condensing gaseous oxidizers directly into the solid state at a temperature less than 50K with a usable life time of at least one hour.
(2) Able to store at least two grams of cryogenic solids.
(3) Having optical inspection windows to determine the content of the storage container.
(4) Designed to deliver cryogenic material into a combustion chamber.
(5) Made of materials compatible with strong oxidizers, such as ozone.
(6) Able to avoid the liquid state in the transfer method, especially when ozone is a component of the cryogenic solid mixture. The transfer of liquid into the combustion region is acceptable only if a method of safely transferring liquid ozone is developed.
(7) Controllable flow rate into the combustion region. The pressure of the transferred material must be greater than atmospheric pressure.

Phase I effort involves design of a system with the above characteristics. Phase Ii effort involves building the designed device and testing it with a 50/50 mixture of oxygen and ozone stored at temperatures less than 50 K.

AF92-075 TITLE: Liquid Crystal Polymer Cryo Composite Tank

OBJECTIVE: Develop a composite cryogenic fuel storage tank, without metal liner, using liquid crystal polymers.

DESCRIPTION: Traditionally, cryogenic tankage has been made out of metals such as aluminum or stainless steel with standards safety factors of 4:1. Such tankage is heavy, requiring extensive thermal management. For ground based systems, such approaches are adequate for most applications. However, for flight weight systems the weight and thermal management of the system is still a critical factor that can make such systems impractical for long term storage in space. The purpose of this effort is to demonstrate that by using liquid crystal polymers, the weight and thermal management problems can be minimized because of the high strength and low thermal conductivity. During the Phase I effort, a prototype flight weight tank design is to be produced. The tank should be made from as many nonmetallic parts as practicable. The manufacturing process can vary between extrusion, protrusion, casting, ribbon or fiber winding, or any combination to complete the task. The design should be accompanied with adequate real data to quantify the improvement in thermal management as compared with an aluminum tank. A cost and weight savings and improved mission profile analysis will be provided for this tank. In the Phase II effort, a laboratory prototype tank will be fabricated and tested. The testing of the design will be at a government facility. In addition to testing the mechanical and thermal performance of the prototype, the test will be compared with theoretically generated data to test appropriate simulation programs. In Phase III, the contractor will pursue commercial applications with manufacturers who produce tankage for satellites and rockets.

AF92-076 TITLE: Innovative Arc jet Design

OBJECTIVE: Develop a new arc jet which has a 20 percent increase in specific impulse and efficiency over existing ammonia arc jets.

DESCRIPTION: Chemically powered orbit transfer vehicles can only deliver 40 percent of the initial low earth orbit mass to geosynchronous orbits. Electric rocket engines can double the mass delivered to geosynchronous orbit. These high performance engines use one half to one third the propellant of chemical engines and this reduction in propellant mass enables a corresponding increase in payload. The most technically mature electric rocket is the low impedance ammonia arc jet. However, its performance is limited to a maximum specific impulse of 820 seconds and an efficiency of 35 percent. This project will develop a low impedance arc jet capable of operating with an efficiency not less than 45 percent and a specific impulse not less than 1000 seconds using a storable propellant. Phase I will design the new arc jet using innovative concepts such as, but not limited to, alternate electrode configurations, regenerative heated propellant feed systems, and utilizing methane or other light storable as the propellant. The goal will be to obtain at least 45 percent efficiency and 1000 seconds specific impulse at a power level of 10 kilowatts. Phase II will fabricate and test this new thruster on a thrust stand to verify its performance and determine its life time. Proposals will be judged upon understanding of the problem, demonstrated expertise in the field, and innovative approaches.

AF92-077 TITLE: Structural Resin Transfer Molded Solid Rocket Motor Cases

OBJECTIVE: Develop innovative structural resin transfer molded materials application methods and fabrication processes for medium to large solid rocket motor cases.

DESCRIPTION: The emphasis on lower life cycle cost, high reliability and ease of maintenance has shown the solid rocket industry that new technologies and new ways of thinking must be used to address these issues. A component of particular concern is the motor case. Current filament winding techniques for the medium and large size motor cases rely on numerous manual operations which result in high component reject rates. Low cost composite case fabrication processes must be investigated to determine the feasibility of applying them to future ICBM systems. Recent work at OL-AC PL indicates that the new generation of engineering plastics coupled with the structural resin transfer molding techniques can yield a reliable, low cost motor case. During the Phase I effort, a feasibility study for applying the liquid crystalline polymers and structural resin transfer molding fabrication techniques shall be performed. Feasibility shall be demonstrated by fabricating three structural resin transfer molded cases. During the Phase II effort, a detailed study of current and future structural resin transfer molded materials and techniques shall be conducted for medium and large solid rocket motor cases. Current and future SRTM limitations for this application will be identified. The contractor will fabricate several motor cases using the various materials. In Phase III, the contractor will present this work to the various solid propulsion contractors.

AF92-078 TITLE: The Optimization of Lithium Solid Polymer Electrolyte Cells

OBJECTIVE: Develop the next generation of lithium solid polymer electrolyte batteries, and examine and define their failure mechanisms.

DESCRIPTION: There is a need to increase energy and power densities for power storage devices on space missions. The average costs per kilogram of placing a satellite into Low Earth Orbit (LEO) and Geosynchronous Orbit (GEO) are $8K and $47K per kilogram, respectively. The need for decreasing payload weight is obvious. Solid state lithium polymer electrolyte cells can provide approximately ten times the energy density of current space power cells. In addition, the operating temperature range of these lithium cells is greater than the current cells in use. However, overcharging and over discharging of lithium cells can lead to cell failure. Presently, the body of data available on cell failure mechanisms is very limited. Understanding of cell failure mechanisms could lead to more robust cell designs. The Phase I effort will be to engineer and construct a prototype secondary solid state lithium polymer electrolyte cell, of sufficiently consistent morphology, such that reproducible energy density, power density and voltage characteristics are achievable. Based on the evaluation and testing of these prototype cells, any other cell criteria which can be optimized to yield a more robust design, as well as enhanced cell performance,

should be defined. During Phase II based on knowledge obtained from Phase I studies, the contractor will engineer and construct a bipolar secondary cell that incorporates these new improved characteristics. This cell should exceed the typical performance values for bipolar secondary hi-polymer electrolyte cells. The contractor will test and evaluate the performance of the bipolar secondary cells. All designs, engineering criteria and performance testing results will be delivered to the USAF.

AF92-079 TITLE: Innovative Methods for Eliminating Combustion Instability in Liquid Rocket Engines

OBJECTIVE: Develop innovative approaches for suppressing or eliminating unstable burn in liquid engines.

DESCRIPTION: Liquid rocket engine development continues to be plagued by the frequent occurrence of combustion instability. Current methods of suppressing such instabilities through the addition of baffles and acoustic cavities, require time consuming empirical cut and try procedures, and design compromises. New and create approaches for controlling and eliminating combustion instability in liquid rocket engines are sought. The following examples are presented to stimulate ideas and are not meant to be limiting in their scope. In solid rocket motors, certain types of instabilities can be suppressed by the addition of small amounts of additives. The use of fuel or oxidizer additives in liquid rocket engines to control instability does not appear to have been explored. A creative and innovative search for compounds which can favorably alter the combustion of liquid propellants is warranted at this time. Since spray and pressure should have significant effect on the combustion process. In addition, other compounds may play a favorable role similar to that of tetraethyl lead antiknock suppression in internal combustion engines. Active control is currently used or considered for a number of combustion applications to impact both performance and stability. Active control of the injection/atomization process should provide new avenues to explore in the quest for improved liquid rocket engine stability. During the Phase I effort, the feasibility of potential approaches would be examined and an experimental procedure for demonstrating their effectiveness would be conceived and designed. In the Phase Ii effort, laboratory scale tests would be conducted to explore the effectiveness of proposed approaches. The effect of promising suppression techniques on engine and system performance would be examined to ensure there were no deleterious effects. Reliability and maintainability issues would be considered at the propulsion system level. Cost effectiveness would also be addressed. In Phase III, the contractor will pursue commercial applications with propulsion system contractor.

AF92-080 TITLE: Non-Imaging Concentrator

OBJECTIVE: Develop a non-imaging optical concentrator to enhance 1,000:1 concentration ratio of 1500 KW off-axis parabolic solar space reflectors.

DESCRIPTION: The Phillips Laboratory is planning to use a solar concentrator, in conjunction with guidance and control devices, to direct solar energy into a hydrogen solar engine to heat the propellant inside a cavity, expand the gas, and exhaust it out a propulsive nozzle to produce thrust. Two 100 ft. x 135 ft. off axis parabolic reflectors will concentrate solar energy into a thrust cavity, located at the two reflectors' focal point. Mis-focused solar energy is normally the reason that an optimum ratio cannot be achieved. When this occurs, the mis-focused energy spills out of the thruster cavity and either is lost, bounces off unprotected materials and equipment, or is absorbed/often with destructive results. The focus of this project is to develop a subscale, secondary solar concentrator which will maximize the system concentration ratio, given a primary concentrator size; while minimizing the secondary concentrator mass, it will still have a significant impact on the guidance and control systems. A prime, space environment requirement for the secondary concentrator demands design simplicity and manufacturing ease to interface with the total solar concentrator-thruster concept. The Phase I project will be used to determine the most suitable candidate concept for further development and a preliminary design of the chosen concept. Phase II of the project will consist of a preliminary design, a detailed design, and the fabrication of a small scale dimensional version; which will fit into or onto the rhenium tube cavity thruster and in front of the fluxmapper system. The project interface requirements will be defined at the beginning of Phase II. The cavity of the present thruster is 8 inches in diameter. Experiments will be performed and data compared with the results of previous experiments to determine efficiency increase and concentration ratio.

AF92-081 TITLE: Lidar (Laser Radar) Detection of Space Debris

OBJECTIVE: Study the concept of using a lidar sensor for space-based measurements of space debris.

DESCRIPTION: Innovative concepts are sought for the development of a lidar system to make space-based measurements of space debris. Damage to spacecraft and orbital platforms by space debris is of growing concern to the Air Force and other agencies. Space debris levels are continuing to increase with each new space launch and with collisions between existing debris. This is of particular concern at certain favored low earth orbits which are used by defense satellites and the shuttle. Extensive passive optical and radar measurements are being made, but these are not particularly sensitive to debris of smaller sizes. Even very small millimeter size debris can be extremely damaging at orbital velocities, as demonstrated by the pitting of the shuttle view ports. In-situ measurements of space debris are sought by using the proposed lidar system to obtain statistically useful data to help validate current space debris models. The Phase I effort will be to study the feasibility of the concept given the current and expected, near-term, state-of-the-art, lidar technology. The Phase Ii effort, if awarded, will seek to develop sensor designs which may meet the proposed objectives, identify specific required key technologies, and identify and address high risk factors through further study and/or development. The fabrication of a scale brass board system leading to the final design of the space qualifiable hardware for launch will be considered. Candidate approaches should consider use of compact, solid state, laser transmitters utilizing efficient laser diode pumping. Tradeoff studies of the merits of using different detection schemes such as coherent, incoherent, quadrant detectors, or focal plane arrays should be done. It is anticipated that the lidar sensor would be launched by a Pegasus or similar class launch vehicle which will determine the lidar size, power, and weight constraints. A number of vendors offer generic instrument platforms that are compatible with the Pegasus and should accommodate the proposed sensor.

AF92-082 TITLE: Passive Microwave Imaging Through Smoke and Obscurants

OBJECTIVE: Develop a passive sensor for the remote identification of military targets and backgrounds in the presence of obscurants.

DESCRIPTION: The USAF has a requirement to assess the effects of aerial bombardment in the presence of clouds and smoke. It is desirable that such a surveillance system be passive. The recent demonstration of a passive microwave airborne sensing capability is the impetus for the present proposal. If synthetic aperture radiometry can be extended to much shorter wavelengths, then angular resolution can be achieved with an antenna array of suitable size to be mounted on an aircraft; this will yield spatial resolution of 3 m or better form an altitude of 1760 m. The meteorological problem is that wavelengths of a few centimeters or less are increasingly affected by attenuation in clouds and precipitation. Phase I will develop the proof of concept of the approach and will include such issues as radiometric sensitivity as a function of wavelength and meteorological environment as well as target and background emissivity and contrast as functions of wavelength. Phase II will be the design of the system using the approach and the fabrication of a prototype system for independent test by the Air Force. Phase III will lead to preproduction prototype.

AF92-083 TITLE: Targeting/Tracking Lidar System

OBJECTIVE: Investigate a system containing a lidar w/ infrared camera which will detect, track, and characterize targets in the lower atmosphere.

DESCRIPTION: A typical lidar system transmits pulsed laser energy into an atmospheric region of interest and measures the light backscattered from along the path of the laser pulse. The backscatter contains neutral density particle and aerosol information as a function of range from the lidar system. Lidar systems operate at any number of ultraviolet, visible, and infrared wavelengths, and either stare to record the temporal behavior of the atmosphere as it passes or rapidly scan a region to obtain an atmospheric snapshot. Scanning or staring systems, especially those operating at nonvisible wavelengths, are not well suited to locate and track targets or atmospheric features which subtend relatively small solid angles as viewed from the lidar system. The problem is further aggravated if the target is in close proximity to other strong backscatter sources; adjacent clouds or ground clutter. An innovative

system is required which ahs maximized capabilities to locate, track and characterize or identify atmospheric targets in the lower atmosphere up to and including cirrus altitudes. The instrumentation called for in this solicitation is one such innovative approach which combines lidar technology with that of passive infrared imagery. Initial trials indicate an infrared sensor is the ideal device to locate and facilitate the tracking of a target both day and night. The lidar can remotely probe the target to determine its range and attempt to define and characterize it. A possible configuration might include ea passive infrared video camera providing a steerable field of view with a crosshair index which can be trained on a target. A co aligned lidar system will then also be trained on the target. Another configuration might have impendent pointing for the camera and the lidar. Phase I should be a feasibility study based on innovative remote sensing concepts and technology combinations leading to an optimized functional design of a Targeting/Tracking Lidar System, and Phase II should result in a detailed hardware design followed by fabrication and testing of the lidar system.

AF92-084 TITLE: MeV Electron Source for Space-Based Ionospheric Modification and Diagnostics

OBJECTIVE: Design an MeV electron accelerator for use on space platforms in support of ionospheric modification and diagnostics programs.

DESCRIPTION: Previous experiments with electron beams in space been limited by practical considerations to relatively low particle energies. However, recent developments in electron beam technology suggest that moderately powerful, relativistic electron accelerator units could be developed for mounting on payloads suitable for research rockets and satellites. Such a development would provide a means for triggering and investigating a new realm of plasma phenomena predicted by theory. These include the creation of dense columns of free electrons and positive ions in the ionosphere, lower mesosphere and upper stratosphere, which could scatter electromagnetic radiation. Such a capability could lead to the development of new diagnostic techniques to investigate ionospheric properties such as electron attachment, recombination, and diffusion times; winds and shears in the lower ionosphere and upper atmosphere; and the determination of atmospheric constituents and pollutants, including their relative concentrations. In addition, a space-based MeV accelerator would provide the means for significantly modifying regions of the space and missile environment. Envisioned are such applications as providing layers or local regions of ionization to efficiently reflect or scatter radio waves, such as by the creation of a diffraction screen for HF/VHF transmission; inducing electrical discharges from the upper atmosphere to the lower ionosphere; and producing optical and other emissions that could provide a means of identifying and quantifying atmospheric constituents in the upper atmosphere. Projected requirements for a pulsed, high energy electron source are as follows: electron energy, peak current, peak power, pulse length, and pulse repetition rate. The relativistic electron source must be designed into a super compact package so that it can be flown on sounding rockets and small satellites, being limited in size to about 3 ft in length by 1.5 ft in diameter and in weight to less than 300 lbs, excluding power source, such as batteries. It must be able to withstand the rigors of operation in the upper atmosphere and space environments. In Phase I, the feasibility of building such an electron accelerator will be assessed and a preliminary design be prepared. In Phase II, a prototype electron accelerator will be constructed and tested. If the tests are successful, the prototype will be considered for an actual field experiment.

AF92-085 TITLE: Advanced Technology for Satellite Microwave Water Vapor Retrieval

OBJECTIVE: Explore the feasibility of employing meteorological model constraints improving the accuracy of water vapor profiles inferred from satellite microwave sounders.

DESCRIPTION: The operational approach to the retrieval of water vapor profiles from the Defense Meteorological Satellite Program microwave sounders is based on a statistical regression which confines the profile to the local climatic variance. The water vapor profiles are used in various meteorological models which in themselves can provide additional information on the variation of water vapor which can enhance the accuracy of the final water vapor profiles. The specification of water vapor with considerable horizontal and vertical resolution anywhere on the globe is required for the effective utilization of modern Electro-Optical systems employing tactical decision aids and optimal tactical operations planning. For Phase I investigate the feasibility of a technique which corrects raw microwave data for recognized errors, exploits retrieval techniques to maximize the information obtained and

incorporates meteorological models to improve the accuracy of resulting water vapor profiles. During Phase II produce a computer demonstration or numerical simulation to verify Phase I.

AF92-086 TITLE: Stratospheric Ozone Perturbation By Sub-Micron Particles

OBJECTIVE: Determine the effect sub-micron particles have on stratospheric ozone.

DESCRIPTION: The exhaust of ammonium per chlorate/aluminum-based solid-propellant rocket motors contains hydrogen chloride vapor and alumina particles. These materials are emitted directly into the stratosphere during the ascent of launch vehicles propelled by SRMs. HCI is known to be destructive to stratospheric ozone and its impact can be determined with currently available radiative-transport models of the stratosphere that incorporate homogenous, vapor phase chemistry and physics. However, the role of sub-micron particles has not yet been well characterized. Experimental research is to ascertain the nature and importance of heterogeneous chemical processes that might occur on the surfaces of sub micron particles that remain dispersed in the lower stratosphere. Data concerning both indirect effects on anthropogenic that photolytically liberate chlorine radicals to destroy ozone, and direct reactions of both ozone and chlorine family members at active sites on the particulate surface is needed. Phase I of the research effort will address the indirect effect and must answer the following question: How are the rates and reaction products of photo dissociation altered by adsorption at surfaces of sub-micron particles? Kinetic experiments must be performed to evaluate the rate constants and product composition arising from surface photo dissociation of the most commonly used CFCs. The experiments should include a proper treatment of effects that are caused by saturation of surface adsorption. Research during Phase II must identify the principal surface reactions with ozone and with chlorine family members. Reactions that occur on sub-micron surfaces in both the presence and absence of solar radiation must be considered. Rate constants for the most significant chemical reactions should be experimentally determined and any heterogeneous catalytic effects must be investigated and quantified. The experimental data must then be analyzed to evaluate the overall ozone depletion potential of SRM particulate emissions.

AF92-087 TITLE: Imaging Based Optical Switching

OBJECTIVE: Develop Imaging based optical switch.

DESCRIPTION: In an non-blocking, square matrix switch sized N inputs/outputs one needs number of cross points. An optical switch based on imaging techniques can reduce the number of cross points needed to essentially zero. The Fourier properties of coherent light propagation makes a phase shift in one focal plane to spatial translation in the opposite focal plane. As a result, the wave propagation itself provides the switching. One can apply this principle to transmitting and receiving arrays. This application creates a new generation of switches. This type of switch supports gigabit data rates in a compact form with essentially no cross points. Phase I of this research needs to determine feasibility of this approach. One would solve the two dimensional equations dealing with plane of multiple sources. With the solved equations, one needs to simulate propagation results of steady mark/zero condition of each active source within array. After understanding the results of steady source, one would stimulate propagation results of all sources within array being at pseudo-random transitions. Results of equation solutions and insulation will fully define feasibility and the needed architecture. Phase II of this research needs to complete a working prototype. One will use the results of he Phase I to construct a prototype, starting with selection of lenses, sources, phase shifter, and receiver sets. Afterwards, one would construct a small array. With array completed, one would complete initial tests with static data to verify the shift to translation characteristics from transmitting plane to receiving plane. With a successful static test, one would complete the prototype by increasing data rate from static state to breakpoint. As a result, the prototype will demonstrate performance and provide data to adjust the developed governing equations.

AF92-088 TITLE: Measurement of Currently Unfulfilled/Partially Satisfied Environmental Data Parameters

OBJECTIVE: Develop optimum satellite techniques to measure unsatisfied or partially satisfied environmental data parameters.

DESCRIPTION: This effort should concentrate on the enhancement, improvement, or development of technique to measure the prioritized environmental data parameters listed below. These parameters are derived from requirements in the Defense Meteorological Satellite Program (DMSP) System Operational Requirements Document (SORD). The parameters can be categorized into atmospheric, oceanographic, terrestrial, and solar/geophysical elements:

Atmospheric:
1. Clouds
2. Vertical Temperature Profile
3. Absolute Humidity
4. Winds

Oceanographic:
1. Sea Ice
2. Sea surface temperature
3. Sea surface tomography

Terrestrial:
1. Soil Moisture
2. Snow Cover
3. Landlocked Ice Cover

Solar/Geophysical:
1. Electron Display Profiles
2. Natural Density
3. Solar Radiation Imagery/Flux

Phase I should address a conceptual design, development or feasibility analysis of innovative techniques to develop an optimum data collection subsystem. The technique should be aimed at improving the satellite measurement of any or all of the above listed parameters. The Phase I design should study the feasibility of satisfying the chosen parameters in an efficient and cost-effective manner. Pros and cons of the proposed system should also be addressed. Power, weight, cost, and state-of-technology constraints should be considerations. Active or passive sensing techniques may be investigated. Phase II will include further development of the Phase I concept into development of a prototype of the optimized system.

AF92-089 TITLE: Computer Efficient Models of Thermospheric Density and Composition

OBJECTIVE: Develop computer models of the neutral thermosphere which are faster and more accurate than those currently available.

DESCRIPTION: In spite of modeling efforts by large organizations, and vast improvements in the speed of digital computers, the accuracy of satellite orbital predictions in low earth orbit has not improved significantly in 20 years. Errors in thermospheric density models at altitudes of 90 to 1000 km are believed to be the cause of this problem. Currently available computer-efficient models are of two types: spherical harmonic models such as Hedin's MSIS and Killeen's VSH; and static diffusion models such as those developed by Jacchia and Slowey, which employ analytic approximations. The VSH model, which is derived by fitting spherical harmonics to the output of a first principles Thermospheric Ionospheric General Circulation Model, provides horizontal winds in addition to density and composition. An empirical model of neutral winds has also been developed by Hedin using techniques employed in the MSIS model. The main difficulty with first-principles models and fast models derived from them is that they require knowledge of all the sources and sinks of energy, some of which are rarely measured or unknown. For example, the Thermospheric Ionospheric General Circulation Model and the VSH model lack the semiannual variation, though it has been in empirical models for 30 years. Empirical models have the ability to fit the actual data. We solicit innovative thermospheric models which possess improved accuracy and speed and are suitable for use on digital computers. Phase I should develop an approach to improving the accuracy and increasing the speed of

existing models. The feasibility of this approach should be demonstrated. Phase II should demonstrate a prototype model which has the improved performance predicted in Phase I.

AF92-090 TITLE: Innovative Guidance & Navigation Sensors and Processing

OBJECTIVE: Develop alternative guidance and navigation update schemes and sensor fusion processing techniques to minimize currently encountered complexity and costs.

DESCRIPTION: Specific areas include the following:

a. Current strategic grade inertial instruments are complex and very expensive. As a result, strategic guidance and navigation systems relying solely on inertial instruments for navigation are difficult to acquire, maintain, and service. If this reliance on purely inertial reference is reduced, a potential savings in cost and complexity arises. Several techniques have been proposed to this end, including stellar, radar, and satellite navigation updates. Phase I should attempt to propose additional unique and innovative schemes or sensors. These concepts should have little or no dependence on externally alterable or vulnerable references. Phase II should include further definition and analysis of these topics.

b. Inclusion of non-inertial navigation update sensors into ICBM guidance suites increases the performance requirements on the processor. Efficient algorithms are required to incorporate navigation updates, making the best use of processor capability. Several parameters are of interest, including update timing, relative accuracies of inertial and non-inertial sensors, and processor throughput requirements. Phase I should attempt to develop a sound approach to the problem and demonstrate feasibility of the solution. Phase II should involve further investigation, exploratory testing, or simulation.

AF92-091 TITLE: Reentry Plasma Phenomenology

OBJECTIVE: Develop new models and validate existing models for turbulent flow-field boundary layers of hypersonic vehicles.

DESCRIPTION: Specific areas include the following:

a. New concepts for mapping or imaging mass and electron densities of turbulent flow field boundary layers remains a challenge for acquiring a database to explore RF degradation under these conditions. Laminar flow fields physics has explored non-turbulent flows with much success. With advances being made in maneuvering reentry vehicles, a through understanding of this phenomenology is required for improving communications and guidance. Much of the ground testing of this phenomena takes place in shock tunnels with short experimental durations which calls for time resolved diagnostics. Survivability or low cost repeatability in a shock tunnel environment is necessary for acquiring data over a series of ground tests. Ideally, a 3D time resolved tool would provide an in depth understanding of turbulent boundary layer conditions. Phase I should investigate one or more advanced diagnostics or innovative concepts and include technical feasibility and performance improvement analysis. Phase II should consist of actual data acquisition and mapping of models at ground test facilities.

b. Turbulent flow during reentry produces modulation of the plasma produced in the boundary layer of the hypersonic vehicle. This plasma modulation can degrade the ability to perform target finding missions, perform a position update or even communicate due to decorrelation of the microwave signals. The degree of plasma modulation and the spectral content of such modulation during turbulent boundary layer flow needs to be investigated. Additionally, the effect that this plasma modulation has on electromagnetic transmission over the frequency bands from S- to Ka band should be addressed. Phase I would determine the feasibility of the effort and Phase II would develop the analytic techniques necessary.

c. A number of both flight and ground tests have been done over the years to measure the plasma conditions during reentry and to address electromagnetic transmission through this plasma. However, in a number of

cases these data have not been thoroughly analyzed to determine all of the elements necessary to compare these data with flow field/plasma models. This data base needs to be analyzed in depth and sufficient information obtained to validate existing state of the art flow field codes. The validation of these codes and, where necessary, development of additional correlations is a part of the effort. Phase I would consist of determining what tools should be employed and Phase II would provide a thorough analysis to produce the database.

AF92-092 TITLE: Electromagnetic Transmission Through Plasma

OBJECTIVE: Develop techniques to facilitate transmission of optical and radar signals through the plasma layer of a hypersonic maneuvering vehicle.

DESCRIPTION: Specific areas include the following:

a. Techniques are sought which would provide information to a reentry vehicle that an interceptor has been launched and is on target for the given reentry vehicle, and which would determine the interceptor launch and trajectory. Development of the technique must include the effects of the reentry conditions on the sensor techniques studied. Phase I would assess the types of techniques which may be applicable. Phase II would entail the development of a method which would provide sufficient information of a potential intercept.

b. Innovative methods are sought to perform Global Positioning System (GPS) updates both prior to launch and during flight of hypersonic maneuvering vehicles. These methods would provide a necessary trajectory update for hypersonic maneuvering vehicles. The methods investigated should be sufficiently rugged to survive launch and reentry conditions. They should also be small enough with sufficient power to be easily installed in a hypersonic vehicle. The noise sources and their impact on accuracy for such a GPS update should be addressed. Phase I should examine possible methods and Phase II should analyze one of the methods.

AF92-093 TITLE: Develop Second Generation Primary and Reserve Batteries for Strategic Missile Applications

OBJECTIVE: Develop innovative designs and materials in second generation silver-zinc batteries with increased energy density and improved voltage regulations.

DESCRIPTION: The requirement for reduced battery weight and volume in advanced strategic missile applications has resulted in the need for higher energy density reserve batteries. Although reserve lithium thinly chloride batteries offer very high energy densities, safety and reliability have become significant issues. The advantages provided by high rate reserve lithium batteries are often negated by additional safety and operational concerns. For example, a requirement for effluent gas containment and neutralization is necessary to protect missile assets during abort. In addition the traditional approach has been the use of a centralized instrumentation power supply, either reserve or manually activated. This has stimulated the development of progressively higher energy density batteries to meet this requirement. Since power has been consolidated in a central supply, safety and reliability can become an issue, especially for high energy density lithium battery systems. One approach is to develop high energy silver-zinc batteries. Another approach to mitigating these concerns is to provide instrumentation power via smaller, lower power, dispersed primary batteries. Each component in such an instrumentation and telemetry system would contain its own primary power supply and cabling. The use of primary batteries would simplify functional testing and reduce safety and reliability concerns relative to the centralized power system. Silver zing batteries have many advantages over lithium batteries such as high reliability, prior successful use in other strategic missile applications, and reduced safety concerns. Improvements in current state of the art silver zinc technology would allow increased energy density and improved voltage regulation which would therefore make the technology more viable for strategic missile applications. Phase I will identify new battery designs and concepts in silver-zinc batteries or alternate battery types. Emphasis during Phase I will be placed on how design innovations and the use of new

materials can improve energy density and improve voltage regulation. Phase II would be to select the most promising design(s), to perform material compatibility verification tests and to validate the design by prototype tests.

AF92-094 TITLE: Innovative ICBM Communications

OBJECTIVE: Develop improved communications technologies for ICBM launchers and launch control centers.

DESCRIPTION: Communications between ICBM launchers and their launch control centers must meet requirements such as operation through nuclear environments, survivability against direct nuclear attack and unattended operation in some cases, and high reliability for long endurance and high confidence message delivery. Future launchers and their control centers may be either mobile or fixed. For mobile elements an additional requirement is that transmissions should not reveal location to enemy forces, such as satellites. Cost is a key consideration for all applications. Innovative concepts, architectures, equipment and technologies are needed to respond to these requirements. Phase I work should include preliminary analyses, evaluation of options and a definition of the Phase II effort. Phase II could include more detailed analysis of concepts or technologies studied during the Phase I and concept demonstration or testing. Two technologies of immediate interest are a horizontally polarized VHF antenna for meteor burst communications and a fast response transmit/receive switch that switches in 1 msec, and switches 4 kilowatts at 50/100 MHZ and 1 kilowatt at 400 MHz. Other areas of interest include the following:

(1) Ground wave, sky wave or troposcatter antennas which survive nuclear attack and can be installed within the fenced area around a missile silo. Small antennas could be an integral part of the silo;
(2) Radomes for SHF/EHF satellite terminals which can survive nuclear attack and support post attack communications;
(3) Conformal or low profile antennas which do not degrade the hardness of current or future hard mobile launchers. All antennas must support noninterruptable/minimum interrupt links between launchers and launch control centers. Ranges of interest are 50 to 400 miles;
(4) Advanced technology, mobile or transportable, low cost ground relays to increase survivability and range of launchers to control center links through networking techniques.

AF92-095 TITLE: Prefabricated Missile Silo Structures: Blast Attenuation, Egress, and Design/Deployment Concepts

OBJECTIVE: investigate innovative techniques for achieving high hardness missile silo structures utilizing rapidly deployable prefabricated components.

DESCRIPTION: Arms control constraints may drive the U.S. to highly survivable basing which will require very high system hardness at reasonably system cost. One approach to achieving high hardness is the use of natural and/or artificial attenuating overburden materials for silos and vertical or horizontal buried hard shell structures. For rapid launch response, overburden must be quickly removed to allow egress. One possible method of reducing deployment cost is to employ a buried hardened launcher capsule in which the capsule is prefabricated in a factory and assembled on site. Innovative approaches are sought in the following areas:

a. Concept definition of innovative attenuating schemes to very high system hardness and preliminary analysis to show level of feasibility. Phase II will involve more detailed analysis of most promising options followed by small scale feasibility tests.

b. Methods of removing various depths of protective overburden. Techniques may include pressurization, explosives, mechanical, or combinations of methods. Phase I will involve definition of innovative concepts for egress and preliminary analysis to show feasibility. Phase II will involve more detailed analysis of promising solutions along with scale tests to show feasibility.

c. Innovative concepts of construction, materials, modularization, and field assembly of prefabricated launcher capsules. Phase I will involve definition and cost evaluation of concepts and procedures. Phase II

will involve detailed design applicable database development and evaluation of the most promising concepts.

AF92-096 TITLE: Improved Radiation Hardness for ICBM Electronics

OBJECTIVE: Develop radiation hardened parts; Electro-Optic precision voltage reference & power IC's; plus software tools allowing inexpensive parts design on different substrates.

DESCRIPTION: Specific areas include the following:

a. Investigate/evaluate/develop guidance system precision voltage reference using LEDs Power/Voltage Fiber Optic (FO) Cabling, Electro-Optic amplifiers, optical Phase Locked Loops, etc. This approach using high frequencies and fiber optic technology can provide for a much higher capability for operating in the nuclear/post nuclear environment. Phase I will identify new voltage references using the different available technologies. Phase II would select promising design(s) to build and test.

b. Hardening a strategic system for operate through requirements depends on integrating the TREE and EMP phenomena. To combine the present tools available would enable evaluation of synergistic effect and an optimum design solution. Phase I will identify the program modules required and do preliminary coding. Phase II will integrate the software modules and perform validation runs.

c. Study the commercial single chip power control electronics and determine the trades involved to obtain hardened low volume power supplies. Phase I will identify single chip power control electronics and determine the trades involved to radiation harden them. Phase II will build and test the most promising designs.

d. Radiation hardness of bipolar integrated circuits is linked to the transistors cut off frequency. High f. devices are being developed by a self-aligned process that forms a very small base structure. This process needs to be evaluated for future hardened electronics. Phase I will evaluate High f. devices for Red hard applications. Phase II will build and test the most promising devices.

AF92-097 TITLE: Internal Measurement of Spherical Surfaces to 5 x 10-6/Inches Radial Deviation

OBJECTIVE: Develop automated gauge for measurement of Inertial Measurement Unit (IMU) Power Shell Interiors to 5 x 10 inches deviation from prescribed radius.

DESCRIPTION: The housing for the inertial guidance unit of the Peacekeeper and Small Missile is formed by two hemispherical beryllium shells approximately 10-11 inches in radius. The capability of these shells to form a perfect spherical cavity to a deviation from constant radius not exceeding millionths of an inch is critical to the proper operation of the inertial guidance system. There is a need for an automated gauge to continuously measure the internal radii of these hemispheres along a 180 degree great circle passing through the physically marked zenith of the hemisphere. Such a measurement must be accomplished at 5 increments around the circumference of the hemisphere. The deviation from prescribed radius along each of the resulting 72 great circle measurement routes shall be displayed in both Cartesian and Polar form in a fashion that will facilitate location of any defect on the measured surface. In addition to measurement of deviation from a constant radius along the 180 degree great circle path, the instrument shall also computer and record the diameter of the base of the hemisphere as defined by the beginning and end of each specific great circle path. In addition, the instrument shall calculate the deviation from prescribed arc length as measured from the zenith to the intersection of the equatorial plane on each side of the physically marked zenith. Readout of the instrument will be in real time and be displayed on video monitor and available on hard copy. The internal surface of the beryllium hemispheres is generated by lapping and is approximately 10 micro inches Root Mean Square. Measurement accuracy must be 5 x 10 inches or better. A Phase I SBIR activity will result in definition of the design for the gauge and report generator together with demonstration of the gauge concept. In this regard, a non-contact gauge is highly preferred over a contact gauge. However, accuracy, reliability and maintainability are mandatory and should guide design philosophy. However, accuracy,

reliability and maintainability are mandatory and should guide design philosophy. The Phase II activity will result in construction and validation tests of a prototype production gauge and report generator.

AF92-098 TITLE: Replace Refigerant R-12/R22 Based Cooling Systems for Missile Guidance Systems

OBJECTIVE: Identify innovative coolant systems that are not CFC based systems utilizing environmentally acceptable coolants.

DESCRIPTION: Chlorofluorocarbons, and Methyl Chloroform are two major sources of Atmospheric Chlorine that are devastating the ozone layer. CFCs will probably be completely banned by the year 2000. Both of these chemicals are widely used flushing/degreasing agents in the production of metallic and electronic DOD material. In addition, closely related materials, Freon R22 and R12 are used in air conditioning systems. Many missile systems use these chemicals in the equipment that maintains the temperature humidity envelope required for steady state field operation of tracking, launch, guidance, security and storage related electrical and electronic systems, electro-mechanical, and mechanical components and the crew's living quarters. Banning of CFC's creates the need to redesign the environmental control systems to be capable of utilizing an environmentally acceptable coolants and respective systems and a final recommended system. System designs and operating characteristics will be identified and compared to CFC R12 and R22 based systems. Phase II SBIR activity will finalize the selected design, construct and test a prototype evaluation unit.

AF92-099 TITLE: New Reliability Model Varying the Dormancy Factor

OBJECTIVE: Develop innovative reliability/logistic models for utilization in determining potential spare parts requirements, considering the dormancy factor.

DESCRIPTION: The current Reliability/Logistic modeling software does not allow logistic analysis for calculating Mean Time Between Failure when dormancy is included in the Reliability formula. There is a need for a means to enter dormancy as a constant when figuring out the number of spare parts required. Components requiring a MTBF analysis experience a dormancy period before they are utilized in the field. A new reliability model should enable a logistic analysis to treat dormancy in relation to the MTBF analysis so the process of calculating the number of required spare parts will be simple, accurate, and reflective of the true field scenario. Phase I SBIR activity will result in a MTBF/dormancy program with strategic/tactical missile hardware. The program should be user friendly allowing for the dormancy factor to be varied. If the program cannot be written in the time allotted for Phase I, some form of evidence of the potential of the requirements being met should be exhibited. Phase II activity would involve program completion/application of the model and training of necessary Air Force personnel.

AF92-100 TITLE: Performance Enhanced Navigation Using Neural Network Technology (PENANT)

OBJECTIVE: Explore neural network technology for improving the consistency of aircraft navigation system solutions.

DESCRIPTION: Operational navigation/reference systems are extremely complex and require integration, management and/or diagnostic functions to be performed within the sensor subsystems, at the sensor output level, at the system level, and at the pilot level. Over the last few years, much effort has been expended on technical efforts which address better ways to perform these functions. These development efforts have met with varying levels of success. Technical deficiencies still exist in the areas of Kalman filter robustness and navigation system fault detection and isolation. Enhancing the performance of these functions would result in improved consistency of the navigation solution, better enabling combat aircraft to successfully complete missions even under instrument meteorological conditions. Proven benefits of neural network technology suggest that this field may prove beneficial for improving the performance levels of these navigation/reference system functions. Among these advantages are the capability to detect and adapt to new classes of failure signatures, the capability to exploit massively parallel computing architectures, the ability to recall information based on content, and the ability to generalize from previous examples. Thus, this study will focus on applying neural network technology to such

integrated navigation system functions as Kalma filter related diagnoses, fault detection, isolation and compensation for individual sensor failures, discrepancies, and degradation as well as system level failure/degradation detection. The emphasis of this program will be to assess the feasibility of applying neural network technology to perform navigation system integration, management, and diagnostic functions within a combat aircraft multisensor navigation suite. The PENANT program is to achieve statistically significant improvements in the consistency of the reference solution. The safety of flight goal is less than or equal to 1.3 aircraft losses per 100,000 flight hours due to integrated reference system failures. This goal is based upon a review of the current state of the art as represented by the F-16 system wide integrity monitoring analysis of outer loop flight control. Phase I of this program will consist of an assessment of neural network approaches, the strengths and weaknesses of each, and an examination of all levels of functionality within an advanced multisensor navigation suite. The purpose is to select representative navigation system functions which show the most potential for improved consistency/reliability if performed by neural network methods. Function will be selected for application of neural network and comparison with traditional techniques. Phase II will consist of in depth analysis of the selected functions, the identification of appropriate neural network techniques, the development and training of the identified neural network, and evaluation of the capability of the neural network to perform the selected function. Phase III will allow the contractor to develop software modules tailored to individual users' needs.

AF92-101 TITLE: Formal Mathematical Methods for Sensor Management

OBJECTIVE: Determine mathematical algorithms for allocating sensor resources in multisensor data fusion processes.

DESCRIPTION: Future avionics systems will employ multiple sensors, advanced computing capabilities, and an integrating architecture that will promote mission effectiveness by improving situation awareness and decreasing pilot workload. These broad system goals are achievable only when sensor observations are available from which to create a unified picture of object position and identity. This estimation process, called multisensor data fusion, leads ultimately to an accurate situation assessment. A sensor management function is present to automatically coordinate and prioritize requests for sensor service from the various system components. Also, the sensor manager must allocate the sensor service load to produce the best observations possible while dealing with problems like these: time varying demands for service, objectives that change with mission phase and unpredictable enemy actions, overlapping sensor capabilities, restricted emission regions, and variable sensor performance arising from physical randomness and perhaps enemy countermeasures. The interaction of the forward multisensor fusion process and the controlling sensor management function constitutes important feedback loop within this system. Phase I will examine the viability and structure of various formal or semiformal mathematical techniques that could satisfy the sensor management function in the feedback process just described. Semiformal structures are those that permit some very limited heuristic or symbolic processes as part of the overall algorithm. However, the emphasis of this effort is on formal numeric methods and the extent to which they can be applied. Representative methods that could be investigated include formal control theoretic techniques, methods from utility theory and operations research, methods such as those used for the weapon-target assignment problem, information-theoretic methods, neural nets, and task directed concepts. Measures of performance shall include computational efficiency, among others. Motivating scenarios shall be representative of tactical Air Force aircraft operations such as occur in deep interdiction missions. The end product of Phase II of this work will be sensor management algorithms appropriate for embedded applications, fully developed, tested and documented. Phase III is envisioned to provide software products coded in ADA for real time application.

AF92-102 TITLE: Multiple, Integrated, Electronically Steered Arrays Radar Performance Enhancements Through Adaptive Processing

OBJECTIVE: Evaluate Electronic Countermeasure and ground clutter suppression capabilities of space time air to air radar architectures.

DESCRIPTION: The operational effectiveness and survivability of future advanced USAF fighters will be greatly dependent upon the situational awareness by the air-to-air radar. These aircraft may employ low observable technologies, advanced launch and leave missiles, and face LO threats which dictate fire control radar designs that

may require multiple, integrated, ESA or even conformal radar architectures. A critical and pacing ingredient of these advanced architectures will be the need for side coverage, which due to aircraft installation considerations, may result in a relatively small planar or conformal aperture to supplement the primary forward looking aperture. Attainment of significant detection and tracking ranges, in difficult ECM and ground clutter interference environments, will be technically challenging. First, the low resolution radiation pattern of the small side aperture, together with the large side hemisphere Doppler frequency gradients, will result in main beam clutter spreads that create large target blind velocity intervals. Second, the side array power/aperture product necessary to search extensive solid angular sectors at the required ranges will be difficult to achieve. The pulse compression techniques, used to obtain high average power with low peak power X-band transmit/receive module active arrays, can yield excessive eclipsing losses and large target blind range intervals. These blind velocities and ranges combine, via multiple pulse repetition frequency waveforms, to form a composite range Doppler blind zone map that may be substantially less than the desired 100 percent clear. Third, the all aspect medium PRF look down waveform results in the presence of directly competing diffuse side lobe clutter, which can readily mask small missile and low radar cross section threats. Fourth, significant reduction in threat RCS will result in a corresponding reduction in target signal to side lobe jammer ratios unless adaptive side lobe cancellation is employed. And finally, the presence of side lobe clutter can greatly degrade the performance of conventional ASLCs, and conversely, ASLC operation will serve to raise the antenna side lobe levels thus further aggravating the side lobe clutter problem. With the tremendous increases occurring in digital signal processing technology, sophisticated airborne radar adaptive processing is rapidly becoming practical and affords the potential of solving the above technical challenges. The Phase I activity will systematically investigate exploiting space time adaptive processing radar architectures for mitigation of the limited aperture/main beam clutter spread, reduced range-Doppler map visibility, side lobe diffuse and discrete ground rejection, and joint ECM/clutter interference suppression problems. The scope of the effort includes formulating and evaluating novel side array manifolding schemes that, in conjunction with innovative receiver channelization concepts, offer the potential for a practical implementation. The Phase I output will consist of a STAP algorithm design, radar architecture definition, and digital computer simulation performance predictions including on aircraft effects. The Phase II effort will demonstrate an in house STAP jammer, and main and side lobe clutter mitigation in near real time. Some breadboard digital array signal processors and appropriate radar receiver/antenna hardware/emulations and tactical environment simulations will be used. Phase III will provide the contractor with the ability to commercialize this adaptive signal processing to other DOD applications. For example, the signal processing developed under this topic could be implemented for future enhancement modifications to aircraft radar systems.

AF92-103 TITLE: 1.5 to 5 Micron Wavelength Tunable Continuous Wave Optical Parametric Oscillator

OBJECTIVE: Develop a continuous wave, single frequency, OPO tunable in the 1.5 to 5 micron band.

DESCRIPTION: TO date, the overwhelming majority of coherent laser radar work has used either CO2 gas lasers at 10.6 micron or solid state lasers operating at either 1.06 microns or the second harmonic of 0.53 micron. Although some researchers have investigated a few other discrete wavelengths for laser radars, no one has ever demonstrated a laser radar with the ability to tune continuously over any appreciable wavelength region. The ability to tune in wavelength would greatly enhance a coherent laser radar's ability to exploit target signatures. In addition, a tunable laser radar could be used to build other types of useful sensors, such as a sensor to detect almost any type of vapor or aerosol. The critical technological challenge to building a tunable coherent laser radar is the availability of a source capable of generating a tunable single frequency output. The state of the art in OPOs is now advanced enough to consider developing one as a practical tunable source for a coherent laser radar. We wave selected the 1.5 to 5 micron region because the atmosphere is quite transparent throughout this region. There is a large existing body of passive sensors and research in this region which we can use to calibrate and compare with our measurements, and laser radiation in the region is relatively safe for exposure to human eyes which greatly simplifies testing. Phase I will focus on the design of the OPO and experimental work to validate the design. This phase will also include a material selection for the oscillator, selection of a pump wavelength and source, and the design of the actual cavity for the OPO. Maintaining adequate frequency stability of the OPO over the time of flight of a pulse shall also be investigated. Phase II will include building the device, demonstrating its operation, and fully characterizing it. It shall identify system improvements such as ways to increase the device's efficiency and stability and reducing the package size. The issue of using a single set of optics and detector over the entire operating wavelength band shall also be investigated. Phase II may also build a second OPO and investigate injection seeding it from the first OPO

to force the two outputs to be coherent. In a heterodyne detection laser radar, the first OPO would be the CW local/master oscillator, and the second OPO would be the source for a pulsed or CW transmitter. Phase III will incorporate a master oscillator/injection seeded slave oscillator combination into a wavelength tunable laser radar. It will investigate all issues associated with a wavelength tunable laser radar such as detector efficiency, optical transmission efficiency, etc. At the end of Phase III the laser radar will be delivered to the Air Force for use in advanced research in target search and identification techniques.

AF92-104 TITLE: Double Pull Electronic Counter-Countermeasure (ECCM)

OBJECTIVE: Investigate, develop and evaluate techniques/tactics to protect airborne radars from Double Pull Electronic Counter Technique.

DESCRIPTION: Velocity gate pull of and range gate pull of are well defined and documented ECM techniques. Double Pull is the coordinated use of both of these techniques. With the rapid development of digital technology, specifically Digital RF Memory at a 6-8 bit capability and growing, Double Pull potentially provides realistic false targets with both range and velocity characteristics. New ECCM techniques need to be developed to negate Double Pull with and without chaff. The techniques to be developed shall be of such a nature that they are a basic part of the fundamental radar design. Also, the techniques must consider the total electronic warfare environment that the radar will encounter and not just an isolated Double Pull threat. This effort will require access to classified foreign intelligence information, a facility, and personnel clearance level of SECRET/NOFORN. Under Phase I of the proposed research, the contractor shall investigate and define new ECCM techniques that will counter the Double Pull ECM threat. In Phase II, the techniques will be fully developed and evaluated to show the greatest potential for success in Phase I of the project. At the conclusion of Phase II, the contractor's final report will document the techniques, as well as possible future enhancements. Phase III would be an airborne flight demonstration of a brass board model for potential future ECCM applications.

AF92-105 TITLE: Improved Real-Time Simulation of Antenna Effects

OBJECTIVE: Develop an improved simulation of antenna effects for Electronic Warfare (EW) signal environment simulation.

DESCRIPTION: Real-time EW laboratory simulators have typically been developed with relatively simple handling of antenna pattern effects. This has occurred for several reasons. First, the computation and storage requirements for sophisticated models were beyond the capability of existing processors. Second, the requirements of the devices being evaluated had only minor reliance upon high fidelity of antenna effect simulation for effective performance. Next, the accuracy of signal modulators was a limiting factor on implementations. Finally, the cost of high-speed digital microwave signal modulators was a prohibitive constraint for most organizations. Recent designs of EW systems have incorporated antenna effects as more central elements to system performance. A notable example is the development of antiradiation missiles which use amplitude and phase antenna pattern effects to generate tracking error signals. Together with the increase in emphasis in antenna effects for system effectiveness are breakthroughs in technology in the areas of signal processing speed and low cost, high speed, precision signal modulators. This topic is intended to develop a cost effective antenna modeling capability which can be incorporated into existing and future EW signal environment simulators. A successful design will address all aspects of antenna effects and develop both a real-time computational model and signal modulation device implementation. In Phase I, the contractor will develop a preliminary design for both antenna algorithmic modeling as well as the precision control of the signal modulation devices. A prototype demonstration of the proposed design is highly desirable to minimize risk in proceeding with Phase II development. Phase II will implement the design generated in Phase I and integrate it with existing simulation equipment to provide an enhanced simulation capability. In Phase III the contractor will be able to answer the need for ground tests to evaluate inherit design flaws before production is approved. In addition, the contractor will be able to improve the simulation of antenna effects at the pure digital phase, brass board and systems phase.

AF92-106 TITLE: High Temperature Superconductor Switching for Electronic Warfare System Applications

OBJECTIVE: Develop low-loss, small-size, HTSC switching with adequate properties for EW system applications.

DESCRIPTION: High temperature superconductivity is beginning to revolutionize microwave system design by enabling smaller, more reliable systems to be produced with higher operating frequency, wider bandwidth and lower insertion loss than conventional technology. Great success has been achieved in producing compact, low loss HTSC components such as microwave delay lines and filters with excellent performance. Work is now beginning on system and subsystem applications development. A means for extremely low loss, compact switching is needed to advance the technology from the component and subsystem level to the full operational system level. This would be done without degrading the advantages of using HTSC by adding heat and size to the system. This effort will explore low loss HTSC switching concepts which will enable microwave HTSC systems to be developed that fully exploit the performance and size advantages of using HTSC while minimizing the logistic penalties of cryogenic cooling. Under Phase I, a small HTSC thin film switch designed for practical use in an EW system will be fabricated. The switch will be measured for important figures of merit such as switching speed, operation bandwidth, insertion loss/return loss, isolation and power dependence in the open and closed state. Switches useful for system applications in the 2-20 GHZ range are of primary interest. Under Phase II, the implementation of the switching concept into a practical high payoff EW application will be pursued. The application may require multiple switches and emphasis will be placed on overall system practicality and payoff as well as the ability to reproduce the desired switching characteristics. A demonstrated subsystem using the developed switching concept will be the goal of Phase II. Phase II will result in a final report documenting results and conclusions along with a hermetically packaged operational subsystem with input and output connectors. The goal of Phase III is envisioned to demonstrate the practicality of the switching concept at the system level.

AF92-107 TITLE: Programmable Emitter Signature Generator

OBJECTIVE: Develop a programmable, radar waveform signature generator for Electronic Warfare signal environment simulation.

DESCRIPTION: Hybrid EW laboratory signal environment simulators have historically concentrated on the generation of gross radar signal characteristics to evaluate aircraft signal intercept and warning systems. This approach was sufficient for the early generations of signal identification and warning systems where the relatively simple gross characteristic template matching approach was sufficient to meet the demands of the operational signal environment. Any differences in discrete warning receiver performance between clean laboratory generated signal and actual emitters could be remedied relatively quickly during flight testing. Modern signal environments, however, are significantly denser and more complex. This drives receiver developers to explore faster and more robust methods to sort and identify signals. This is done by using more subtle characteristics of signal waveforms such as pulse shape and unintentional frequency variations that occur with different microwave oscillators and amplifiers. Complexity of the newer EW system designs also serves to drive the need for more realistic laboratory testing. Tracking down design problems in integrated and interdependent systems is much more difficult and is becoming prohibitively expensive to resolve with flight testing only. This topic seeks to develop a cost effective, programmable emitter waveform generator which can integrate with other aspects of the current generation of laboratory signal environment generators, to produce not only the gross but also these more subtle radar signal characteristics. The recent developments in direct digital synthesizer and arbitrary waveform generator technology appear to offer considerable promise or success in the area. A successful design will address signal definition requirements and to offer considerable promise or success in this area. A successful design will address signal definition requirements and programming, high speed digital control interfaces, minimization of unwanted simulator artifacts, and ability to operate at frequencies up to 18 GHz with octave or multi-octave operating bandwidth. Under Phase I, a preliminary design for the signal generator device will be developed. A prototype demonstration of the proposed design or critical aspects is highly desirable to minimize risk in proceeding with Phase II development. Phase II will implement the design generated in Phase I and integrate it with existing simulation equipment to demonstrate the viability and performance of this enhanced simulation technique. Under Phase III, the contractor will be able to provide enhanced testing capability to both manufacturers and federal test facilities of weapon systems and advanced threat identification systems.

AF92-108 TITLE: Engineering R&D for Permanent Avionics Suites

OBJECTIVE: Develop Permanent Avionics Suites for Air Force aircraft.

DESCRIPTION: PAS means that the suite's avionics components and subsystems will deliver adequate performance during a ten year service life with no maintenance actions. Adequate performance means no individual or combination of avionics components and subsystems degrades the total aircraft system below its minimum specified performance. No maintenance actions means that the component or subsystem shall require no attention no application of tools, Avionics ground equipment, or personnel. In all cases, battle damage is excepted. Ten year service life means nine years of peacetime service with about 400 flight operating hours and 300 ground operating hours each year, or 750 flight/1500 ground; and one year of no wartime service with 1200 flight hours and 600 ground hours, or 1200 flight/800 ground. The wartime service can be expected to occur at any time during the service life and not be continuous. The PAS is expected to merge with existing and future total aircraft systems with no new penalties over existing avionics suites. Proposals may assume replacement or abolition of Government regulations, procedures, standards, or policies which would thwart the goals of PAS, but they must be explicitly stipulated, when known. The intent of Phase I is to create engineering techniques for development and fielding of equipment which can be trusted to deliver both high instantaneous and high sustained performance without attention. Techniques are desired to develop replacements for existing components and subsystems; for complete new subsystems; for conceptual and computational engineering tools for design, development and trade off analyses; for conceptual and computational tools which can be used to calculate and demonstrate the value of PAS in terms of: vehicle mission effectiveness, group mission effectiveness, deployment response time, peacetime, and wartime costs, etc. Note that construction of a complete avionics suite is likely a job suitable for a large prime contractor but scores of smaller efforts are required to build the technology base which makes PAS possible. Efforts under this program will be to develop the techniques for adequately specifying and verifying sustained performance and the development of practicable PAS warranty requirements, measures, and remedies. Phase II will be breadboard or brass board hardware, software, tests, or analyses, which result in a significant advance in the development of PAS. Phase III will be incorporation of these techniques in PAS.

AF92-109 TITLE: Improved Reliability Through Compliant Interconnects

OBJECTIVE: Develop compliant interconnect techniques for improved reliability and maintainability.

DESCRIPTION: Future requirements for electronic systems are becoming more complex and performance driven. This has resulted in electronic assemblies being composed of many different incompatible materials in an effort to achieve the electrical, mechanical, thermal, environmental, and system throughput requirements. Innovative techniques are needed at all levels of the electronic assembly which will remove or lessen the stresses on the interconnects cause by the differences in thermal coefficient of expansion of the various materials and structures. Methods must be developed which decouple these mismatches in TCE while providing reliable and maintainable electrical, mechanical, and thermal interfaces to the system. Some of the more familiar approaches being pursued today include elastomers, button board technology, and soft die attach. Phase I of this effort will identify, analyze, and trade off alternate techniques, processes materials which will promote the greatest potential for obtaining reliable electrical, mechanical, and thermal interconnects. During Phase II, the most promising candidates will be further developed, analyzed, characterized, and verified through hardware assembly and testing. Phase III would result in a commercially viable compliant interconnect technology.

AF92-110 TITLE: Very-High Speed Integrated Circuit Hardware Design Language Behavioral Simulation Acceleration Engine

OBJECTIVE: Design a system that will improve the simulation time of VHDL models 3-4 orders of magnitude.

DESCRIPTION: In order to insure the correctness of DOD's digital system designs, a significant amount of simulation is imperative before manufacturing and field testing costs are incurred. Systems simulated thoroughly will be better optimized, will require fewer redesigns, and consequently they will enter production more rapidly and

with lower cost. Although simulation is an accepted methodology for the design of individual integrated circuits, it is not generally applied for the design of boards, processors, subsystems, and entire systems. One primary reason is that simulation models of the behavior of these entities rapidly become too large for today's workstation based simulators to simulate in a time efficient manner. Phase I of this effort is to investigate the constructs of the VHDL IEEE ANSI 1076 and identify data structures, paradigms, algorithms, and architectures which collectively offer the potential for 3 to 4 orders of magnitude improvement in simulation time. During Phase II, the most promising candidates will be further developed, modeled, and analyzed. The expected result of this effort is a specification for implementing a custom VHDL behavioral simulation acceleration engine. During Phase III, hardware and software for the accelerator would be implemented and integrated into a working prototype system.

AF92-111 TITLE: Direct Diode Pumped Optical Parametric Oscillator for Infrared Sources

OBJECTIVE: Produce tens of watts of tunable output power in the 1-5 micron spectral region.

DESCRIPTION: This device must operate in the continuous wave mode and use all solid state components for compactness and reliability. Currently demonstrated high power diode laser technology should be utilized as a narrow bandwidth pump source. A narrow bandwidth can be achieved by locking the diode source to an external cavity. Compared to a frequency doubling scheme, which is also a nonlinear device, an OPO has the advantages of wide and continuous tenability. Although diode lasers have been used for frequency doubling with 40% efficiency, a diode pumped OPO has never been demonstrated due to the threshold power required. If this technical obstacle can be overcome, OPO operation is also possible. This technology enables the use of infrared sources in flight where power consumption and volume are critically constrained. It also creates a range of new applications in both military and commercial markets. Phase I will demonstrate the feasibility of the approach by addressing the central issue of obtaining commercial markets. Phase I will demonstrate the feasibility of the approach by addressing the central issue of obtaining a low enough OPO threshold for diode pumping. Phase II will then demonstrate full tuning range, conversion efficiency, beam quality, and spectral purity of a prototype laboratory device. Phase III would package and environmentally test the compact device.

AF92-112 TITLE: Carbon and Tellurium Doping Sources for Molecular Beam Epitaxy

OBJECTIVE: Develop carbon and tellurium sources applicable to doping of molecular beam epitaxy grown semiconductor materials.

DESCRIPTION: Heavy p and n type doping of III-V compound semiconductor materials is a requirement for several major classes of advanced microelectronic devices. Experience with gas source based epitaxial techniques has demonstrated the utility of carbon as a source of acceptor atoms. Carbon has been found to resist migration during growth of semiconductor materials unlike other candidate dopants such as beryllium. At present, these carbon doping methods are typically based upon organometallic compounds, which introduce the additional complication of large quantities of unwanted gases, and are as such, not directly applicable to solid source MBE. This program seeks a source of carbon, which can be introduced at high concentrations in a conventional MBE environment. Tellurium has been identified as a donor atom relevant to a wide range of III-V semiconductors. Due to its vapor pressure vs. temperature characteristics of potential source compounds it shows great promise as an n type dopant source. In the same fashion as for carbon, this program seeks a solid source MBE relevant source for general III V compound doping at high doping concentrations. To the maximum extent possible, direct application no existing solid source molecular beam epitaxy systems is desired. Modifications to the vacuum and control apparatus in these systems are not desirable. Phase I is expected to be a theoretical and experimental effort which identifies innovative techniques by which he doping of semiconductors may be accomplished. Control, reproducibility, range of fluxes, source lifetime and purity of dopant be as will be applied as a measure of success. The Phase II effort will include fabrication and demonstration of appropriate dopant sources. One prototype source of each type, capable of additional testing in a government MBE system, will be considered a Phase II deliverable. For Phase III the sources would be made commercially available for the growth of lasers, heterojunction bipolar transistors, and high electron mobility transistors in MBE systems.

AF92-113 TITLE: Automated Submicron Thermal Imaging/Defect Analysis System for Microelectronic Integrated Circuits (IC)

OBJECTIVE: Develop automated high spatial recognition imaging temperature and surface defect measurement system for IC applications.

DESCRIPTION: Automated imaging systems have been used for many years for measuring the temperature of electronic devices; these systems typically have spatial resolution on the order of a few microns. State of the art microelectronic fabrication technology has advanced to the point where devices with submicron dimensions are a reality. Due to the small physical size of the active devices and the high power densities within the device structures, surface analysis and thermal design of the circuits are critically important to insure circuit performance and reliability. In order to insure proper device and circuit design, a direct measurement of device temperature and substrate quality is essential. Today's imaging systems do not provide the necessary spatial resolution to obtain an accurate thermal profile for submicron microelectronics devices. Finite element computer models require actual device structures and material properties to get accurate temperature profiles. Automated techniques for substrate surface analysis are evolving. Surface analysis is usually performed manually with the use of microscopes and/or photomicrographs. The development of automated techniques for detection, classification, determination of orientation, and distribution of surface features such as etch pits and oval defects would improve integrated circuit yield and performance. This program is to address the design, fabrication, testing, and delivery of a submicron thermal imaging and surface analysis system for microelectronic integrated circuits. Phase I of the program will address the theoretical and practical aspects of such a system and the definition of a system design. Phase II of the effort will be design, fabrication, testing, and delivery of the system. The system requires quick scan of a digitally controlled scanning stage with a readout and spatial resolution of 0.05 micron for interrogating up to three inch diameter wafers. Device and circuit temperatures will range from 300 to 500 Kelvin requiring 0.1 measurement resolution. An auto calibration, real time color image, hardcopy system shall be incorporated and be capable of both CW and pulsed operation. Phase III would provide commercially available equipment for the valuation of microelectronic and microwave materials, devices and integrated circuits.

AF92-114 TITLE: Microwave High-Temperature Devices

OBJECTIVE: Develop microwave devices utilizing the improved electrical and thermal characteristics of advanced materials.

DESCRIPTION: Airborne radar, electronic warfare, and communication systems require solid state microwave transmitters, receivers and signals control components with increased performance and affordability. The use of advanced semiconductor materials and processing techniques, monolithic integrated circuits, and advanced packaging and interconnect technologies are key development areas to pursue in building highly integrated advanced microwave components and subsystems. Performance parameters of greater output power, improved reliability, and higher operating temperatures are very difficult to solve with conventional gallium arsenide monolithic microwave integrated circuits. The development of high temperature semiconductor materials and devices will be an enabling technology from which advanced MMICs with the required performance will be demonstrated. Large bandgap semiconductor materials that are presently under development include silicon carbide and diamond. The objective of the program is to develop a practical high temperature transistor for use at microwave frequencies. The transistor thin film active layers and associated contacts must be amendable to conventional batch fabrication procedures and eventually suitable for MMIC implementation. In Phase I, emphasis will be placed on developing the device processing technology necessary to produce microwave devices. There is an especially high interest in developing metallization processes for producing high temperature capable ohmic and Schottky contacts to SIC, but proposals are not limited to this narrow scope. Phase II will focus on demonstration and optimization of processes which will enable device operation at temperatures up to 600 C. Phase III would provide affordable and commercially available high temperature microwave devices for advanced DOD systems.

AF92-115 TITLE: Corrosion Detection and Life Analysis for Aircraft Structural Integrity

OBJECTIVE: Develop a corrosion detection technique and fatigue life analysis for aircraft structures which accounts for corrosion effects.

DESCRIPTION: The biggest threat to aircraft structural integrity for the past 20 years has been corrosion. The detection and modeling of corrosion would help the Air Force to maximize the structural safety of its aircraft and keep maintenance costs to a minimum. Corrosion can go undetected in the hidden areas of an aircraft structure for years while it initiates and propagates structural damage. Although programs are in place to reduce corrosion, it will never be eliminated. Currently, there is no sensor that reliably detects the onset of corrosion. The detection and treatment of corrosion before it creates major structural damage would save the Air Force a significant amount of money and maintenance man-hours. The structural integrity of aging aircraft is of major concern in both the commercial and military sectors. An accurate fatigue life analysis is necessary to ensure the structural integrity of aging aircraft. Analytical deficiencies currently exist primarily due to the inability to account for the effects of corrosion on the fatigue behavior of aging aircraft. Corrosion effects each fatigue phase in the total structural life of a component. For example, fatigue crack growth behavior is influenced not only be the presence of a corrosive environment at the crack tip, but also by the presence of corrosion in front of the crack tip which causes accelerated growth. Corrosion particularly influences the total fatigue life when multiple site damage is present. It is necessary to obtain a fundamental understanding of the fatigue phenomena in the presence of corrosion to preclude the occurrence of excessive structural problems in aging aircraft. The end product of Phase I will be a report detailing the feasibility of these development of a corrosion detection package consisting of the necessary hardware and software technique and corresponding structural life analysis. The end product of Phase II will be a corrosion detection package consisting of the necessary hardware and software and a structural life analysis that accounts for the effects of corrosion. Phase III of this project would entail the refinement of both the detection technique and the life analysis.

AF92-116 TITLE: Experimental Instrumentation/Damage Monitoring for Hypersonic Vehicle Certification

OBJECTIVE: Develop accurate and reliable methods to measure damage and temperature in coupon and small component test specimens.

DESCRIPTION: Future high performance aerospace vehicles will operate in high performance/temperature environments. The operating temperature of their structural components can easily exceed 2000 F. To certify the safety of these vehicles, structural integrity tests must be performed for specimens at high temperatures. Damage growth properties of materials are greatly affected by temperature. Therefore, there is a need to develop a reliable method to measure temperature and damage for coupon and small component test specimens. Since future vehicle components will consist of metallic polymer matrix composite, metal matrix composite, and refractory matrix composite materials, it is desirable that these methods be applicable to a number of material systems. The most reliable means of damage measurement is to optically monitor the damage as it grows under cyclic loading. This method is difficult to perform under a high temperature environment due to high levels of infrared radiation. The electrical potential method of damage measurement requires visual verification because of the possibility of electromagnetic interference caused by the test heat source. Specimen temperature measurements are generally taken with thermocouples in contact with the surface. However, these temperature probes tend to behave as heat sinks and are not extremely accurate. An alternate method is needed to accurately measure surface temperature and/or calibrate less accurate thermocouples. Phase I will detail the feasibility of developing methods to measure temperature and damage for a variety of material types at temperatures exceed 2000 F. Phase II should result in the development of innovative methods to accurately measure temperature and damage for coupon test specimens operating at high temperatures. Phase III of this project would entail the refinement and automation of these techniques.

AF92-117 TITLE: Three-Dimensional Mapping of Hypersonic Flow-Field Properties

OBJECTIVE: Develop techniques to measure gas property distributions throughout an Electron Beam excited hypersonic flow field.

DESCRIPTION: Advanced methods are required to quickly and quantitatively describe the entire flow fields in experimental hypersonic research. This arises from the need to experimentally verify computational fluid dynamic programs as well as advance hypersonic technology, including impact on the National Aerospace Plane. While techniques such as laser velocimetry and hot wire anemometry are being advanced in a number of performance directions, extensive flow field data cannot be quickly obtained by these because of their time consuming nature to map complete flow fields. Electron Beam techniques have been pursued in the past for low density flow field visualization and gas diagnostics. Currently at Wright Laboratory, EB Planar Flow Visualization, utilizing sweeping beam, is a routine use tool in Mach values of flow parameters. However, gas density and temperature measurement techniques have been previously developed to quantify these parameters along a thin electron beam. It is the intent of Phase I of this effort to investigate and develop theory and the approach which could plausibly couple the air properties measurements to the sweeping 2D/2D EB flow visualization techniques. An element of this phase would be to upgrade, by a factor of two or more, the measurement accuracies over those previously attained. Phase II would include hardware and software development, demonstration, and verification at the Flight Dynamics Directorate's 20 inch Hypersonic Wind Tunnel. A Phase III program would lead from extension of the quantitative 3D flow properties capability to like 3D determination of the thermo chemical properties of high speed, low density flows.

AF92-118 TITLE: Advanced Photonic Sensors for Flight Systems

OBJECTIVE: Determine advanced sensor applications of photonic technologies for aircraft vehicle management, flight management and flight control.

DESCRIPTION: By extending the amount of sensed data and fusing it to situational information, improvements can be made in flight performance, probability of mission success, and aircraft survivability. The emerging technologies in photonics have untold potential for advanced applications in aircraft flight systems. Optical physics may provide advanced sensing capability with components that have smaller size, less weight, and require less power. This effort will investigate photonics technologies and determine new sensing opportunities for vehicle management, flight management, and flight control. Phase I is an investigation of the photonics technologies and determining the state of the art sensing capabilities. For each sensing technology, potential flight applications will be derived. Computer simulation will be used for preliminary proof of concept. The speculated benefits will be described per each application. Phase II will involve the laboratory demonstration of the most promising of the advanced applications. Phase III would provide control data acquisition opportunities for advanced aircraft of all types, as well as manufacturing and other applications. Sensors resulting from this activity should provide cost effective alternatives for many measurements and enable the performance of others.

AF92-119 TITLE: Common Input/Output Interfaces for Vehicle Management Systems

OBJECTIVE: Reduce the proliferation of I/O interfaces in vehicle management systems through adaptable common modules.

DESCRIPTION: Current flight control systems are highly intensive. Future Vehicle Management Systems, encompassing flight and integrated control functions, will have even more demanding requirements. VMS functions may interface to a multitude of sensors and actuators, each having different interface requirements. Historically, this has resulted in the development of unique and specialized I/O modules for each function and system architecture. A recent trend in aircraft avionics is the use of Common Processing Modules to simplify maintenance, reduce spare parts requirements, and lower system life cycle costs. Common modules have not been proven practical for flight control because of the myriad of I/O interfaces currently required for flight critical systems. However, advances in Digital Signal Processing technology are enabling the development of flexible and programmable I/O interfaces not previously possible. DSP software can replace complex analog circuit designs and allow a DSP module to replace a variety of specialized I/O modules. This makes possible a common I/O modules. Phase I will examine flight control sensor and actuator interface requirements and will investigate the applicability of DSP technology towards creating common I/O modules. A design of an adaptable common I/O module will result. Phase II will develop a laboratory brass board to demonstrate the ability to interface with typical flight control sensors and to adapt to

changing interface requirements. Phase III would extend the ability to interface various I/O devices, as well as the capability for adapting to changing interface requirements. This capability would significantly simplify the implementation of System management techniques.

AF92-120 TITLE: Fiber-Optic Techniques for Survivability Enhancement

OBJECTIVE: Identify protection techniques for fiber optics systems to enhance the survivability of flight critical data busses.

DESCRIPTION: The physical smallness of optical fiber enables several flight control system vulnerability reducing techniques. Intrinsically, optical fibers provide a smaller target than most electrical cabling. With the smaller size, fibers can be routed to take advantage of structural shielding. But to increase the protection, it may be feasible to embed the fibers in fuselage and wing skins. Optical fibers have also been demonstrated at a laboratory level for their ability to be embedded into glass and carbon-carbon composites, cast aluminum, and cast titanium. In the future, embedded fiber could be feasible in sheet aluminum, fiber-reinforced metal matrix composites, and aluminum/composite laminates. The embedding techniques need evaluation to determine the positive of negative battle damage effects. Fiber optics are inherently immune to electromagnetic threats. Their employment is the optimum solution to EM vulnerability of flight control systems. Ballistic threats cause the major source of vulnerability to fiber optic systems. With electric cabling, a certain amount of damage can be sustained, causing an impedance mismatch, but data communication can still occur. With optical fiber, the damage usually results in fractures, shutting off data communication. So, in comparison to electric cabling, fiber is more vulnerable to shell fragmentation due to its fragility. But since optical fiber is smaller than electric cabling, protective techniques such as embedding in skins and structural shielding become more feasible. The approach is to investigate the favorable characteristics of fiber optics that will reduce the flight control system vulnerability and to develop techniques to provide protection to distributed optical data busses. Phase I will examine techniques to enhance the survivability of the fiber-optic data bus. These techniques will include structural shielding, adhesion, lamination, and embedding optical fibers to minimize their susceptibility. This phase will examine the state of the art technologies in fiber embedding/adhesion and evaluate them for applicability. This phase will examine the state of the art technologies in fiber embedding/adhesion and evaluate them for applicability. The most promising technologies will be combined into a viable set of protection techniques: technology maturity issues, structural issues, manufacturing issues, and maintenance/repair issues. Phase II will gauge the relative merit of the techniques by using test evaluation. Samples of the promising techniques will be fabricated. To optimize the test and evaluation, a test plan will be prepared for each sample. The ballistic, fragmentation, and fire testing will be done, evaluated and compared to a survivability assessment. Phase III would extend the survivability concepts demonstrated to increase the reliability of electronically directed systems. This should result in more confidence for application of advanced systems to critical applications.

AF92-121 TITLE: Sensor Development/Verification for Aircraft Structural Health Monitoring

OBJECTIVE: Design and develop fatigue crack, corrosion, and composite delamination sensors and associated instrumentation.

DESCRIPTION: Current operational aircraft are getting older, and newer aircraft are using more composite materials. The older metallic aircraft have serious problems with fatigue cracks due to fatigue and corrosion. Current Air Force Damage Tolerance Design Methodology requires that an aircraft be designed with assumed initial flaws. These assumed flaws, coupled with knowledge about the aircraft's flight history, help set conservative inspection intervals. Inspections that are manpower intense, decrease the operational readiness of an aircraft and can result in damage where none existed previously. Newer aircraft using composites are over designed to compensate for scatter in material properties and possible undetected delaminations. Consequently, the benefits to be achieved through weight reduction are not as great as first expected. As with metallic components, they also have to be inspected periodically for damage. Metallic and composite structures would benefit from the strategic placement of fatigue crack, corrosion, and delamination sensors. These sensors would not only reduce the frequency of required inspections but also reduce the aircraft downtime required for the inspections. Phase I should result in initial designs and bread board prototypes. The bread board prototypes would offer a proof of concept. Phase II should result in

refined designs and brass board prototypes which would be tested in a laboratory simulating typical environmental conditions expected to be seen by the user. These tests would characterize sensitivity, accuracy, and robustness. Phase III would result in the commercial availability of the innovative crack, corrosion, and delamination sensors. These sensors would fine widespread application to aircraft of all types. It is envisioned that these sensors could be used by logistical support organizations and as a part of a Structural Health Monitoring System. They could significantly enhance the reliability and maintainability of existing and future aircraft.

AF92-122 TITLE: High Angle of Attack Agility Enhancement

OBJECTIVE: Improve combat performance of advanced fighters through the application of Innovative Flow Control Devices.

DESCRIPTION: Advanced fighter configurations such as the next generation Multi-Role Fighter, can be generally characterized as having chined fore bodies, swept wings with sharp leading edges and other signature dedicated features. The fore body and wing are prime vortex generating shapes which produce highly non linear aircraft aerodynamic characteristics, at high angles of attack, that seriously limit aircraft agility. These non-linear aerodynamic effects can be effectively controlled, with the proper application of unique mechanical and/or pneumatic flow control devices, to produce superior combat performance. Phase I will include an experimental investigation of innovative flow control devices applied to a typical advanced fighter configuration. Phase II will include flow control performance validation with experiment and simulation, prior to a Phase III flight demonstration.

AF92-123 TITLE: Optical Signature Control Materials and Techniques

OBJECTIVE: Develop new and improved materials and techniques for controlling the optical signatures of aircraft.

DESCRIPTION: The Air Force is interested in conducting research into the science of understanding and controlling the optical signature of aircraft with emphasis on the infrared region. Specifically, research shall involve controlling emissivity/reflectivity in the ultraviolet, visible, and infrared regions of the electromagnetic spectrum. Investigations may include bulk materials properties and/or novel concepts based on combinations of constituent materials in some unique construction. Phase I will address application requirements and goals as well as initial formulation, fabrication and evaluation of specific subjects for proof of concept. Phase II will further develop and optimize the material(s) techniques, and produce larger samples for a full spectrum of evaluations. Phase III will scale-up the concepts for full-scale flight demonstration.

AF92-124 TITLE: Direct Fluorination Technology

OBJECTIVE: Develop direct fluorination by preparing a series of perfluoropolyalkylether fluids with varying molecular structures.

DESCRIPTION: Perfluorinated materials are the only materials with the inherent oxidative stabilities at elevated temperatures to meet the extremely demanding requirements for high temperature nonstructural materials. While fluorinated organic materials have been available for over 30 years, the wide spectrum of molecular structures that could be totally fluorinated was extremely limited until the recent improvements in the state of the art of direct fluorination. Theoretically, any hydrocarbon precursor can be perfluorinated, all of the original hydrogen atoms replaced with fluorine atoms using this powerful direct fluorination technology. Practically, there are still many obstacles to the application of that technology to such a wide range of materials. The main objective of the Phase I effort will be to demonstrate the feasibility of applying this technology to the preparation of a series of perfluoropolyalkylether fluids with varying molecular structure. The Phase II effort will extend that technology to a wider range of molecular structures for base fluids as well as to polyfunctional materials that are required for the development of perfluorinated elastomers and additives for the perfluoropolyalkylether fluids. In addition, the Phase II effort will address the issues involved with scale-up of this technology to large samples of fluids and

polyfunctional compounds. During the Phase III effort, the issues to be addressed would primarily be involved with the further scale-up of this technology to commercial scale samples of fluids and polyfunctional compounds.

AF92-125 TITLE: Advanced Thermal Protection Materials

OBJECTIVE: Investigate advanced thermal protection materials and associate technology.

DESCRIPTION: Advanced thermal protection materials are required for future ballistic and maneuvering reentry vehicle systems. Projected maneuvering reentry environmental trends, for example, include extended heating, heat soak-out effects, and large structural loads. Phase I will investigate advanced materials and associate technology including innovative materials concepts, analytical/experimental techniques to assist in materials selection and potential performance assessment, and mechanistic studies on critical material/environmental interactions. Reentry vehicle components and elements include the nose tip, aeroshell/heatshiled, antenna window, control surfaces, interface joints, thermal insulation, specialized surface treatments, boundary layer, and trailing wakes. Phase I studies within this broad technical field must address key technical challenges for significant improvements over the current state of the art. Phase II will continue the R&D of promising materials and technological elements, with emphasis upon understanding of the interrelationships between compositional valuables and thermal protection performance. Phase III will develop a materials and processing capability for processing high performance material for flight test demonstration.

AF92-126 TITLE: High Performance Light Metal Alloys and Metal Matrix Composites

OBJECTIVE: Develop improved light metal alloys and composites based on aluminum, beryllium, titanium, and magnesium systems.

DESCRIPTION: Unique approaches which result in new aluminum, beryllium, magnesium, and titanium alloys and composites are required to support the technology system requirements identified in AFSC Forecast II Study. Incorporated are ultrahigh temperature aluminum alloys to replace titanium for applications up to 900 F, and ultrahigh temperature titanium alloys to replace super alloy for applications to 1800 F. Environmentally stable, ultra light magnesium and beryllium alloys are also desired. Included in the response of all alloys to secondary processing, titanium alloy requirements specifically address three areas: temperature stability up to 1800 F; strength up to 210 ksi; and high modulus/density ratio. Improvements in strength, stiffness, and reduction in density may be possible using novel alloying additions. Metal matrix composites offer considerable promise for aerospace applications because of their strength-to-density ratio and potential use at high temperatures. Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Phase I of the program will address application requirements and goals and develop mechanical property data or indicators. Phase II will optimize chemistry and processing and also produce larger amounts of materials for a full spectrum of mechanical property evaluation. Phase II will also include preliminary evaluation of trade and design studies to give an early indication of future application potential. Phase III would evaluate procedures to scale-up to production size parts and develop processing parameters for the production of qualified parts.

AF92-127 TITLE: High-Temperature Structural Materials for Advanced Air Force Systems

OBJECTIVE: Develop and characterize advanced high temperature structural materials and model forming processes.

DESCRIPTION: New approaches are requested to develop and characterize advanced high temperature structural ceramic composites, intermetallic materials and composites, and model forming processes for advanced structural materials. For ceramic composites, research may include the following: new, unique continuous ceramic reinforcement/ceramic matrix systems and coatings; reinforcement/matrix interactions during processing or use; continuous fiber development, test techniques to determine mechanical and physical behavior as a function of temperature and loading history; and analytical modeling of composite behavior. For intermetallic materials and composites, research may include new or novel methods for synthesis of intermetallic materials with emphasis on

achieving theoretical density, low defect content, and low synthesis temperatures; methods for identifying, synthesizing, characterizing, and modeling intermetallic composites, and methods of fabricating composites to provide chemistry control on a submicron scale while maintaining the ability to vary and control the final micro structural scale. For modeling of forming processes research may include modeling of the unit forming process; the material behavior in response to the demands of the unit process; the interface between the work piece and the die or mold; and novel methods for obtaining physical property data and constitutive equations for insertion into the models. Phase I will focus on the critical issues which, when solved, will provide proof of concept. Phase II will be structured to develop and refine those feasible concepts to the point where an assessment could be made of ultimate potential to help meet Air Force advanced materials needs. Phase III will pursue material development effort aimed at specific aerospace components.

AF92-128 TITLE: Improved Nondestructive Evaluation

OBJECTIVE: Develop of new, nondestructive, evaluation techniques for advanced aerospace applications.

DESCRIPTION: Advanced, innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation techniques. Applications focus on the detection, imaging and characterization of flaws and other integrity-reducing anomalies in flight vehicle and engine materials including metals, and metal and nonmetal matrix composites. Improved techniques are needed for real time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed for the detection, imaging and characterization of bulk and surface anomalies both metallic and nonmetallic structures, the evaluation of the integrity of bond lines in structures containing in structures in advanced composite structures, establishing the quality of high temperature material coatings, the inspection and evaluation of electronic device materials and components, and the quantitative characterization of materials properties. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factor and field inspections, or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the clear potential for ultimate use in realistic manufacturing or in service environments. Phase I of this program will address the initial formulation, fabrication, and evaluation of specific NDE techniques for demonstration of proof of concept. Phase II will perform enhanced development for optimization of the techniques investigated in Phase I. Phase III will, as appropriate, perform the remaining development required to bring the technique or equipment of a marketable state.

AF92-129 TITLE: Advanced Semi conducting Materials

OBJECTIVE: Develop advanced semi conducting materials and improved processes for growth of these materials.

DESCRIPTION: Advanced Air Force systems will require new and novel semi conducting materials to meet challenging power, frequency, speed and temperature requirements. Conventional semiconductors such as bulk silicon and gallium arsenide cannot meet these requirements. Materials systems of interest include innovative Group IV and III-V heterostructures and super lattices; and semiconductors such as silicon carbide and the nitrides for high temperature applications. Many of these materials will be in the form of extremely thin-layered structures of different materials. These artificially structured materials require the development of improved techniques for epitaxial growth. Innovative improvements in growth techniques such as molecular beam epitaxy, metal-organic chemical vapor deposition, and laser ablation are sought as well as new techniques. Process modeling of the growth techniques is of interest. He offeror is reminded that this is a materials task, and projects that are primarily device development of device processing will be considered nonresponsive. Phase I will address process development and initial testing to show proof of concept. Studies and/or design without actual testing are not appropriate for Phase I. Phase II will develop advanced semi-conducting materials for relevant processes to demonstrate potential. In Phase III, advanced semi conducting materials will be optimized for specific applications.

AF92-130 TITLE: Nonlinear Optical Materials

OBJECTIVE: Demonstrate approaches for obtaining nonlinear optical materials with superior properties compared to those presently available.

DESCRIPTION: Nonlinear optical materials are required for a variety of potential Air Force applications including optical signal processing, and new laser sources. However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts must address materials issues for either inorganic and organic materials in either bulk or thin film forms. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only for the proposed growth or processing techniques. Phase II will develop advanced nonlinear materials and relevant processes to demonstrate potential. In Phase III, advanced nonlinear optical materials will be optimized for specific applications.

AF92-131 TITLE: High-Temperature Superconducting Materials

OBJECTIVE: Develop processors for growing high-temperature, superconducting, thin films for electronic and opto electronic applications.

DESCRIPTION: High temperature superconducting materials offer a variety of application opportunities. For example, detection of infrared radiation can potentially be improved by increasing sensitivity, operating temperature, and signal processing speed over present technology. The properties of HTS materials must be established and controlled, and detection techniques must be evaluated in order to fully assess their value as sensors. Modeling of the superconducting mechanisms, development of unique thin film deposition and processing methods which produce films with the required properties, and optoelectronic response and temperature dependent noise measurements are examples of topics considered appropriate for this program area. The topic addresses development of thin film processing techniques and characterization of optoelectronic properties. Device development will not be supported. Phase I will address initial formulation, fabrication and evaluation of specific subjects for proof of concept, as well as application requirements and goals. Phase II will develop high temperature superconducting materials and relevant processes to demonstrate potential. In Phase III, high temperature superconducting materials will be optimized for specific application.

AF92-132 TITLE: Biotechnology for Nanostructures, Electronic, Optical and Waste Management Applications

OBJECTIVE: Apply biotechnology to obtain novel processes or materials to solve Air Force problems.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of biotechnology to aerospace requirements. Such program should address the fabrication of materials with compositions and/or micro structural morphologies of such complexity that they are only obtainable via natural processes. The study of this area could conceivably lead to the development of lower energy processing and materials with very specific electronic or electro optical properties and also contain very few micro structural anomalies. Since biological materials often perform several functions with ease, an investigation of the tradeoffs involved in natural material systems could lead to a design philosophy for multifunctional materials with, for example, both electro-optical and structural properties. Lastly, bioremediation is an area receiving attention for the removal of materials such as coatings and for the disposal of either current or previously discarded toxic materials. Phase I programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, fabrication, and evaluation required for proof of concept. In Phase II, the process or design concepts from Phase I would be developed through optimization and scale-up efforts in order to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product after a Phase III program.

AF92-133 TITLE: Surface Preparation of Metals for Adhesive Bonding

OBJECTIVE: Develop nonchemical base surface preparations for metal.

DESCRIPTION: Phase I would produce nonchemical processes for forming good bonding morphology on the surfaces of copper, aluminum and titanium. A process is needed to improve bond durability, increase service temperature range and provide cost reductions as well as reductions in the use of hazardous materials and volatile organic compounds. Existing surface preparations are based on chemically grown oxides. These oxides are hydrated and thus have limited temperature stability and are grown on the metal surface. In addition, the chemical processes are based on strong acids and bases and toxic/hazardous materials including chromates. Phase I work will demonstrate the feasibility of the use of physical process for producing the desired surface morphology for adhesive bonding. Phase II will involve optimization of the processes developed in terms of speed and uniformity of surface preparation in Phase I. Phase III will involve commercialization of the treatments developed to replace existing chemical base processing.

AF92-134 TITLE: Snap Cure Epoxy Adhesive and Resin Formulations

OBJECTIVE: Develop high strength rapid cure resin and adhesive formulations.

DESCRIPTION: Existing adhesive and resin products are not designated for rapid temperature rise rates, and when so heated do not provide high strength products. Chemical formulations designed for rapid cure via induction heating, etc., are needed for structural repair application of composite and metallic components and are Phase I anticipated goals. Formulations not designed for rapid temperature rise and cure tend to foam and bubble causing unacceptable porosity in the part. In addition, rapid cure of these systems causes chemistry changes which contribute to low strength polymers. Phase II work will optimize the products developed under Phase I for rapid core capabilities and development of high levels of mechanical properties and commercialize them under a Phase III effort. The Phase III effort will include field-testing of the products, modifications to conform to customer needs, and establishing formulations to be put into production.

AF92-135 TITLE: Precise Flux Control for Lattice Matched Super lattice Materials

OBJECTIVE: Develop a methodology for maintaining tight flux control during frequent load changes on flux source.

DESCRIPTION: Lattice matched super lattice materials grown using Molecular Beam Epitaxy (MBE) are becoming an area of increased interest due to the unique properties they possess. A major obstacle in achieving consistent material properties is the flux transient caused at shutter opening. This transient becomes very significant in super lattice materials where the layers are much thinner. Tight flux control is much more important when attempting to match lattice constants. An effective method for reducing the area of these transients by at least a factor of 50 is desired. This method must take into account the variation in the temperature characteristics of the effusion cell caused by the cycling of the cells during super lattice growth. The Phase I effort is anticipated to feature just one improvement or may incorporate several improvements. The Phase II goal is to produce a marketable MBE control system which achieves the above objective in addition to a user friendly recipe growth capability. The Phase III goal is to enable commercial support for in-house MBE control system, as well as distribution and support for other government, industrial and academic users.

AF92-136 TITLE: Integrated Product Development (IPD) for Electronics

OBJECTIVE: Develop IPD modeling capability to capture design and manufacturing attributes for electronic multichip module components.

DESCRIPTION: IPD is the integrated design of the product, manufacturing, and support processes together with emphasis on efficiency, improved quality, and reduced cost. The Air Force has a particular interest in improving the

product life cycle, of multichip modules that require new packaging techniques and innovative interconnect structures. Three areas of particular interest include modeling existing techniques that are used to trade off system parameters, technical parameters, defining an information architecture that includes both product and process information that can be presented in a functional, logical, or physical view upon demand; and identifying/developing applicable design and decision support tools to facilitate integration. Phase I will address application requirements and goals for proof of concept. This includes identifying attributes to describe the function, sizing, component behavior and fabrication processes needed in a multichip module electronic design. Phase II will develop and demonstrate the methodology applied to a targeted electronic product design. This would include a capability to model both product and process information for analysis. Phase II will establish the information storage and retrieval mechanisms for modeling the behavior of complex multichip modules and appropriate interconnect structures needed for the design. Phase III will develop a candidate IPD software tool that can facilitate the integration of product and process information to perform multichip module designs. This activity will provide storage and retrieval mechanisms for modeling the behavior of electronic products using new packaging strategies.

AF92-137 TITLE: Space Power, Energy Conversion, and Thermal Management

OBJECTIVE: Develop survivable and lightweight space power technology for spacecraft applications in the 5 to 100 kilowatt regime.

DESCRIPTION: Develop photovoltaic energy conversion source devices, components, materials and subsystems for advanced space power system applications. Proposals should relate to the following technologies: high efficiency, highly radiation resistant photovoltaic cells; survivable photovoltaic cell stack; and ultra lightweight cells and lightweight/low cost planar and concentrating arrays for application to space missions ranging from a low threat environment to a high-threat environment including tactical missions and electric propulsion for Orbital Transfer Vehicle. Phase I effort twill be preliminary investigations to demonstrate feasibility of the proposed concepts. Phase II effort goals will be to fully demonstrate the capabilities of the proposed technology as it applies to survivable space-power systems. Phase III efforts are expected to include optimization of performance and final verification of concept capabilities as well as clarification of any unresolved production and manufacturing issues.

AF92-138 TITLE: Aircraft Power, Power Electronics, and Thermal Management

OBJECTIVE: Develop power electronic devices and systems for aircraft applications.

DESCRIPTION: Develop one or more of the following advanced power and power electronics technologies for future aircraft: high temperature components, fluids, and seals for hydraulic systems; cold weather; high temperature electrical power and distribution components; and novel thermal management techniques for cooling integral generators, power electronics, and electro hydrostatic/electromechanical actuators. Phase I goals include analytical derivations and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III goals include demonstrating flight qualified flight readiness hardware.

AF92-139 TITLE: High Power Technology for Aerospace Applications

OBJECTIVE: Develop high power component technology for aerospace applications.

DESCRIPTION: Development of one or more of the following advanced high power component technologies is needed for future aerospace high power applications; advanced lightweight power sources with power densities less than 0.02 kilograms/kilowatt; superconductivity as applied to pulsed power componentry; and high power superconductive devices and systems, especially those using high temperature superconductors. Phase I goals include analyses and proof of concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III will involve a full prototypical demonstration.

AF92-140 TITLE: Combustion Ignition for Gas Turbine Engines

OBJECTIVE: Develop advanced ignition devices and systems for reliable ignition of aircraft gas turbine engines.

DESCRIPTION: Future gas turbine engine combustors will be physically smaller, operate at wider fuel/air ratios and at lower residence times. In order to maintain or increase ignition system performance under these stringent conditions, advanced ignition systems must be developed to improve the reliable light and relight of combustor and augmenter flows during initial start up and at high altitude operating conditions of an engine. These advanced ignition system components must be more durable to reduce maintenance costs while tolerating increased temperatures and pressures in combustor and augmenter environments. These systems should show potential for weight and cost reductions as well as possible combinations with other subcomponents such as flame sensors. The goal of Phase I will be a feasibility demonstration of the ignition concept. Phase II goals will include a full scale demonstration of the ignition techniques in a modern gas turbine engine. Phase III efforts will include optimization and refinement of he ignition technique, as well as clarification of any unresolved production or manufacturing issues.

AF92-141 TITLE: Smart Actuators for Aircraft Turbine Engines

OBJECTIVE: Conduct preliminary design and analysis of a “smart” actuator for aircraft gas turbine engine applications.

DESCRIPTION: In order to meet future gas turbine engine weight goals, control systems will be more distributed, employing fiber optic data busses interfacing to self containing smart actuators and sensors. Currently, sensor and actuator compensation is accomplished in the engine digital electronic control unit. While this approach contributes to very high cable and harness weights and consumes a large portion of the engine control’s processing time, it is the only practical method due to the temperature limitations of today’s silicon based microelectronics. Advances in fiber optic technology and in high temperature, silicon carbide semiconductor technology, make feasible the design of “smart” sensors and actuators. A “smart” actuator that is co packaged with an electronic modules that provides control signal compensation and actuator control loop closure directly at the source. The “smart” actuator should is an actuator that is co packaged with an electronics module that provides control signal compensation and actuator control loop closure directly at the source. The “smart” actuator should be a totally self-contained device providing all signal compensation, including self diagnosis and built in test. The goal of Phase I is to investigate current technology “smart” actuator developments and to conduct a preliminary design of a “smart” actuator for advanced engine applications. The preliminary design should be based on advanced fiber optic and SiC technologies. The preliminary design will include a description of all compensation functions. A detailed design and fabrication of a prototype actuator shall be conducted on Phase II. Phase III will include qualification testing on a demonstrator engine.

AF92-142 TITLE: Turbine-Engine Test Instrumentation

OBJECTIVE: Develop new sensors/systems for accurately determining strain and temperature under actual engine operating conditions.

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state of the art of structural instrumentations has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor. For these reasons, new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding the temperatures and strains typical of turbine engines for extended periods while detecting strain to within plus or minus 5 percent and temperature to within plus or minus 1 percent. Additionally, proposed techniques should have minimal influence on blade structural parameters and gas flow path characteristics.

The goal of Phase I will be a basic feasibility demonstration of the advanced sensing concept. Phase II goals will include a full scale demonstration on the technique in an environment which duplicates the anticipated conditions in a modern gas turbine engine. Phase III efforts are expected to include optimization and refinement of the sensing technique, as well as clarification of any unresolved production or manufacturing issues.

AF92-143 TITLE: High Temperature Thermally Stable Aviation Turbine Fuel Development

OBJECTIVE: Measure fuel degradation and test additives to improve the thermal stability of JP-8 fuel.

DESCRIPTION: Aircraft subsystems generate waste heat that must be removed to ensure adequate component reliability and life. Fuel is utilized as a main heat sink on most aircraft. New high heat sink fuels are needed to absorb the large heat loads projected for future aircraft. Studies indicate that thermal stability improving additives can be added to increase the operating temperature of JP-8 fuel from 325 F to 425 F. Phase I of this program will focus on identifying and testing additives to improve the thermal stability of JP-8. As part of the testing, new test methods/devices are needed to quantitate fuel degradation. It is highly desirable that these devices be able to operate at temperatures as high as 900 F and pressure of 500 psig or higher in either a static or flow environment. Phase I can include experiments to test the feasibility/capability of the test method/device. Phase II of this effort will include testing of fuel/additive combinations in aircraft components or devices which simulate the environment of aircraft components. In addition, new test methods/devices for which the feasibility was demonstrated in Phase I can be fabricated and used to test thermal stability additives. Phase III of this effort would include packaging for the commercialization and marketing of the test methods/devices and/or fuel additives to industry and government agencies.

AF92-144 TITLE: Methodology for Turbine Engine Lubrication Sensitivity Analysis

OBJECTIVE: Develop methodology to assess impact of lubrication systems on turbine engine performance.

DESCRIPTION: For turbine engine design purposes, methods have been developed to assess the impact, e.g., the sensitivities of compressor flows, efficiencies, on projected engine performance. Such methods typically employ iterative computer algorithms to calculate the sensitivities. The cycle decks are typically restricted to basic performance parameters with, perhaps, some capability to determine the effect of parametric changes on projected missions. Cycle decks are not available to assess impact of performance of new lubricants and lubricant system designs using software codes for personal computer implementation. Development of these critical methodologies and software are required to perform sensitivity analyses so that Integrated High Performance Turbine Engine Technology design goals might be efficiently met. Phase I activities will include assessment of the concept, gathering of pertinent data on current and planned lubrication systems' performance projected for advanced turbine engine designs, assessment of projected mission profiles and selection of algorithms, software, and hardware required to implement the system for sensitivity studies. Phase II activities will include development of the methodology and software sufficient to perform such sensitivity studies using a personal computer. Demonstration and delivery of the software will be required. Phase III will develop software designed for use by turbine engine engineers, aircraft designers, and lubricant and lubrication system component vendors to effectively perform lubrication system sensitivity analysis.

AF92-145 TITLE: Auxiliary Bearings for Magnetically Supported Rotors

OBJECTIVE: Develop auxiliary bearings for magnetic bearing systems.

DESCRIPTION: Studies of active magnetic bearing systems have shown the potential payoffs and high risks involved in the development and application of this technology for advanced aircraft gas turbine engines. Active magnetic bearings represent an innovative approach to aircraft engine rotor support with the potential of providing significant benefits not possible with conventional rolling element bearings. The successful application of magnetic bearings would result in engines with no oiling systems, high rotor speeds, reduced blade tip and seal clearances, reduced weight, and enhanced rotor dynamic control. However, technology for advanced, fail-safe auxiliary

bearings has been identified as a critical factor in successfully achieving an operational aircraft engine magnetic bearing system. In an aircraft engine configuration wherein the primary support for the main shaft rotor is provided by an active magnetic bearing system, the auxiliary bearings would serve as a fail safe support mechanism. The unalleviated rotor will be statically supported by the auxiliary bearings. Additionally, in t he event of a power failure in the magnetic bearing control circuit or during excessive bearing loading conditions caused by the loss of turbine or compressor blades or due to a severe aircraft maneuver, the selected auxiliary bearings must be capable of withstanding these high loads so as to prevent contact between the magnetic bearing rotor and stator. The auxiliary bearings, under these conditions, must have sufficient life to enable the pilot to fly his aircraft safely to the nearest airbase. Phase I goals will include the design and analysis of innovative auxiliary bearing concepts with potential of meeting the speed, temperature, and loading requirements, as related to the conditions described above. Phase II activities will include the detailed design, fabrication, and testing of selected, promising, auxiliary bearing configurations. Phase III effort will involve working with large and small engine contractors to introduce active magnetic bearings into their engines.

AF92-146 TITLE: Very Low Cost Air breathing Propulsion for Standoff Munitions

OBJECTIVE: Develop a very low cost air breathing propulsion system for tactical standoff missions.

DESCRIPTION: Develop minimum cost air breathing propulsion concept(s) for powering standoff air-to-ground munitions at high subsonic speeds. Concepts other than rockets or turbojets are of interest in t his program. Simplicity and low cost are sought. The propulsion system encompasses the propulsion unit, the fuel, its delivery system, and all means for starting the propulsion system and controlling it. The Phase I effort will involve examination of new propulsion systems, projection of performance, limited preliminary design, projection of feasibility and definition of critical experiments required to prove the concepts. Phase II will involve conducting critical experiments leading to fabrication and demonstration of an integrated propulsion system. Construction of a prototype and further necessary testing would be carried out in Phase III.

AF92-147 TITLE: High Mach Combined Cycle Engine Technologies

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6 flight speeds.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turbo ramjets and air-turbo rockets to be very attractive propulsion concepts at Mach 0 to 6 flight speeds. Both concepts combine the flexibility and efficiency of turbo machinery at flight speeds of Mach 0 to 4 with the simplicity, low weight and high specific impulse of the ram jet in the Mach 3 to 6 flight range. Currently, plans are underway to develop technologies for both a turbo ram jet and an air turbo rocket under the High Mach Turbine Engine Technologies program. Under this program, technologies which would be applicable to either cycle are of primary interest. Examples of these technologies include air intake systems, exit nozzles, solutions to reduce the length and weight of the inlet and nozzle components, ram burner structures, ram burner fuel injection/flame holding schemes, endothermic fuel reactor/engine integration, heat exchangers using either fuel or a nonexpendable fluid to cool air, ram burner cooling techniques and air driver power generation devices. Proof of concept testing is preferred, but analytical investigations will also be considered. The goals of Phase I will be to identify a novel concept, quantify its payoff and conduct a small scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate feasibility and to plan experiments for larger scale development in Phase II. The goal of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

AF92-148 TITLE: Automatic Brightness Control for Cockpit Electronic Display Instruments

OBJECTIVE: Develop methodology, sensors, and related electronics for controlling displays' brightness from sunlight through night vision conditions.

DESCRIPTION: New and modernized older military aircraft cockpits are being equipped with various electronic display technology instruments, multicolor and monochromatic, cathode ray tubes, dot matrix and segmented devices. The typical aircraft, so equipped, will now have a smaller number of individual instruments in the cockpit than required in the era of the old, dedicated analog, needle and dial instruments. However, controlling the luminance of these new multifunction instruments, under all operational conditions and flight maneuvering possibilities, becomes significantly more complex. This is because the legibility threshold of these displays under the very broad range of cockpit ambient light conditions must now be dealt with on an individual display basis. Not only must the fidelity of portrayed alphanumerics, graphics and video be preserved, but also intended color and grey shades must be maintained under the changing ambient. Doing the brightness adjustment task manually, especially for each of the primary flight display instruments, subjects pilots to a highly undesirable workload. The Phase I effort will include the development of a technique/methodology, a definition of the sensors and the electronics required to accomplish the desired results automatically, and a basic demonstration of the concept. This effort should consider various aspects:

(1) The control of display instrument brightness over the range of 0.01 to 10,000 ft. lamberts with a sufficient number of gradations so as to not cause brightness changes that are noticeable and distinguishable to the pilot throughout this range.
(2) The capability to handle up to 5-6 primary flight display instruments concurrently.
(3) The capability to relate the individual light sensor locations to the locations of the primary flight display instruments in the cockpit.
(4) Timing constraints, as related to day and night operations, and reaction times needed for the system to respond to ambient light changes – considering the adaptation characteristics of the human eye.
(5) Capability of the system to sense speed and direction of moving shadows across the cockpit instrument panel and, using these outputs, to influence the ABC.
(6) Built in Test (BIT)
(7) The same design should be practical and economical to install in a variety of military aircraft types, to promote standardization.
(8) Design should lend itself to standardization of component parts.
(9) Making use of existing on board aircraft computer for some of the functions, where practical

The Phase II effort will design and fabricate the necessary unique sensor components, and three breadboard ABC systems will be assembled for test and experimentation in static and dynamic simulators. These systems are to be based on the Phase I developed concept. Following the evaluations, three additional flight worthy prototypes will be fabricated for military flight testing; these tests will also involve aircraft types similar to those utilized for commercial purposes. During Phase II, the prototypes resulting from the Phase II effort would be re-designed into a producible ABC system. Sufficient quantities of the production design would then be fabricated to enable MIL-SPEC qualification testing.

AF92-149 TITLE: Verification and Validation of Associate Systems

OBJECTIVE: Identify verification and validation techniques for associate systems software.

DESCRIPTION: Currently, there are research programs within each military service and NASA to exploit the significant potential of associate systems. Associate systems perform functions previously thought to require human judgment, knowledge, or intelligence, using heuristic, search based techniques. Conventional software verification and validation techniques do not apply to associate systems because the system is both a piece of software and a model of human knowledge and reasoning, and, like all models, will never be perfect. Even if the software is completely valid and reliable, the embodied model may be in error. In addition to the problems generated by the model characteristics, associate systems employ both numeric and symbolic information, which make traditional numeric verification and validation techniques in feasible. Unless compelling evidence can be adduced that such associate software can be trusted to perform its function without error, it will not be used, or may not perform up to expectations. In either case, the decisions generated by the associate system may be inappropriate or wrong, and, if relied upon, may result in considerable damage to the user of the system. Therefore, the verification and validation of associate systems is a critical task. Phase I work will identify specific verification and validation issues concerning the current implementation of the Pilot's Associate software. The Pilot's Associate is a knowledge-

based, decision-aiding system being developed to support tomorrow's single-seat fighter. The unique aspects of the Pilot's Associate software will be used to determine the real issues surrounding verification and validation of associate systems. Based on these issues, appropriate verification and validation requirements for associate systems will be identified. After requirements determination, the effort will concentrate on research into the integration of existing applicable verification and validation techniques and the design of new techniques to address requirements not covered by the existing techniques. Upon completion of the Phase I effort, the verification and validation techniques that have been considered will be rated in terms of technical merit and feasibility, and the best ideas will be chosen for pursuit in Phase II. Phase II of this effort will investigate the most promising Phase I techniques using the Pilot's Associate software as a test case. The Phase II goal will be to develop an integrated, computer-based technique to meet the verification and validation requirements of associate system software. Products of the Phase II effort will include the integrated, computer-based technique for verification and validation of associate systems software, a detailed final technique as applied to the Pilot's Associate software. Phase III effort is directed toward the development of a comprehensive computer based tool set for verification and validation of software for associate systems.

AF92-150 TITLE: Low Cost Manned Simulation of Air Combat

OBJECTIVE: Provide the tools to perform Air-to-Air and Air-to-Ground manned simulation of future combat systems.

DESCRIPTION: As part of the Department of Defense critical technologies, simulated of advanced technological capabilities is crucial to the wise investment of research and development dollars. The level of fidelity required for parametric analysis of technologies at Wright Laboratory is low when compared to simulations used for training systems and flight controls development. Present low cost, low fidelity, manned, simulation facilities permit only beyond visual requirements. Virtual reality is a display format which shows a great deal of promise in overcoming these limiting factors. A person may don a head mounted display device and be placed in a virtual world created with computer generated images. These images are updated by the subjects' head movements and other dependencies such as time and position of objects in the virtual environment. The contractor will outline a software architecture and define display requirements for a virtual simulation of air-to-air and air-to-ground scenarios integrated with our existing low cost, manned, simulation facility. The core simulation will be a version of the Advanced air-to-air system performance evaluation model. The virtual simulation will utilize state of the art image processors and head mounted display tracking technologies for out the cockpit views. Phase II will accomplish full scale development of a single virtual pilot station complete with head mounted display, head tracker, control stick and throttle. This first pilot station would only be a prelude to the vast potential of this virtual environment. Phase III efforts could create a small low cost tool which would offer an alternative to multi million dollar dome simulator facilities. This approach should be inexpensive enough to allow introduction into the entertainment market or a multitude of industrial applications.

AF92-151 TITLE: Cost Methodology for Premilestone I Planning

OBJECTIVE: Devise/develop effective cost methodology for use in Premilestone I Planning.

DESCRIPTION: This category of Premilestone I planning methodology is intended to cover the following three specific areas of interest in FY92:

(1) Advanced avionics and integrated avionics software
(2) High performance turbine engines and other innovative propulsion systems
(3) High temperature materials properties and dollar per pound for manufacture

Phase I should address Premilestone I cost estimating for emerging technology to be fielded into new weapon system/subsystems. This will provide needed approaches to estimate the cost impacts of specific technologies into total weapon systems/subsystems cost modeling. During Phase II the contractor will develop a working computerized cost model compatible with IBM PC applications and build an appropriate database. For Phase III the

contractor will develop additional definition of the appropriate database, i.e., airframe, avionics, propulsion, etc., with larger working database of aircraft systems.

AF92-152 TITLE: Applications of Advanced Processing and Computing Techniques to Emerging Systems

OBJECTIVE: Apply advanced processing and computing techniques and architectures to emerging aeronautical systems and to their development and analysis.

DESCRIPTION: Advanced processing and computing techniques and architectures offer enhanced mission effectiveness and high payoff under certain circumstances:

(1) Applied to emerging aeronautical systems/subsystems. Two areas of specific interest are identifying mobile targets and pilot aiding.
(2) Applied to the development and analysis process for these emerging systems/subsystems. Areas of interest are hardware and software solutions to the data management, organization and presentation requirements of Integrated Product Development planning.

Innovative software and hardware technologies, such as object oriented programming, adaptive networks, and knowledge representation are solicited. High importance is placed in Phase I upon the proposed approach, the potential application, testing methodology, and validation of the capability and maintenance of developed software/hardware systems. Phase II and III efforts are to provide software/hardware products such as integrated multimedia platforms, software and/or hardware systems addressing aircraft system functionality/development and advanced simulations.

AF92-153 TITLE: Mission Area Planning

OBJECTIVE: Formulate and evaluate operational concepts.

DESCRIPTION: In the field of Mission Area Planning the Air Force has a number of requirements:

(1) Formulate operational concepts to perform tasks more effectively and to achieve operational and support objectives.
(2) Evaluate concepts on the basis of effectiveness and cost.
(3) Provide support for interpreting and evaluating Operating Command deficiencies.
(4) Refine operational requirements and define responsive development options.
(5) Provide information/decision support for acquisition decisions, traceability, and quality management.

This involves the full spectrum of Air Force aeronautical missions and operational concepts for integrated DoD and/or Allied forces components. Specific areas of interest are as follows:

a. Develop methodology, techniques, and tools for conceptualization and definition of: evolutionary training systems; collective/group training systems; systems for relating strategies to tasks, composite forces, and military modeling, and systems for relating doctrine, strategy, tactic, training or organization to task accomplishment.
b. In the area of bomber defense, develop innovative ways to defeat airborne and ground launched threats to bomber aircraft. Methods should include investigating lethal and/or non-lethal concepts.
c. Develop methods and models for procedures to develop and validate operational capability in the strategies to tasks process. Areas of interest include planning, management, deficiency analysis, requirements push/analysis, documentation and information support systems, decision support systems, function analysis, cost and risk analysis, technology insertion and organization. Consideration should be given to the evolution of concepts and systems and their development in large, complex enterprises. Ideally, the tools developed should be generic in nature.
d. In the future, total system integration may take on new meaning. It may grow to encompass a large or even total force structure. Consideration may have to be given to the possibility that an all-stealth force may not

be desirable for cost or performance reasons. In the future, the notion of a system may imply more than one aircraft. Each such system may have as its components many diverse aircraft, even though in outward appearance many may look alike. Expectations are that this perspective on the notion of a system may achieve new levels of operational effectiveness.

In Phase I the contractor will develop a definition and conceptual solution to the problem and perform an analytical assessment of the proposed solution. Phase II will entail an in depth analysis of the solution and/or development of the methodology, techniques and computer=aided tools to allow implementation. In Phase III fully implement the proposed solution.

AF92-154 TITLE: Decision Support System for Early Acquisition Supportability

OBJECTIVE: Devise/develop a methodology to logistics life cycle cost modeling for use in Premilestone I Planning.

DESCRIPTION: Seventy percent of decisions defining total life cycle cost have been made by the end of Premilestone I system concept studies. Therefore, a decision support system capable of identifying acquisition supportability options and their associated costs is needed. An analytical methodology and tool capable of assessing and providing premilestone I logistics LCC estimates is required to aid key weapons system program decisions such as defining the operational scenario, establishing quantitative performance requirements, specifying deployment locations, and selecting the system maintenance concept. The analytical methodology should define integration of emerging technologies into total system/subsystem logistics support planning and LCC cost models. Examples of emerging technologies to be addressed in development of the analysis methodology are USAF logistics research, development and acquisition strategic plans programs (PRAM) and RAMPTIP Programs and AFLC Technology Application Program Management (TAPM) programs. The logistics supportability analysis methodology should also be capable of assessing LLC impacts of the emerging technologies individually or in combination for a specific system application. Additionally, assessment of the integration of the emerging technology into the AFLC Weapon system Master Planning and Modification Requirements Review Board processes should also be identified and the LCC impacts determined. In the area of logistics supportability analysis methodology, the decision support system should also be able to determine the cascade effect of changing system requirements as they effect DOD 5000.1 defined integrated logistics support elements of weapon system supportability. For example, as the range requirement for the system is changed, what effect does that change have on maintenance activities, manpower and training requirements, safety, facilities, support equipment, etc. During Phase I the contractor will study feasibility of developing flexible supportability decision support methodology and provide a detailed development plan with supporting technical analysis, identification of data sources, and analytically appropriate documentation, and deliver a usable IBM-AT based system to the government. For Phase III provide feedback on system deficiencies and improvements for system use, incorporate government identified improvements, and deliver a fully developed decision support system with all system documentation.

AF92-155 TITLE: Automatic Probe Seeking Aerial Refueling Drogue

OBJECTIVE: Study the possible design approaches to provide an aerial refueling drogue which automatically seeks the receiver probes.

DESCRIPTION: Current drogues in aerial refueling probe-drogue pod systems cannot control their flight characteristics while in trail. The drogues fly in a position depending on the drag and weight of the drogue/hose/coupling and the flight airspeed/altitude. These drogues become unstable in air turbulence and are also affected by the receiver aircraft bow wave. Currently, the receiver pilot must make vertical, lateral flight control corrections and make speed corrections with his throttle to engage the drogue/coupling. Drogue movements/perturbations can result in a missed hookup, which is time consuming, and can prevent the receiver aircraft from a making a hookup, which can result in aborted missions. In some cases, the perturbations can cause damage to the receiver aircraft; e.g. canopy/windshield flight controls, instrumentation, pilot tube; with a loss of aircraft a distinct possibility. A drogue which eliminates the lateral and vertical receiver aircraft flight movements and automatically seeks the probe tip position in the last 20 feet of receiver aircraft closure can eliminate aircraft

damage, significantly reduce pilot workload, and reduce time consuming drogue misses. During Phase I, design and analyze potential automatic probe seeking aerial refueling drogue techniques. Phase II of the project will provide a prototype design and flightworthy prototype system of the tanker coupling/drogue system and the receiver's probe. Phase III would involve a flight test and service test on the prototype system.

AF92-156 TITLE: Superior Fiber Inserts for Nuts

OBJECTIVE: The development of a fiber insert for nuts that will allow multiple uses.

DESCRIPTION: Nuts with fiber inserts are currently being used in military aircraft. These nuts are not considered reusable, when the nut is demated it must be thrown away! This procedure often leads to aircraft not being mission ready because spare parts are not available. Phase I would consist of the selection of fiber insert material which have a memory, returns to its initial position after demating so it can by used again. These inserts would then be fabricated, installed in a nut, and laboratory tested to demonstrate their recovery capability. In Phase II these nuts would be installed on an aircraft and the concept validated. After concept validation, the intent of Phase III would be the use of these reusable nuts on production aircraft systems/subsystems.

AF92-157 TITLE: Armament Research

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air-delivered non-nuclear munitions and armaments. These include bombs, sub munitions, warheads, projectiles, fuzes, dispensers, seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid state inertial components, exterior ballistics, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes; conformal ejector racks; high voltage storage and switching techniques; millimeter wave seekers for mid course and thermal guidance; heavy metal, self forging, fragment warheads; heavy metal shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid generation techniques and warhead hydro code assessment techniques.

AF92-158 TITLE: Compact, Low Acceleration, Single Shot, Light Gas Launcher

OBJECTIVE: Investigate a compact light-gas launcher which minimizes the launch accelerations of experimental packages.

DESCRIPTION: A two-stage light gas gun is presently used in the Aeroballistic Research Facility, Eglin Air Force Base, Florida, to launch experimental and research aerodynamic configurations into the instrumented portion of the ARF. Because these models are relatively fragile, it is important to minimize the acceleration loads they experience during the launch cycle. Also, since the facility has limited length, the launcher must be compact. In conventional two stage light gas gun design, compactness and low launch accelerations are usually mutually exclusive. However, it is believed that during the past few years, some unique designs and concepts have been proposed which combine these two very desirable features. Some of these concepts also include other desirable features such as a cartridge case which contains stacked propellants, piston, and light gas. Such features would add to the ease of operation and possibly make weaponization of such launchers more attractive in the future. Phase I of the SBIR task will be to propose unique designs for a single shot light gas gun for use as a laboratory launcher. Along with the design, an analysis of the launch cycle will be conducted which will encompass launch weight, muzzle velocity, launch accelerations, pressures, etc. The most promising design will be selected for Phase II. Phase II of this effort will be to construct the single-shot launcher designed in Phase I. The launcher will be installed and tested in the ARF at Eglin AFB as a research tool. The launch cycle prediction routines should be documented.

AF92-159 TITLE: Test Mode Anechoic Chamber Characterization

OBJECTIVE: Exploit the latest microwave technology to characterize the performance of anechoic chambers containing large irregular shaped objects.

DESCRIPTION: The Air Force is placing greater emphasis on digital modeling and the use of ground simulation facilities prior to, and in lieu of, costly flight testing. Installed test facilities containing aircraft and missile-sized anechoic chambers are the last step in the ground testing. Evaluation of the anechoic chambers is performed after the initial construction and repeated periodically during its lifetime. Once a large object is placed in the chamber, the evaluation, or characterization, of the chamber must once again be performed to determine if free space conditions are being represented. This is frequently the most time consuming and tedious part of the test activities. The goal of this task is to develop techniques and methodologies for accomplishing these characterizations with greater accuracy. A secondary goal is the automation of these characterization tests in order to minimize the test setup time. The technical challenge is to exploit recent advances in Radio Frequency (RF) measurement technologies and techniques to allow greater resolution of anechoic chamber performance by characterizing and isolating "hot spots" as opposed to a total chamber characterization. Phase I of this SBIR program should include a survey of potential technologies and techniques and propose a preliminary methodology for anechoic chamber performance evaluation in the presence of large irregular shaped objects. Phase II of this SBIR program is to demonstrate in an anechoic chamber that the proposed methodology does provide greater resolution and isolation of "hot spots" that contribute to overall chamber performance degradation. Phase III of the SBIR is to produce an automated system that has application to any anechoic chamber containing large irregular test items. The automated system should, in addition to providing detailed resolutions, be of such a design and implementation that it reduces the overall characterization time by a significant amount.

AF92-160 TITLE: RF Simulation Range Extent Device

OBJECTIVE: Exploit Radio Frequency (RF) technology to develop a radar target and ground clutter range extent simulator.

DESCRIPTION: Analog devices are being used in RF simulators to provide for signal delays to simulate range extent for ground clutter and radar targets. These devices provide discrete delays, or fixed tap spacings, close to the range gate size of the radar and are usually made from specific lengths of coaxial cable. The main problem with using coaxial cable is the stability of the delay through the device over a temperature range. A critical limitation of the device is the fixed length, or item delay spacing, of each tap, as well as having a fixed number of taps. The goal of this program is to develop the components or device that can be integrated into an existing RF simulator and that will provide range extent that is stable over temperature. The device must also have the capability to allow easy programming of the tap spacings and/or the number of taps used. This will enable an RF tester to readily respond to changing test requirements without having to build new discrete tapped delay lines. Phase I of this SBIR program should include surveying of various methods of achieving the programmable/variable range extent, accomplishing preliminary designs to exploit the concept, and reporting the advantages and disadvantages of each proposed concept. Finally, the Phase I task will culminate with a recommendation of the candidate approach to be demonstrated in Phase II. Phase II of the SBIR task is expected to demonstrate in the laboratory the ability of the selected concept to provide the programmable/variable range extent over a changing temperature profile. This demonstration will be provided by a brass board of the range extent device. Phase III is expected to provide a production version of the prototype programmable/variable range extent device demonstrated under Phase II of this SBIR program.

AF92-161 TITLE: Composite Hydraulic Components

OBJECTIVE: Reduce weight of aircraft armament subsystems by investigating hydraulic components manufactured from composite materials.

DESCRIPTION: In recent years, work has been accomplished to develop hydraulic powered carriage and release equipment. The programs have led to the development and use of 8000 pounds per square inch hydraulic

components in bomb rack and missile launcher systems. This concept as many benefits and looks promising for future carriage and release hardware. However, as with all aircraft subsystems, weight is critical. Weight reduction must be explored as the hydraulics are further developed. The goal of this task is to investigate the use of composite materials for manufacturing hydraulic components, such as valves and accumulators. The components must be capable of 8000 psi hydraulic operation, compatible with standard aircraft hydraulic fluid, and designed to withstand proof pressure testing at 16000 psi. Phase I of this SBIR task is to identify components and select composite materials to satisfy the pressure and operational requirements. Conceptual designs of the selected components will be the end items in this task. Phase II of this SBIR task is expected to demonstrate the feasibility of the Phase I designs. The conceptual designs should be detailed, fabricated, and laboratory tested during Phase II. Production of components for system application is envisioned for Phase III.

AF92-162 TITLE: Ultrahigh Frequency Simulation Video Transmitter For Projectiles

OBJECTIVE: Develop an X or K band wideband FM subminiature 10 MHz analog “video” transmitter.

DESCRIPTION: The development and testing of next generation smart sub munitions and precision guided projectiles demands the ability to transmit very high bandwidth “video” format data of the focal place detector or instrumentation cameras output to a ground telemetry station for capture and subsequent analysis. Current video transmitters are too large for these applications and have been developed with discrete or hybridized Radio Frequency (RF) components. Current technology also has the characteristic of low power efficiency requiring excessive power. For video transmission at currently authorized S and C bands, narrow channel allocations, due to interference with adjacent allocations, preclude the use of high deviation ratios necessary to obtain desired FM signal gains needed for high resolution data acquisition throughout the projectiles trajectories. The goals of the program are to apply advanced RF monolithic microwave integrated circuit technology to develop subminiature analog video transmitters with data subarriers that can withstand the high G environment of rocket delivered sub munitions and cannon launched, precision, guided weapons. Phase I will include analysis and design of an Ultrahigh Frequency, monolithic, component transmitter and data link; demonstration of the performance of the critical device components; and documentation of the effect of modulation waveform characteristics on link performance. The advantages, disadvantages and performance of the different concept s will be reported and presented along with actual bench demonstrations of 10 megahertz video signal input. The Phase I will culminate with the recommendation of a candidate approach to be pursued in Phase II. Phase II of the project is expected to develop a data link system with at least 4 breadboards and 10 brass boards for component testing at actual environments, link testing over typical ranges, and flight demonstrations in simulated precision guided munitions. Phase III of the project is expected to produce a prototype, ultrahigh frequency, data link system with modular components that can be produced to meet the stringent packaging and environmental requirements for developmental and testing of production sub munitions and cannon launched projectiles.

AF92-163 TITLE: Laser Radar Scene Projector

OBJECTIVE: Design and develop a Laser Radar scene projector.

DESCRIPTION: The design, development, and testing of Laser Radar (LADAR) seekers requires a Laser Radar projector. LADAR seekers are currently undergoing various phases of development and will require laboratory and field testing and evaluation. A LADAR scene projector is a key component in providing the Air Force with the ability to evaluate seeker performance in laboratory tests and hardware in the loop (HIL) simulations. An HIL simulation consists of a test unit mounted on a flight motion simulator with a LADAR scene simulator providing high fidelity target scene. The LADAR scene simulator consists of a scene generation system and a LADAR projector. The LADAR projector converts the output of the scene generator into a radio metrically correct representation of the scene. Under this SBIR the contractor will design, develop and build a high fidelity LADAR projector. The projector must preserve all the phenomenology present in a LADAR scene. Two types of LADAR scenes are possible. In the unresolved target scene, the target is smaller than the LADAR beam. In the resolved target scene the beam is smaller than the target. Essentially, a LADAR image is a high resolution angular position array of range, Doppler or amplitude returns. Since LADAR uses a coherent c=source of illumination, the seeker may use direct energy of heterodyne detection techniques. The reflection of coherent light from a surface

incorporates an intensity distribution, frequency modulation due to target motion and local vibrations, target surface coherence length effects, and lint. The scenes must be generated at least as fast as the seeker frame rate can be synchronized to the seeker. Phase I includes a determination of system technical specifications from the projector performance requirements. The technical specifications will be used to formulate candidate designs. The designs will be evaluated to determine optimum performance considering cost, performance, reliability and maintainability. Phase II consists of the fabrication and demonstration of system component technologies, followed by the integration, installation and validation of a fully operating projector.

AF92-164 TITLE: Knowledge Automatic Target Recognition Discrimination (KATRED)

OBJECTIVE: Apply knowledge based and neural network techniques to the five automatic target recognition discrimination levels.

DESCRIPTION: Numerous applications of image processing, knowledge based procedures, and neural networks have been used to solve the automatic target recognition problem without success. This SBIR is to investigate the complexities of applying KBP and NN to five levels of ATR discrimination. Discrimination levels are defined as the location in the decision hierarchy for detection, classification, recognition, identification and characterization with detection being the least complex. Detection is defined as the discrimination level at which targets are distinguished from nontargets. Classification is defined as the level at which a target class is declared, aircraft or vehicle. Recognition is defined as the level at which target subclasses are declared, fighter, bomber, truck or tank. Identification is the level at which the target type is declared. Characterization is the level at which the detailed physical characteristics of the targets are determined, with missile of M1A1. Phase I will apply KBP and NN techniques to classical image processing and develop paradigms and algorithms for each discrimination level or images in the visible range. Knowledge specifications and decision procedures will be determined for each level. The targets of interest in Phase I are buildings, vehicles, and people. The resolution requirements for R and LADAR images should be expressed in terms of pixels on target, pixel area, and grey scale. Phase I will construct the discrimination methodology for Phase II. Phase II will extend the effort to developing hardware and software by investigating the effectiveness of paradigms and algorithms with near IR, medium wavelength, and long wavelength infrared images, and millimeter wavelength images. Data fusion should be addressed separately. Images with multiple targets will be used. Targets of interest in Phase II are extended to aircraft, aircraft shelters, command and control facilities, armored vehicles, and soldiers. ADA language will be used for both phases. Government image data will not be available.

AF92-165 TITLE: Optimization of 1.3, 3-Trinitroazetidine (TNAZ) Synthesis

OBJECTIVE: Optimize the production process for synthesis of TNAZ.

DESCRIPTION: TNAZ is a high density, high energy, low melting, less sensitive explosive of great promise for use in the formulation of high energy composites for Air Force warheads. The present production process of TNAZ requires five separate synthetic steps. First epichlorohydrin and t-butyl amine are combined to produce the intermediary alkyl-azetidel. The azetidol then is combined with methanesulfonyl chloride to yield the corresponding mesylate. The mesylate group is then displaced by sodium nitrate producing the mononitro salt in the third step and further nitrated to the dinitrosalt in the fourth step. In the fifth step a final nitramine is added using nitric acid. Overall yield of the process varies from 10 to 25 percent. Improvements in yields, optimization and control of reaction conditions, reduction of waste production and substitution of costly reagents are essential to develop a commercially feasible synthesis process. The Phase I effort should examine and define suitable alternatives to the present reaction pathways to increase yields especially the troublesome second step formation of the mesylate. Laboratory scale work would identify optimum reaction conditions, stoichiometry, reagents, solvents, and provide plans for waste elimination or recycling. In addition, techniques and instrumentation will be developed to enable accurate monitoring and control of all reaction processes. The goal of the effort is to achieve an overall yield of at least 60 percent, while reducing waste by products by half. The follow on Phase II effort should include conducting and demonstrating engineering scale up and production of 100 pounds of TNAZ utilizing the optimized process as identified in Phase I. Special emphasis should be placed on insuring all aspects of safety to assure thermal hazards are minimized. All processes and reaction conditions should be optimized in the scale up process.

AF92-166 TITLE: Laser Diode Initiation of Primary Explosives

OBJECTIVE: Develop a low cost laser initiation system for use with out of line explosive trains.

DESCRIPTION: Significant development work is underway to develop laser initiation systems for various types of explosives and propellants. This work, however, is concentrating on systems employing insensitive ignition mixes within the limitations of current laser diode technology. This has resulted in the use of relatively high power expensive devices. In the majority of AF fuzing systems, an explosive train interrupter is used which employs very low energy hot wire initiation. In these systems, the sensitivity of the ignition mix is not an overriding issues because detonation before arming is nonhazardous from a system standpoint. There may be significant advantages to be obtained by laser initiation of out of line explosive trains. Not the least of these include elimination of mechanical switches to electrically protect the detonator. To be of use in these types of systems, the diodes must below cost as typified by laser diodes used in commercial compact disk applications. The primary goal of this task is to develop a low cost laser mix capable of detonating when exposed to low level laser pulse. Phase I of this SBIR will involve demonstrating the capability to ignite an ignition mix with the energy from a low cost diode. Phase II of this SBIR will involve fabrication and laboratory demonstration of a laser initiated out of line explosive train and quantifying its potential performance parameters.

AF92-167 TITLE: Algorithm Development for hard Target Encounter

OBJECTIVE: Develop a concept for a generic algorithm to perform fuze function decision making for smart fuzzed hardened target munitions.

DESCRIPTION: hard target fuze algorithms in eh past have been developed with the assumption that acceleration level discrimination and integration over time are the only meaning full inputs available of fuze decision logic to determine target layer impact and distance traveled. Recent recorded accelerometer data suggest other useful information may be extracted from the accelerometer output signal. For example, additional information might be present in the form of frequency shifts at target material interfaces. Another possibility relates to momentary signals/events, such as impacting a steel section while experiencing high level deceleration in concrete. The primary goal of this program is to develop an algorithm of discriminating widely varying target types capable of determining position within the target for burst point control. The primary technical challenge is to determine what information can reasonably be expected from accelerometer data and how that information can reduced for use in a fuze algorithm. Phase I of this SBIR task will determine techniques for handling the accelerometer signal to extract all the useful information. At present, only large amplitude shifts have been shown to serve as useful inputs to the fuze algorithm. The Phase I effort twill conclude with an approach for utilizing accelerometer data to the fullest possible extent. Phase II of the SBIR takes will be a laboratory demonstration of the techniques proposed in Phase I and will include a study of target encounter information expected from the accelerometer output signal. Phase II will conclude with an acceleration signal processing algorithm to discriminate target types and determine position versus time in a known target.

AF92-168 TITLE: Explosive Initiator Modification and Modeling

OBJECTIVE: Investigate the use of dopants or other species implanted into initiator explosive/bridge materials to enhance output.

DESCRIPTION: Initiator explosive and bridge materials have undergone considerable development in an overall attempt to optimize slapper detonator performance and safety. However, the shock initiation mechanisms remain unclear from a kinetic viewpoint because the pressure induced reaction itself is poorly understood. Furthermore, the energy conversion efficiency for an exploding foil bridge is strongly dependent upon resulting flyer velocity, the measurement of which involves a rather complex procedure. If reactive species could be impacted into energetic materials in an orderly manner, subsequent measurements of explosive output might give new insight into the initiation mechanisms. On the other hand, modification of the exploding foil itself in an attempt to increase the

electrical to mechanical energy conversion efficiency may prove to be even more fruitful. Phase I of this program would include an evaluation of methods for accomplishing explosive initiator optimization validate by several preliminary tests. Phase II would explore a conceptual model in detail, focusing on the most promising dopants/species with the highest potential for enhanced performance.

AF92-169 TITLE: Inflatable Aero-Surface Technology

OBJECTIVE: Develop new techniques in inflatable aero surfaces for weapon fins and wings.

DESCRIPTION: A continuing problem in carrying weapons in conformal or internal carriage aircraft is the interference of fixed wings and or fins with aircraft structure. Many complex, mechanical, fin and wing, folding techniques have been tried to efficiently carry missiles on aircraft pylons and in bars. A new technique to solve this problem is to inflate missile wings after launch. The basic goal of the program is to identify techniques and materials suitable to allow aero surfaces to be conformally packaged along a missile's skin and then inflated by gas generators to perform normal lifting and/or controlling functions. The technical challenge is to find suitable metal or composite materials which can be inflated to form aerodynamic airfoil shapes ad which can withstand the dynamic environment inherent in an aircraft launched missile or dispenser vehicle. Phase I of this effort should concentrate on analyzing and defining inflatable wing/fin concepts, surveying potential materials, and generating preliminary designs of preferred concepts. Phase II would include final design of selected fin and wing concepts, conducting static deployment tests, win tunnel tests, structural/vibration tests, and performance of production cost estimates.

AF92-170 TITLE: Laser Doppler Velocimeter (LDV)

OBJECTIVE: Develop a self-contained optical sensor for measuring the wind velocity vector gradient over a 2.5 kilometer range.

DESCRIPTION: Current aircraft platform fire control systems use the wind velocity vector at the firing platform to predict wind effects on projectile trajectory. This approach assumes homogeneous wind between the platform and the target. Wind, however, is rarely homogeneous due to nonuniform topography prediction could be at the firing platform to predict wind effects on projectile trajectory. This approach assumes homogeneous wind between the platform and the target. Wind, however, is rarely homogenous due to nonuniform topography prediction could be significantly improved if wind velocity vectors could be determine data fixed intervals along the flight path of a projectile. The technical challenge is to develop a small device to determine wind velocity vectors over 2.5 kilometers in real time. LDV technology may also provide an innovative technique for measuring relative velocities between the platform and target for fire control and air to air fuzing. The Phase I approach will develop a laser Doppler evlocimtere design with supporting analysis showing feasibility and expected performance using available technology. Phase II will include fabrication and testing of the Phase I design to demonstrate proof of concept. Phase III will integrate the Phase II LDV system with a fire control system.

AF92-171 TITLE: Advanced Missile Safe and Arm Concepts

OBJECTIVE: Develop concepts for optimizing the performance, cost, safety, and reliability of air launched missile safe and arm mechanisms.

DESCRIPTION: Current air launched missile S&A mechanisms employ electro mechanical devices to accomplish the completion of the explosive train. Current widespread developments are underway to eliminate all moving parts by using programmable electronics and slapper or exploding foil initiators, which do not require explosive train interruption. The complications necessitated by these new development dictate that we reevaluate the in line versus out of line trade-offs for inertially armed devices. The new in line technology is currently being evaluated against existing out of line devices employing technology which is at least 40 years old. To assure that the ordnance community is not on the wrong development track, we must evolve new out of line concepts that are not constrained by the older technology. Many advances in small electrical prime movers have recently occurred to keep pace with

the demand necessitated by robotics, optics and consumer electronics. In addition, sensitive initator advanced including the SCB and laser detonators may offer potential for improving the electrical sensitivity explosive sensitivity trade off. The primary goal of this program is to evolve concepts that would increase the performance and reliability of air launched missile S&A devices while reducing cost, weight and volume. The primary technical challenge is determining what combination of technologies can optimize the conflicting requirements of missile S&As. Phase I of this SBIR will include analytical designs with a combination of technologies that appear most promising to achieve the overall goal. Phase II of this SBIR would provide laboratory demonstrations of one or more of the selected designs. As a result of this Phase II, S&A alternatives will be available for missile systems applications.

AF92-172 TITLE: High Current OHMIC Contracts for Gallium Arsenide

OBJECTIVE: Explore new types of low resistance ohmic contracts applicable to gallium arsenide.

DESCRIPTION: There is presently no reusable, testable, solid state, high voltage switch suitable for military fuzing applications. GaAs can provide the switching speed, reliability, and breakdown voltage essential for high performance detonation of exploding foil initiators that will be used in advanced fuzes. However, high current ohmic contracts for adequate electrical connection to the GaAs remains a problem. Scale-up of either high resistance ohmic or Schottky contacts does not appear feasible; development of more uniform, low resistance ohmic contacts is more likely to be a solution to the problem of carrying ten-kiloampere current pulses repeatable within a compact low inductance configuration. The Phase I effort should be a study of all applicable types of ohmic contacts and deposition techniques appropriate for GaAs. This should include a determination of the relative potential for scaling them up to handle many kiloamperes of current. Phase II should be a demonstration of the optimal types of ohmic contacts using laser activated, semiconductor quality, GaAs wafer sections. A controlled test method must be established for determining the level of current density which can be routinely handled in a pulsed mode using individual contact areas of up to 5 square millimeters.

AF92-173 TITLE: Semiconductor Bridge (SCB) Detonator

OBJECTIVE: Develop SCB detonator concepts applicable to non nuclear fuzing and safe and arm systems.

DESCRIPTION: The SCB detonator, developed by Sandida National Laboratories has shown significant improvements in narrowing the all fire/no fire band and in decreasing function action time. However, the device has not found its way into conventional weapons because of the difficulty of attaching the semiconductor chip to a conventional header and system development vs. reluctance to employ new component technology. One approach to eliminating above may evolve from tape Automated Bonding the SCB die to a strip line and assembling the device to an explosively loaded cup in the current manner of exploding Foil Initiator assembly. This may be possible because it is compatible with copper, and it is non hydroscopic, therefore not requiring hermetic sealing above can only be eliminated by demonstration of the distinct advantages of the SCB for typical, conventional, weapon systems application. These demonstrations may include fabrication and testing of configurations for igniting class 1.6 explosive directly with a minimum head height initiator; minimizing firing energy for a 1 AMP, 1 watt no fire detonator; peizo electric and inductive generator firing of the SCB; minimizing the explosive output necessary for igniting approved explosives; and quantifying shock survivability. The primary goal of this program is to develop and demonstrate a new class of initiators which will increase the electrical safety, response time and simplicity of out of line initiator systems for conventional armaments. Phase I of this SBIR will demonstrate a simple header configuration compatible with ignition and evolve concepts for weapon system applications. Phase II of this SBIR will demonstrate selected concepts by development, fabrication and function testing of completed detonators. The result of this Phase II will be a family of economical detonators which could be qualified to offer significant performance advantage over existing systems.

AF92-174 TITLE: Aliphatic Polymer Fiber Optic Pressure Sensor

OBJECTIVE: Develop an ultra rugged aliphatic polymer pressure sensor based upon he principle of refractive index pressure sensitivity.

DESCRIPTION: Military structures that incorporate thick layers of reinforced concrete cannot be destroyed simply by general purpose bombardment with weapons that explode upon impact. These hardened targets are designed and built to withstand prolonged impact bombing; therefore, penetration munitions with special fuzing for warhead burst point control are required to defeat such targets. Advanced fuzing will take advantage of weapon deceleration and internal pressure as inputs, contingent upon the development of very rugged sensors that can be interfaced with a fuze microprocessor. The sensor must exhibit no resonant frequency limitation that would impart its function below 10 kG acceleration. Pressure sensors have traditionally been diaphragmatic or unidirectional in nature, not designed to measure hydrostatic pressure distinct from acceleration in a rigorous, high G environment. It would be a significant achievement to make use of an isotropic method of pressure sensing which is more compatible with the penetrator weapon environment. Phase I of this SBIR task will involve an evaluation of the optical transmission of silicone rubber, polyethylene, or other aliphatic polymer fibers with a high degree of axial straight chain orientation. Transmission measurements should e performed both at standard atmospheric pressure and under either high static pressure or high pressure shock. If conceptually feasible, Phase II would involve adaptation of the sensing technique to measurement of high pressure shock profiles such as those experienced by a penetrator weapon during hard target encounter.

AF92-175 TITLE: Store Trajectory Analysis Technology

OBJECTIVE: Take advantage of new developments in telemetry hardware for bomb flight dynamics characterization.

DESCRIPTION: In the past there has been much effort devoted to characterizing weapon separation from aircraft. The requirement of ran accurate trajectory measurement has its foundation in two areas: establishing safety of separation and refinement of aero ballistic models to provide more accurate weapon delivery. Recent developments in small, low cost, telemetry/RF devices has opened the door for much lower cost weapon evaluation instrumentation. It is envisioned that both aircraft and captive weapons could be instrumented with multiple antennas and subminiature transmit and receive modules. Multilateration and regression techniques could then be used to process a chirped CW, or other wave form to obtain a six degree of freedom trajectory for the weapon. The processing will effectively determine the distance from each antenna on the weapon. The goal of this effort is to determine hardware, software, and test environment requirements for realizing one inch and one degree resolutions on weapon position in space. The technical challenges are to develop requirements for the transmit, receive, and antenna components, to develop processing algorithms that make optimal use of multiple CW signals, and to keep the instrumentation low cost. Phase I of this SBIR task is to conduct a study of system architecture to meet the resolution requirements and accomplish a preliminary design of both hardware and software. The design will exploit the advances in subminiature telemetry devices and surface mount technologies. Phase II of this SBIR task will fabricate breadboards to determine in the laboratory if the accuracy requirements can be reached. In addition, production cost estimates will be evaluated. Phase III is expected to yield the production design. Multiple systems will then be built and implemented for several weapon evaluation programs.

AF92-176 TITLE: Innovative Dual Mode Sensor

OBJECTIVE: Develop low weight, volume, and drag approaches for IR/RF sensor for medium range air to air missiles.

DESCRIPTION: Current approaches for configuring dual mode sensors in the Infrared and Radio Frequency bands have several system performance problems. Tip-mounted IR sensors in front of an RF Antenna result in undesirable impacts to antenna patterns and very high drag penalties for the overall missile. Side mounted or pup up IR sensors minimize impact to the RF sensor performance, but still add considerable drag and also place other restrictions on the missile control system. The technical challenge for this effort is the development of innovative approaches for

implementing a dual mode IR/RF sensor with application to seven inch diameter class medium range air to air missiles. Successful approaches would maintain missile radar and kinematic performance while not imposing significant constraints on endgame trajectories. Approaches should be affordable and read for transition to a system application in the 1995 timeframe. Phase I of this SBIR task is to develop concepts for implementing the IR/RF sensor which are compatible with medium range air to air missiles in terms of realistic physical and performance requirements. Identify key technical issues for each concept. Perform requirements analysis. Key performance factors will be demonstrated. Phase III applies results of previous phases to develop a detailed design and brass board system. Sensor performance verified through captive flight testing.

AF92-177 TITLE: Thermal Imaging System

OBJECTIVE: develop a reliable method of measuring temperature distributions on hypersonic structural components to 2000 C.

DESCRIPTION: Future, high performance, aerospace vehicles will operate in high temperature environments. In order to ensure the integrity of these vehicles, various subassemblies are testing in high temperature facilities. To assure that these components are tested to the specified environmental conditions, a reliable and accurate method of measuring the temperature distributions on the component needs to be developed. The heat source for these test components is typically the Vortek II focused light source. The Phase I effort should develop and demonstrate a concept for a thermal imaging system. In Phase II, the system will be refined, demonstrated, and calibrated in a high temperature facility.

AF92-178 TITLE: Methods for Reducing Plasma Effects on the NASP

OBJECTIVE: Reduced plasma effects on eh NASP communications system.

DESCRIPTION: Due to both thermal and impact ionization, a plasma of significant electronic density is generated in hypersonic flight. The high density of electrons interferes with, or even blocks, electronic communications. Part of the plasma comes from ionization of the ambient air, and part comes from erosion and ablation of the vehicle surface. For example, sodium silicate is commonly used to protect carbon carbon composites from oxidation. Because sodium has a very low ionization potential, it contributes heavily to the plasma density. Alternate coating materials, perhaps one which would deliver a highly electronegative molecule, are a possible means of electron suppression. In Phase I, the contractor will evaluate methods for plasma reduction and select one for demonstration in Phase II. Methods may involve alternate materials or may be independent of material properties. The contractor must be familiarly with methods of hypersonic vehicle construction and have a clear understanding of the effects of plasma on electronic communications.

AF92-179 TITLE: High Temperature Strain Sensors for NASP Material Tests

OBJECTIVE: Develop strain sensor technology for use at temperatures in the 3000 F range.

DESCRIPTION: Testing and data generation programs for metal and non metals designated of ruse on NASP will be conducted at temperatures up to and above 3000 in air. Accurate strain measurements will be required to calculate materials properties as well as to design efficient hot structures. Phase I work will demonstrate either or both of contact and non contact strain sensors in both static and dynamic testing from room temperature to at least 3000 F. Phase II work will optimize and extend the Phase I technology.

AF92-180 TITLE: Materials for High Temperature Antenna Applications

OBJECTIVE: Antenna materials for use at temperatures up to 2500 F.

DESCRIPTION: Antennas for hypersonic vehicles such as the NASP are exposed to sever environmental conditions for extended periods of time and must provide high structural and electrical performance at high temperatures. For example, an electronically steered antenna may be composed of an array of open ended waveguides. If the antenna must also be thermally insulating, the dielectric constant of the material may fall below the value necessary to provide the cutoff frequency of the waveguide. The ideal material would be porous and have ea very high dielectric constant. It would also be fibrous to survive fabrication, handling and assembly as well as its operating environment. In Phase I, the contractor will select one or more promising materials and design a test antenna. Material selection must be supported by test data covering the operating range. In Phase II, the test antenna will be built and demonstrated over a representative range of operating conditions.

AF92-181 TITLE: Ozone Enhancement

OBJECTIVE: Means to enhance atmospheric ozone levels during flight.

DESCRIPTION: The possibility exists that the X-30 may be able to reverse the damage to the atmosphere rather than cause it. Some researches have claimed that with a hydrogen/oxygen reaction, one may be able with additives, to stimulate ozone formation rather than harm ozone as with hydrocarbon exhaust products. The objective of this SBIR will be the identification of any material which would encourage the formation of ozone in the Earths atmosphere during flight tests. The initial SBIR should include a preliminary investigation of combustion on the X-30 with the aim of selecting a chemical process that would generate ozone in the anticipated X-30 flight envelope from takeoff thru orbit. The selected process will be demonstrated in the laboratory at a simulated X-30 flight condition. The second phase of the SBIR should include a laboratory demonstration of the process under the atmospheric conditions that will be encountered by the X-30 in its entire flight envelope. The demonstration shall quantify the increase in ozone generated by the combustion process using the chemical process or catalyst and compare it to the baseline, unmodified combustion process. The demonstration can be conducted in conjunction with X-30 engine testing.