# AIR FORCE

## Proposal Submission

The responsibility for the implementation and management of the Air Force SBIR program is with the Air force SBIR program manager is Mr. James R. Meeker. Inquires of a general nature or where a problem may exist requiring the AF SBIR program manager's attention should be sent to:

Department of the Air Force
HQ AFSC/DLSR (Mr. J.R. Meeker)
Andrews AFB DC 20334-5000

Under no circumstance shall a SBIR proposal be submitted to the above.

Five (5) copies of each Phase I topic proposal shall be addressed to office as designated in the following:

AF87-001 thru AF87-020
AD/PMR
Building 350, Room 428
Eglin AFB FL 32542-5000

AF87-021 thru AF87-027
AEDC/DOT
Building 1099 Mail Stop 900
Arnold AFS TN 37389-5000

AF87-028 thru AF87-036
ESD/XR-1
SBIR Program Manager
Brown Building
Hanscom AFB MA 01731-5000

AF87-037 thru AF87-065
RADC/XPX
(ATTN: Mr. B. M. Donovan)
Griffiss AFB NY 13441-5700

AF87-066 thru AF87-072
HQ AFESC/RDXP
Building 1120
Tyndall AFB FL 32403

AF87-073 thru AF87-090
HQ Aerospace Medical Division
AMD/RDO
(ATTN: Ms. B. Williams)
Brooks AFB TX 78235-5000

AF87-091 thru AF87-108
AFWAL/GLXPM
Area "B" Building 653 Room 406
Wright-Patterson AFB OH 78235-5000

AF87-109 thru AF87-123
AFWAL/GLXPF
Area “B” Building 45 Room 149
Wright-Patterson AFB OH 45433-6553

AF87-124 thru AF87-139
AFWAL/GLXPP
Program Group
Building 18A, Room A-103
Wright-Patterson AFB OH 45433-6563

AF87-140 thru AF87-157
AFWAL/GLXPA
Avionics Program Office
Building 22, Room S-110
Wright-Patterson AFB OH 45433-6543

AF87-158 thru AF87-159
ASD/AEE
Special Assistant for Program Coordination
Building 57/Bay 5
Wright-Patterson AFB OH 45433-6503

AF87-160 thru AF87-165
ASD/XRX
Director of Planning Strategy
Building 11A, Room 201
Wright-Patterson AFB OH 45433-6503

AF87-166 thru AF87-178
AFSTC/OLAB
PO Box 92960
Los Angeles AFS CA 90009-2960

AF87-179 thru AF87-180
HQ AFSTC/XN
ATTN: Lt. Steele
Building 497, Room 205
Kirtland AFB NM 87117-6008

AF87-181 thru AF87-184
AFGL/XOP
Building 1107, Room 229
Hanscom AFB MA 01731-5000

AF87-185 thru AF87-192
AFRPL/TSTR
Building 8582, Room 12
Edwards AFB CA93523-5000

AF87-193 thru AF87-200
AFWL/PRC
Building 413, Room 282
Kirtland AFB NM 87117-6008

AF87-201 thru AF87-240

BMO/MYSC
Building 523, Room 302
Norton AFB CA 92409-6468

AF87-241

AFOSR/XOT
Building 410, Room A-113
Bolling AFB
Washington DC 20332-5000

AF87-001 TITLE: Armament Research

OBJECTIVE: To develop new and innovative ideas/concepts and analysis methodologies in the area of non-nuclear munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of non-nuclear munitions and armaments. These include explosives, energy sources and conversions, bombs, submunitions, warheads, fuses, dispensers, guns, rockets, ammunition feed systems, sensors and seekers, explosives, propellants, carriage and release equipment, aerodynamic and structural technologies, tactical missile guidance and control technologies, exterior ballistics, analysis, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fusing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal self-forging fragment warheads, heavy metal shaped charges, long rod penetrators, reactive fragment warheads, and Computational Fluid Dynamics.

AF87-002 TITLE: Bomb Terminal Guidance

OBJECTIVE: To determine the characteristics and specifications of terminal seekers, their costs and applicable targets for future use with weapons equipped with low cost inertial guidance.

DESCRIPTION: The Air Force Armament Division (AD) is currently entering into a program to demonstrate low cost inertial guidance applied to unguided bombs. The accuracy on target of bombs equipped with this low cost inertial system is expected to be improved by an order of magnitude or better depending upon the launch conditions. The program is called the Inertial Guidance Technology Demonstration (IGTD).

For points targets or hard targets one still needs Precision Guided Munitions (PGMs). The accuracy of the IGTD weapon will allow the use of a small field of view, strap down terminal seeker permitting attack of a certain class of targets with very small CEPs. The seeker and associated electronics must be low cost in order to consider any future use.

AF87-003 TITLE: Microstrip Phased Array Millimeter Wave Radar Antenna

OBJECTIVE: To investigate the potential of developing a micro strip phased array millimeter wave antenna.

DESCRIPTION: The Air Force is in need of “Brilliant Weapon” radar guided missile technology for both air-to-ground and air-to-air missiles. This entails the need for radar seekers that are small, low cost, lightweight, yet have a high power output. One of the components, which can advance the state-of-the-art in radar missile guidance technology, is in the area of the antenna. By using a phased array antenna the gimbal can be eliminated, thereby saving space and weight in the missile. Additionally, elimination of the gimbal reduces the hardware needed in front of the warhead, allowing the warhead to operate against the target with less obstructions, and making a micro strip antenna reduces the weight of the antenna itself.

This program will concentrate on the design of a phased-array antenna, as well as developing micro strip techniques. It should have a +20 degrees steering capability in azimuth with a scan rate of 40 degrees per second. It should be capable of handling 100 watts of output power. The antenna should be developed for a missile which has approximately 12-15 inch diameter body shell .

AF87-004 TITLE: Monopulse Optics for Radar

OBJECTIVE: To investigate the potential of using optics to replace monopulse waveguide feed networks.

DESCRIPTION: The Air Force has a need for “Brilliant Weapon” radar guided missiles for air-to-air and air-to-ground applications. It is a major objective to make these radars more powerful, have greater target detection capability, operate in high clutter environment and yet be small and have low power requirements. This effort is to

take one aspect of the radar and attempt to microminiaturize it. When attempting to identify targets, the polarization of the return signal is invaluable. For tracking targets a radar must be able to determine the direction of the target relative to where the antenna is pointing. This can be done by several techniques. The most popular is monopulse where the angular error is obtained on the basis of a single pulse. However, the feed networks required for waveguide monopulse can be complicated, large and lossy, Using optics to miniaturize and simplify the waveguide network should reduce the losses and ease the complexity of the system.

This program shall investigate the potential of using optics to replace monopulse waveguide feed networks. A cluster of four feeds is necessary to obtain both elevation and azimuth error signals. It should be able to handle approximately 100 watts of transmit power through the sum channel. The optical monopulse system should provide high efficiency, compactness, be simple and lightweight, have low losses, provide low aperture blockage, and have excellent boresight stability independent of frequency. An additional area of interest is the separation of the polarization received signal. It should be constructed to handle millimeter wave frequencies.

AF87-005 TITLE: Real-Time Optical Fast Fourier Transform (FFT)/Computers

OBJECTIVE: To examine the capability of using real-time optical fast Fourier transform/computer for processing radar data such as that from synthetic aperture radar.

DESCRIPTION: There is a need in the Air Force for “Brilliant Weapons” radar to guide missiles in both air-to-ground and air-to-air applications. These radars must be powerful, yet small, compact, and lightweight. One aspect of the radar which can be redesigned to meet those requirements is to examine the capability of using real-time optical fast Fourier transform/computer for processing radar data such as that from synthetic aperture radar. This FFT/computer should provide high speed, high volume operation while keeping the processor small and lightweight. The signal processor should handle 20 million operations per second (MOPS) for the FFT and 50 million operations per second for image matching with a memory of 10 bits.

AF87-006 TITLE: Recrystallization of Nitroguanidine

OBJECTIVE: To investigate methods of recrystalization of standard low bulk density nitroguanidine into large cubical or spherical shaped particles suitable for use in insensitive castable formulations.

DESCRIPTION: The Air Force is interested in developing an insensitive explosive to replace the current explosive used in MK80 series general purpose bombs. Utilitizing an explosive that is less sensitive to shock and thermal stimuli will increase operational readiness by allowing more munitions to be stored in existing facilities. Nitroguanidine holds great promise as an ingredient in insensitive explosive formulations. Formulations being investigated utilize high bulk density (greater than 0.9 grams/cc) nitroguanidine and other solid ingredients with minimum amount of liquid binder to obtain a pourable mixture. Due to high solids content (84%-86%), the relative sizes and shapes of the solid particles and critical in obtaining a pourable mixture. Current facilities produce high bulk density nitroguanidine crystalic that are small (les than 100 micron) and needle shaped. This type of nitroguanidine is unsuitable solids insensitive for use in high-particles that have an average particle diameter of 400-600 microns are needed for use in insensitive castable formulations.

The program will concentrate on continuous methods that are feasible for scale-up to production requirements (about 10 million pounds per year).

AF87-007 TITLE: Correlation of Small Scale Tests for Explosive Sensitivity and Performance to the Full Scale Munition

OBJECTIVE: To develop better small scale correlation of explosive sensitivity and performance tests to eliminate costly large scale testing.

DESCRIPTION: The current process of developing a new explosive formulation involves many small scale screening tests which do not translate or correlate to the all up full scale munition. This could be due to mass, confinement and critical diameter. Improved methodology is needed in small scale testing to improve correlation with large scale testing and screening capability.

AF87-008 TITLE: Concepts for Advanced Weapon Suspension Devices

OBJECTIVE: The objective of this program is to develop advanced weapon suspension devices that do not protrude into the airstreams after the weapons have been released fro the aircraft.

DESCRIPTION: Weapons are currently attached to aircraft with suspension devices. There are two general categories of these suspension devices, bomb lugs and missile hangers. Both are attached to and extend from the surface of the weapon to the aircraft. When the weapon is released from the aircraft, the free flight. Your advanced standoff weapons and missiles, this degradation in unacceptable.

Contractor developed advanced weapon suspension devices should not protrude into the airstreams after the weapons have been released from the aircraft and these devices should be compatible with or readily adaptable for use with existing bomb racks and missile launchers.

AF87-009 TITLE: Precision Tracking Platform for Portable Time, Space, Position Information (TSPI)

OBJECTIVE: To develop a highly portable radar tracker capability which utilities Global Position System (GPS) capabilities, celestial navigation, or any other physical phenomena to make real-time platform data corrections.

DESCRIPTION: With the increased sophistication of guided weapon systems under development, requirements to crack these weapons at lower altitudes and with better accuracies are exceeding the capabilities of our fixed based precision trackers. Most precision tracking systems are fixed based radar systems with coverage over specific ranges and above specified altitudes. A need exists to develop a technique by which a portable, medium precision tracking system can be used to provide high precision data in range and angles. With the ability to locate the radar system close to the coverage zone, the radar system will not require high transmitted power or contain a highly accurate angle tracking system. With current electronics and additional inputs such as Global Position System (GPS) and celestial navigation, a system could be designed to provide real-time correction to the tracking platform data for increased accuracy.

AF87-010 TITLE: Lightweight Composite Gun Barrels

OBJECTIVE: The objective of this program is to identify and analyze possible composite materials for application to aircraft gun barrels and to design, fabricate, and test a lightweight composite gun tube.

DESCRIPTION: Advancements in materials have extended their possible application to modern rapid fire aircraft guns. Of particular interest is the development of a lightweight composite gun barrel that will withstand the internal ballistic cycle of 20-30mm aircraft guns. Rapid fire weapons produce temperatures in the 1600F-1800F range and pressures up to 70,000 PSI during a single shot cycle less than 5 milliseconds in duration. Larger bore, lower pressure rocket launchers and 105mm composite gun tubes have been developed and successfully produced. Smaller bore composite gun tubes have been demonstrated but not successfully produced. Smaller bore composite gun tubes have been demonstrated but not successfully tested at operational temperatures and pressures. Thirty millimeter gun tubes made by wrapping a steel liner with wire reinforced composite have been fabricated. The next step in advancing the state-of-the-art in aircraft gun tubes is an all composite, lightweight (i.e., approximately half of the current production weight) tube, capable of withstanding the operational environment.

AF87-011 TITLE: Portable High Explosive Pressure Transducer Calibration

OBJECTIVE: The objective of this program will be to investigate mechanical, hydraulic, or pneumatic devices capable of generating pressure pulses up to 200 psi with rise times of less than 25 microseconds, with an accuracy of one percent or less.

DESCRIPTION: The measurement of tree air high explosive pressure waves is an important part of the development of new non-nuclear weaponry. The calibration of a high explosive pressure transducer is the key to accurate data and presently is a major weak link in the measurement of high explosive phenomena. The present calibration procedure is to use various means of quick opening valves, drop ball devices and vibration type calibrators. All simulated high explosive pressure pulse.

This program shall investigate mechanical, hydraulic, or pneumatic devices capable of generating pressure pulses up to 200 psi with rise times of less than 25 microseconds, with an accuracy of one percent or less. The pressure pulse generator must be portable, with a minimum of ancillary equipment and must be designed for a one or two-man operation.

AF87-012 TITLE: Development of Explosive Technology for Preferred Path of Detonability Warheads

OBJECTIVE: The objective of this effort is to determine the feasibility of and techniques for locally altering the sensitivity of the parent explosive of a warhead.

DESCRIPTION: Current and developmental non-unitary and directional warheads require complex and costly multipoint initiation systems such as explosive hydra networks to produce plane wave detonation systems typically require the inclusion of non-reactive inert materials and a variety of explosive types to accomplish the desired or preferred path of detonation through the warhead fill. By removing the need for non-reactive materials and simplifying the initiation system to a single point system these warheads could be made more efficient and less costly with identical effects on fusing system cost and complexity.

This effort shall determine the feasibility of and techniques for locally altering the sensitivity of the parent explosive of a warhead, including Insensitive High Explosive (IHE), along specific paths from a single initiation point such that detonation fronts are propagated along these paths to the desired main full detonation sites without initiating the main fill in the process. A direct analog is the doping and alteration of the electrical characteristics of silicon substrates for integrated circuits. Alteration of the parent explosive by implanting analogs to those for integrated circuits (Ics) will be explored as well as more obvious mechanical techniques wherein the preferred paths are molded or machined into the parent explosive and then filled with a suitably modified form of the parent explosive.

AF87-013 TITLE: New High Energy Storage devices for Inline and Electronic Fuses

OBJECTIVE: The objective of this effort is to identify and investigate non-capacitive technologies for storage of electrical energy in Air Force fuses.

DESCRIPTION: Current inventory and development electronic fuses use electrical energy from environmental devices such as ram air turbine generators. In some cases the electrical energy is provided to the fuse via an umbilical to the aircraft during the initial motion following release. In all cases the electrical energy must be stored after generation for use by logic circuits and safe, arm and fire mechanisms. Typically the energy is stored in a capacitor of some description or in an inductor then drawn off the fuse mechanism to operate its circuits. When the target is detected, energy is used to initiate the explosive train by setting off an electrical detonator. With the advent of more and more complex fuses, which require the stored energy to last for long flight times or to survive severe impacts or power high drain electronic devices, the demands placed on current capacitor technology have exceeded its capabilities. Generation of sufficient electrical energy for fusing requirements is not a problem, but storing that energy at a sufficiently high density, in a small enough volume and with high enough efficiency of extraction is a notable problem. Efforts to advance the state-of-the-art for capacitive devices are already underway. The intent of this effort is to explore alternatives to capacities for storage of electrical energy in fuses.

This effort shall identify and investigate non-capacitive technologies for storage of electrical energy in Air Force fuses. Critical factors are: 1) small size, 2) high energy density, 3) high (1500 volts) and low voltage capabilities, 4) impact survivability, 5) maximum discharge rates compatible with slapper detonator technology, 6) high energy capacity (several joules), required to advance these technologies shall be assessed.

AF87-014 TITLE: Low Cost Recyclable High Voltage Switch

OBJECTIVE: The objective of this effort is to investigate recyclable low cost switching techniques.

DESCRIPTION: In-line fuse firing systems under development by the AIR Force utilize a solid dielectric explosively activated switch as the primary candidate for slapper detonator triggering. This technology has been explored extensively and has proven advantages for many weapon applications. However, an alternative approach is desired especially for applications where high shock survivability is not required. The explosive switch is not recyclable, limiting the testability/reliability of the total fusing system. It is highly desirable to eliminate such explosive components housed with testable components (electronics, etc.). The explosive switch is the only component that now prevents the development of a totally testable fuse electronic subsystem.

This effort shall investigate recycable low cost switching techniques. The switch must have a short function delay (100 nanoseconds or less) for a 2000 volt firing system voltage. It is highly desirable to eliminate such explosive components housed with testable components (electronics, etc.). The explosive switch is the only component that now prevents the development of a totally testable fuze electronic subsystem.

This effort shall investigate recyclable low cost switching techniques. The switch must have a short function delay (100 nanoseconds or less) for a 2000 volt firing system voltage. It is preferred that the switch be capable of manufacture using semiconductor micromachining technology.

AF87-015 TITLE: Conversion of Stored Chemical Energy to ElectroMagnetic Energy

OBJECTIVE: The objective of this program will be to investigate concepts of converting chemical energy into electromagnetic energy.

DESCRIPTION: Because of current trends of targets of interest, there is a need for unique and innovative methods of energy partitioning and enhancement of target coupling techniques. Maximizing the efficiency in the conversion of chemical energy into various forms of electromagnetic energy is of interest.

AF87-016 TITLE: Non-acceleration Techniques for Determining Rigid Body Motion of Penetrating Weapons in High Shock Environments

OBJECTIVE: The objective or this effort is to develop and evaluate at least one new device for measuring the rigid body motion of penetrating weapons in real time.

DESCRIPTION: Current Air Force development efforts for “smart” fuses for penetrating weapons rely upon electronic accelerometers using piezo effects to gather real-time data on the rigid body motion of penetrating weapons for burst point control. These accelerometers, be they normal instrument type or solid state, have operating features which severely complicate the processing of data by fuse logic to determine distance, velocity and acceleration changes in the weapon caused by target features. Severe difficulties arise when trying to discriminate between the actual low frequency rigid body accelerations which are reflective of projectile motion within the target and the higher frequency body responses indicative of body ringing caused by short shock pulses of high amplitude. Added to this problem is the difficulty in identifying and rejecting or accounting for apparent motion data caused by the elastic/plastic responses of the penetrator such as bending and the off-axis components of motion resulting from unpredicted angles of attack, etc. A new device capable of providing real-time motion data to a “smart” fuse under conditions of high shock is needed. This effort shall find or develop and evaluate at least one new device for

measuring the rigid body motion of penetrating weapons in real time. Potential viable technologies will be identified and the effort required to advance them to practice will be determined.

AF87-017 TITLE: Advanced Radiographic Techniques and Applications

OBJECTIVE: This effort is to advance in the area of radiography as an analytical tool.

DESCRIPTION: This requirement is for advances in the area of radiographic instrumentation for diagnosis of high explosive dynamics and terminal effects of high velocity projectiles. Specific topics of interest include multiple pulsed flash x-ray sources; large format, high resolution x-ray imaging detectors; high resolution, small aperture sources; multispectral radiographic sources; and tomographic signal processing for flash radiography. Also of interest is radiographic electronic data reduction for density, volumetric measurement, velocity, fragment size, frame-to-frame correlation and other image reduction techniques.

This effort is to improve the productivity of advanced development and test programs, to provide time resolved multiple exposure images of terminal/in bore hypervelocity projectiles, automate and standardize reduction of radiographic imagery and to advance the utility of radiography as an analytical tool.

AF87-018 TITLE: Feasublity Study of Pre-Impact Target mapping for Air Force Penetrating Weapons

OBJECTIVE: The objective of this effort is to study the feasibility of providing the current and planned Air Force hard target weapons with a pre-impact target mapping capability.

DESCRIPTION: Current Air Force weapon development programs include the development of penetrating weapons capable of defeating hardened underground structures and facilities. The capability of physically penetrating a given target has been achieved as well as a degree of post impact burst point control by monitoring the rigid body motion of the penetrator in real time. In spite of these achievements the effectiveness of the weapons is limited by the degree to which the impact parameters can be controlled and the extent of pre-encounter target knowledge. The effect of target variability on weapon effectiveness is substantial in that the post impact path of the weapon can become unpredictable (making current burst point control mechanisms useless), and the placement of critical components within a complex target is easily varied. A method for determining the position and structural detail of the target immediately prior to impact is required. Given this real-time intelligence the existing burst-point control mechanisms can be enhanced to provide an optimized burst point irrespective of target variability. This effort shall carry out a study wherein the feasibility of providing the current and planned Air Force hard target weapons with a pre-impact target mapping capability is determined. Millimeter wave technology holds some promise of providing this capability but may not be the only avenue to purse. This effort will determine the feasibility of pre-impact target mapping and identify the technologies requiring further development to achieve this goal.

AF87-019 TITLE: Application of Artificial Intelligence to Target Vulnerability Assessments

OBJECTIVE: The objective of this effort is to develop Artificial Intelligence techniques for target vulnerability assessment methodologies.

DESCRIPTION: The assessment of the vulnerability of targets to conventional weapon kill mechanisms has evolved over three years to an empirical science. Major methodology development efforts have been directed toward developing analytical tools and techniques for predicting the target component damage resulting from the kill mechanism/target component interaction. These efforts have resulted in several models, one of which is the Pointburst Damage Assessment Method (PDAM), used largely in the vulnerability assessment of armor targets. These analytical models and algorithms, used to estimate vulnerability, rely on an experimental database to make realistic estimates of actual damage achieved. Frequently, there is a data base deficiency from which to make vulnerability assessments; thus the vulnerability analyst is asked to use expert opinion in employing the methods of assessments. Artificial Intelligence (AI) advancements have resulted in capabilities to substantiate machine

intelligence for human decision-making. There appear to be applications of AI to vulnerability methodology that may improve assessments.

This effort shall developed Artificial Intelligence techniques for target vulnerability assessment methodologies. Specific comparisons of these new techniques to existing methods are required. As the results of this effort will be used by vulnerability analysts, emphasis must be placed on clear communications. Reliance on Artificial Intelligence jargon should be minimized.

AF87-020 TITLE: Variable Configuration E/O Simulator Development

OBJECTIVE: This effort would define concepts and fabricate prototypes of modular simulators which could be used for the performance testing of optical threats in the 532 Nanometer to 14 micrometer region.

DESCRIPTION: Research and development is required for variable cross section electro-optical simulators to provide an analytical resource for the testing of various electro-optical threat/countermeasures systems. This effort would define concepts and fabricate prototypes of modular simulator which can be used for the performance testing of optical threats in the 532 Nanometer to 14 micrometer region. Parameters to be simulated include entrance aperture, number of reflecting or transmissive components, exit pupil, focal length and number of focal planes. Parameters to be measured include spectral power density, pulse duration, interpulse period, wave front distortion and percent of time on target. The simulator will also be utilized to present a typical threat system cross section to a countermeasure system under test. This effort will also define operational techniques for effective use of the simulator including remote operation, and pointing at and tracking of the threat source.

AF87-021 TITLE: Cryogenic radiation Monitoring Microscope

OBJECTIVE: Develop a cryogenic radiation monitoring microscope as a diagnostic instrument to evaluate cryogenic arrays when they are produced.

DESCRIPTION: The demand for a cold background, IR scene generator has led to several developmental programs to produce cryogenic arrays which have elements which can be selectively heated. A cryogenic radiation monitoring microscope is needed as a diagnostic instrument to evaluate these arrays when they are produced. The microscope would have to operate at cyrogenic temperatures and under vacuum conditions in order to reduce its own radiation loads. It would require all reflective optics to cover the wavelength range from 1-25 micrometer and would need a mechanism to remotely select bandpass filters. The system would have a scanning capability over the surface in 0.1 mil steps.

The detector in the instrument should have sufficient sensitivity throughout the wavelengths of interest to detect features ranging in temperature from 1500K to 20.

AF87-022 Title: Dynamic Pressure Response Calibrator

OBJECTIVE: Develop an improved dynamic pressure calibrator.

DESCRIPTION: Dynamic pressure measurements, made in support of turbine engine and rocket propulsion testing, require use of complex transducer/tubing configurations. Analytical estimates of system frequency response need to be verified experimentally. Current devices for determining the frequency response characteristics are often limited in amplitude range, bandwidth, etc. An improved dynamic pressure calibrator is needed. The operating frequency range should be 2 to 500 Hz with the output amplitude flat within +0.5 dB over this range. Absolute amplitude accuracy is of secondary importance but should be within +1dB. The output level should be selectable from 1 x 103 to 1 psi rms, The output waveform options to include sinewave and random is highly desirable. External volumes up to 10in and tubing diameters up to ¼ “ ID must be accommodated. Means for measuring the generated pressure levels and signal phase during operations must be included.

AF87-023 TITLE: Real-Time Flow Vector Measurement

OBJECTIVE: Develop instrumentation to measure and display in near-real-time the local three-dimensional airflow velocity vectors at a plane approximately 6 to 36 inches upstream of full-scale aircraft propulsion system inlets.

DESCRIPTION: The output signals must be unable as inputs to a closed-loop automatic control system for the vector magnitude and direction. A primary requirement is that the sensor(s) produce minimal disturbance or interference to the flow field entering the inlet. Small sensors (1-in maximum dimension) or non-intrusive (remote) sensors are required. Instruments currently used for similar measurements include combination total-and-static pressure probes for air speed and cone or hemisphere probes for flow angles. A flying cruciform with an integral force balance has been used based on the lift coefficients generated by the cruciform elements as functions of angle and Mach number. The instruments should operate over the Mach number range of 0.3 to 0.9 at static pressure of 0.5 to 14.7 psia, and total temperatures of –120 to 200 deg F. Flow angle range is from 60 deg below horizontal to 20 deg above horizontal in the vertical plane and +15 about the axial direction in the horizontal plane. Frequency response must be sufficient to display vectors at rates of change of Mach number up to +0.1 per sec, and flow angles changing at 0 to 10 deg/sec. Required accuracies are +0.02 Mach number and +1.0 deg during transient operation. Continuous operation up to 12 hours without servicing is required.

AF87-024 TITLE: Composite Materials Tester

OBJECTIVE: Develop a concept for a composite materials tester.

DESCRIPTION: Composite materials (mainly graphitic) are tested in the Aeroballistic Ranges at the Arnold Engineering Development Center. To design successfully the models used, the strength properties of these materials should be known, preferably under dynamic conditions. A concept for a composite materials tester is needed, leading to the building of such a device for use at AEDC.

It should have the following capabilities:

(a) Determine ultimate tensile strength in each of three orthogonal axes.

(b) The corresponding stress-strain curves.

(c) Perform tests at strain rates up to 104 in./in./min.

(d) Perform similar range of test for cross axis shear strengths.

(e) Require use of minimum material to obtain strengths.

(f) Not introduce off axis loads during testing.

The materials to be tested are in short supply, variable in properties, have low strains to failure and are not isotopic.

AF87-025 TITLE: Ballistic Range/Track Alignment Diagnostics

OBJECTIVE: Develop an expedient and inexpensive technique to conveniently check the alignment of the track assembly which includes a 1000-ft-long guidance track (four surrounding guide rails), and a 500-ft-long recovery tube housed in the AEDC Hypervelocity Range/Track G facility.

DESCRIPTION: Preliminary engineering analysis indicates the feasibility of using a reusable telemetry/on board recording package containing accelerometers and/or displacement sensors and an appropriate rechargeable power source to satisfy this requirement. The sensor package must fit within an AEDC-supplied projectile. This will require the dimensions of the sensor package to be no more than 2 inches in diameter and less than 18 inches in length. Design of the projectile and encapsulation of the package into the projectile will be done by AEDC. This

diagnostics package must be capable of withstanding launch accelerations of 10,000 g's axially and 5000 g's radically. Recording/transmission of information must begin upon launch and must continue for at least 2 seconds. A data sample rate of approximately 10 kHz required.

AF87-026 TITLE: Pulse Digital Conversion System

OBJECTIVE: Develop an instrument which provides a one-step conversion process directly from pulse rate to digital.

DESCRIPTION: Turbine flowmeters and tachmeters are commonly used for measurement of fluid flows and rotor speeds during engine and rocket propulsion testing. These devices produce pulse outputs proportional to flow rate or speed. Typically, two signal conversions (pulse to analog then analog to digital) are required prior to recording the outputs on digital recorders. The conversions to and from analog are undesirable and introduce additional measurement errors. An instrument is needed which provides a one-step conversion process directly from pulse rate to digital. The pulse rates vary from 2 to 5000 Hz with each channel required to operate over 200 to 1 range. The recorder data acquisition rate will be from 1 to 200 readings/second (16 bit words). The system should not require control signals from the data recorder other than simple read commands. The frequency response should be 10 Hz or greater, with accuracy and resolution at all pulse and data acquisition rates .01 percent or better. System packaging should permit use of up t0 30 data channels simultaneously. The wide frequency operating range and data acquisition rates preclude the use of simple digital pulse rate or period measuring counters.

AF87-027 TITLE: Protective Duct Coating

OBJECTIVE: Develop a coating for ferrous metal which can be subjected to temperature extremes from 120F to 600F in a moisture-laden atmosphere.

DESCRIPTION: AEDC experience many problems related to rust and other foreign debris being ingested by test engines or impacting test models. The predominate source of this problem is ferrous metal ducting interior surfaces which are constantly subjected to high air mass flows at extreme temperature ranges. Various coatings have been applied to the surfaces in the past with limited success. A coating which can be subjected to temperature extremes from 120F to 600F in a moisture laden atmosphere is required. In-house studies and conversions with coating manufacturers have indicated that a coating which will meet all the criteria is not presently available.

AF87-028 TITLE: Quality Assurance of Surface Mounted Printed Circuit Board Assembly Soldier Joints

OBJECTIVE: To develop methods for an overall solder joint quality assurance system.

DESCRIPTION: Surface mounted components have many advantages in production and design (higher component density, lower assembly costs, improved production control) for military electronics. Within five years, surface mounted designs are expected to surpass conventional through-hole designs in volume. The main drawback of surface mounted PCB assembly is difficulty inspecting solder joints, especially those covered by leadless components. Some new techniques for surface joint inspection have become available recently using x-rays and pulsed lasers. Pure inspection techniques, however, provide only after-the-overall solder joint quality assurance system are desired. Integrated concepts techniques will be developed and demonstrated.

AF87-029 TITLE: Electronic Equipment Shelters

OBJECTIVE: Develop design concepts for electronic equipment shelters using advanced materials.

DESCRIPTION: Present shelters for electronic equipment are built using foam-and-beam panels with metal skins, or aluminum or paper honey comb materials. Materials limit configuration choices because of size and weight limitations vehicles which transport them. Delamination of materials remains a problem. Develop design concepts

for electronic equipment shelters. Investigate possible advantages of developing or using metal-composite or composite materials for shelters. Use non-isotropic strength properties to suit the stress distribution in composite materials. Conductivity and bonding requirements must be addressed. Provide a detailed evaluation of using new composite and fiber reinforcement materials.

AF87-030 TITLE: Phased Array Antenna Elements

OBJECTIVE: Develop a wideband phased array antenna element for use on airborne surveillance platforms.

DESCRIPTION: Develop a wideband phased array antenna element for use on airborne surveillance platforms. The element must be small, lightweight, efficient, and easily producible. The radar will be a dual frequency surveillance/tracking system optimized for the detection of low radar cross section targets. Array elements should be sized for UHF to L band surveillance frequency and an L band or higher tracking frequency. Possible applications include either conformal or planar phased arrays. Effort should include design, fabrication, and test of a single element, and a brief study of the element's producibility and it's utility for use in an airborne phased array.

AF87-031 TITLE: Reduced Cost Transmit/Receive Modules

OBJECTIVE: Develop methods to lower the cost of packaging single chip and multiple chip microwave monolithic integrated circuits (MMIC) transmit/receive modules.

DESCRIPTION: Transmit/receive modules are a major cost in building phased array radar surveillance systems. Any significant reduction in the cost of these modules will result in a dramatic reduction is system cost. The primary area of interest is for UHF or L band modules to be used in future airborne surveillance systems. Task objective is development of innovative methods to lower the cost of packaging single chip and multiple chip microwave monolithic integrated circuits (MMIC) transmit/receive modules. Any study should include a study of the impacts on reliability, maintainability, and life cycle cost. The impact on size, weight, and power dissipation should be addressed. The task may be completely conceptual in nature, or may include the development of detailed plans or hardware.

AF87-032 TITLE: Automated Air Traffic Control System Concepts

OBJECTIVE: Develop new concepts for safe movement of aircraft using passive identification methods and data link interchanges.

DESCRIPTION: Future Air Traffic Control (ATC) systems will need new concepts for the safe movement of aircraft. Systems using passive identification methods and data link interchanges are possibilities. Current systems use high powered emitters (e.g. radar) for identification and active UHF/VHFradio for communication requirements. Additionally, navigation equipment does not afford a common grid reference nor does it lend itself to long range relative accuracy. The future system must allow for information distribution and processing flexibility and be precise enough for safe ATC operations. Potentially applicable technologies for possible interface and/or merger would be the Inertial Navigation Systems, NAVSTAR GPS, Joint Tactical Informational Distribution System (JTIDS), and other related ongoing programs.

AF87-033 TITLE: Airspace Management

OBJECTIVE: To develop a roadmap for dealing with and incorporating a military air traffic control management system in conjunction with the FAA.

DESCRIPTION: The Federal Aviation Administration (FAA) has outlined their National Airspace Systems (NAS) Plan which previews how they will perform air traffic control (ATC) in the future. This Air Force has an interest in this FAA system upgrade due to the potential effect it will have on the military mission requirements. There are a

number of issues within the NAS Plan that may positively or adversely affect military ATC and flying mission responsibilities. There is a need to identify key issues in the NAS Plan as they relate to current and future military requirements. There is also a need to develop a potential roadmap for dealing with and incorporating a military management system in conjunction with the FAA

AF87-034 TITLE: Meteor Burst Communications (MBC) Throughout Improvement

OBJECTIVE: Provide a user handbook or computer models which can relate MBC system parameters to guide optimal sitting and operation of MBC systems for reliable throughout.

DESCRIPTION: Military and non-military use of meteor burst communications(MBC) has increased recently. MBC systems operate in the 40 MHz frequency range and use take-off signal elevation angles between 5 and 30 degrees depending on the transmitter/receiver geometries. The received signal is perturbed by the nature of the path which includes irregular terrain, vegetation, ground installations and troposheric ducting. Ways are needed to achieve a reliable system throughput through: modeling of transmission path effects on received signal perturbation; use of adaptable antenna patterns to exploit atmospheric ducting; or other methods. Provide a user handbook or computer models which can relate MBC system parameters to guide optimal siting and operation of MBC systems for reliable throughput.

AF87-035 TITLE: Discrimination of Arctic Radar Clutter Returns

OBJECTIVE: Devise radar signal processing algorithms to compensate for arctic radar clutter effects

DESCRIPTION: SEEK IGLOO and North Star warning radars have observed strong radar clutter Returns. Investigate the origin of the clutter returns to migration, atmospheric anomalies, etc. Estimate the relative effect of these processing algorithms to compensate for these clutter effects.

AF87-036 TITLE: Command, Control, and Communications Systems/Subsystems

OBJECTIVE: To develop new concepts and innovations for Command, Control, and Communications Systems/Subsystems

DESCRIPTION: This category of innovative concepts is intended to cover all facets of Command, Control and Communications (C3) System and Subsystem research, development and procurement. The innovator is given latitude to include areas not specifically addressed by other specific C3 topics. This general area covers the full spectrum of AF C3 Missions including: Strategic C3; General Purpose Forces C3; Ballistic Missile Tactical Warning/Attack Assessment; Atmospheric Surveillance and Warning: World Wide C2; Air Traffic Control; and all communications technologies. Emphasis is placed on potential long term planning concepts. Topics as diverse as weapons and improved operating concepts techniques, and technologies may be submitted. Some other areas of interest include: advanced communication networks, database, management systems, information processing technologies, multilevel secure communications, onboard satellite data processing systems, advanced HF/VHF/UHF/SHF/EHF communications systems, applications of artificial intelligence, innovative RD organizational concepts, air surveillance systems concepts and technologies, signal processing, etc. This topic is instructed to provide a maximum of innovative flexibility to prospective participants.

AF87-037 TITLE: Simulation of Bistatic Target Detection in Clutter

OBJECTIVE: To develop computer software to stimulate a bistatic radar system.

DESCRIPTION: The use of bistatic radar systems to detect targets against high clutter background has had little study. There is a paucity of information on which to construct such systems. The percent effort would entail the development of computer software to simulate a bistatic radar system. For reference, a similar monostatic simulation

was reported in RADC-TR-86-3. The simulation would include waveform generation, transmission, reflection of the radar signal from targets and discrete and distributed clutter, bistatic reception, processing of the received signal, and detection of any targets. The transmitter is airborne and the passive receiver is either airborne or ground-based. The clutter may consist of rain, chaff and/or ground reflections; amplitude statistics may be Rayleigh, log-normal or Weibull distributed. The radar simulation should include flexible location schemes for a number of targets at arbitrary positions. The output would be the probabilities of detection of each target, for constant false alarm rates (CFAR processing). The initial phase would develop the simulation flowchart and the analytical formalism of the individual component subroutines (clutter, CFAR, signal transmission, system, and generate representative cases.

AF87-038 TITLE: Time-Domain Measurements in the Near Field

OBJECTIVE: To perform a research program to investigate theory, experimental techniques, and computations in the area of near-field measurements in the time domain.

DESCRIPTION: The measurement of the complete bistatic radar cross section (RCS) of a general scattered over a broad frequency range is so time consuming on conventional radar measurement ranges that broadband, bistatic data is virtually non-existent. However, near-field cw measurements have been developed in recent years that supply complete, Complex radiation patterns with a single scan of the antenna or scatterer. Moreover, it is conceivable that base band time-domain measurements could also be done in the near-field at relatively low power. Such near field time domain measurements would enable (with a single scan) the determination of bistatic radar cross section over a wide frequency band. We, therefore, recommend an innovative research program to investigate theory, experimental techniques, and computations in the area of near-field measurements in the time domain, the technique would first be developed and applied to pulsed antennas. Specifically, the contractor would be expected to extend to the time domain the existing near-field formulation for measuring antennas at a single frequency. The time-dependent far-field of a pulsed test antenna would then be determined from time-domain measurements taken in the near-field of the antenna. By means of the near field time-domain formulation, cw far-field patterns of the test antenna would be computed over an appreciable bandwidth of frequencies. The computed cw far-field patterns would be compared with the corresponding far-field patterns would be compared with the corresponding far-field patterns obtained from conventional cw measurements at a few test frequencies. Finally, the technique would be applied to simple scatterers illuminated by a pulsed electromagnetic wave.

AF87-039 TITLE: Reduction of Scattering from Reflector Antennas With Tapered Feed Illuminations

OBJECTIVE: To develop reliable, low cost, easy-to-implement techniques for reducing unwanted radiation –mode scattering to levels that will allow their use on low section platforms.

DESCRIPTION: The radiation mode scattering from uniformity illuminated reflector antennas can be eliminated by terminating the feed with a conjugately matched load. However, for reflector antennas with tapered feed illuminations the radiation mode scattering remains high even under ideal load conditions. Moreover this strong radar return is not being addressed by present efforts to reduce antenna radar cross section. Reliable, low cost, easy-to-implement techniques, suitable for retrofitting existing antennas, are needed for reducing this unwanted radiation-mode scattering to levels that will allow their on low cross section platforms.

AF87-040 TITLE: Demonstration of a Dispersed, Highly Thinned, Phased Array Radar

OBJECTIVE: To design an experiment that can be used as a proof-of-concept for dispersed, highly thinned Phased Array Radar.

DESCRIPTION: Airborne and space-based microwave sensors of the future could be dispersed and highly thinned for a variety of reasons – to maximize the use of all available surfaces on an aircraft and to increase survivability. The economics of deploying such sensors strongly suggest the use of a controlled ground based experiment in order to demonstrate the underlying principles behind a dispersed, highly thinned phased array. Thus, the object of Phase I of this effort will be to design an experiment that can be used as a proof-of-concept. The design shall be to the

subsystem level and give evidence of addressing the following technical issues surrounding a system with the following characteristics: (a) self-organizing , (b) reconfigurable, (c) self cohering on clutter or signals of opportunity, (d) self registration, (e) beam forming on transmit and receive, (f) communication among sub-elements of the dispersed system, (g) self surveying, (h) self diagnosing and healing.

AF87-041 TITLE: Near-Field Scanning

OBJECTIVE: To establish the validity of near-field scanning on an external sphere as a practical and economical technique for measuring very large antennas, and prepare a preliminary functional design for such a range that would be suitable for measuring large antennas.

DESCRIPTION: Development of the concept requires several investigations. First, the theory of scanning on an external sphere must be rigorously formulated. Then suitable sampling intervals and efficient far-field computation methods must be determined. The supporting measurement system must be designed to match the special requirements of the method. The effects of dynamic range, bandwidth, phase and amplitude measurement errors, probe position error, must be established. Finally, a simple laboratory experiment that demonstrates key issues should be designed and carried out to test the method. Some task examples are: Develop expressions for the mechanical motion of the probe (Foucault Pendulum): develop data sampling roles and computer computation methods for accurate and efficient determination of antenna far fields from measured near-field data, prepare a preliminary functional design for a near-field range that could accommodate X-band antennas up to 20 meters in diameter.

AF87-042 TITLE: Dynamic Matching Techniques for Monolithic Microwave Integrated Circuit (MMIC) Modules

OBJECTIVE: To develop a replacement for the circulator between the transmit/receive module and the radiating element in microwave radars.

DESCRIPTION: Monolithic Microwave Integrated Circuit (MMIC) modules are currently under development for active aperture phased array surveillance radar antenna systems. The motivation is to reduce the size, complexity, and cost of phased arrays for space, airborne , and ground applications. A large change in element input impedance occurs when the array is canned. To isolate the module from this change, a ferrite circulator is inserted between the module and the antenna element. The insertion of the circulator is in direct conflict with the concept of MMIC technology and increases the module cost because it requires the introduction of circuit elements as a separate step in the production process. Therefore, research is desired to investigate techniques that: a) compensate for the scan-dependent impedance by introducing stub toners, b) diode controlled shorting pins in the element, or c) additional transmission lines from the element to ground. The technique will focus on printed circuit arrays and circuit elements that already exist or are compatible with MMIC technology.

AF87-043 TITLE: High Dynamic Range External Modulator

OBJECTIVE: To develop a narrow line width stabilized laser with a high electronic dynamic range external modulator operating at 1.3 micrometers with a single mode optical fiber, optical detector and high dynamic range/electronic output.

DESCRIPTION: Electronic based systems will evolve toward hybrid electro-optic or all optical systems. Introduction of optical fiber to replace copper cable has been well established. There is also strong potential for single mode optical finer to replace conventional waveguide. Advantages are obvious: large bandwidth, low dispersion, small size/weight, low attenuation; however, replacement with single mode optical fiber involves replacing a passive waveguide with an active optical system. Thus parameters not heretofore addressed must be considered, e.g. phase noise, non linearity, dynamic range. These parameters must be well controlled to assure “transparency” to the signal. It is necessary to develop high dynamic range lasers or external stabilized laser with a high electronic dynamic range external modulator operating at 1.3 micrometers with a single mode optical fiber,

optical detector and high dynamic range from 1 microvolt with nonlinear distortions better than 60 dB and operating at radio frequency inputs up to 60 GHz.

AF87-044 TITLE: Wideband Active Array Control Components

OBJECTIVE: To develop low cost hardware integration of the active electronic functions required at the sub array and concepts for low-cost phase shifters and time delay steering of phased arrays up to 60 GHz.

DESCRIPTION: Large distributed array antennas for Electronics Surveillance Measures (ESM), surveillance and communications will require intelligent active electronics at the sub array or element level. Coherence, timing, control and information signals will be distributed to the sub array electronics by lightweight, wideband optical or millimeter wave communication operating through space or fibers. Novel approaches are required for the low cost sub array. These functions are: multi-plexing/demultiplexing information on communications links, integrated sensors to determine sub array position, orientation and electronic functioning signal generation, control (phase shifting, time delay), isolation, radiation and processing and electronically controlled reconfiguration of sub array electronics to survive failure or damage.

Novel ideas are sought for low-cost phase shifters and for time-delay steering of phased arrays up to 60 GHz. Total time delays and increments should be appropriate for phased arrays up to 20 meters. Integration of analog and digital control components on a single chip is desired. Similarity, the integration of optical and microwave devices. The long term goal is to integrate digital, microwave devices. The long term goal is to integrate digital, microwave (including non-reciprocal) devices, and optical devices on a single, low cost wafer.

AF87-045 TITLE: Structural Multifunction Phased Array Antennas

OBJECTIVE: To develop new concepts for reconfigurable structural array antennas operating in the microwave and millimeter wave bands.

DESCRIPTION: Multifunction array antennas will be necessary for future airborne C3I surveillance. ESM and communications relay systems. To increase endurance, reduce platform radar cross section and increase payload volume, the array antennas will be incorporated into the load bearing skin of the aircraft. New concepts for reconfigurable, structural array antennas operating in the microwave and millimeter wave bands are required. Methods to permit designers to effectively integrate array elements or sub arrays which cover the whole band to achieve all aspect coverage are required. Alternatively, the ability to rapidly reconfigure radiating elements to achieve specific radar, ESM or communications missions is of value. Array architectures and control philosophies must be considered also. To minimize bulky, multi-band corporate feeds, attention should be given to the use of large bandwidth busses to distribute coherence, timing, control, and information signals to distributed digital and control processors at the element or sub array levels. These distributed processors must effectively integrate local element/sub array performance monitoring and position information with global function, pointing and adaptive cancellation requirements to control the active electronics of the element/sub array. Adjunct technologies to effectively integrate the design and fabrication of active structural arrays with radomes for environmental and RCS control are desired. Innovative approaches are invited to solving any portion of the above problems.

AF87-046 TITLE: Optical-To-Microwave Laser Diode Source

OBJECTIVE: To develop new optical sources to enhance the performance of microwave electronic systems.

DESCRIPTION: New optical sources shall to generate stable, narrowband microwave signals in the 5 GHz range by photo detection of a pulsating optical beam from a miniature semiconductor laser diode, with no microwave oscillator present to modulate the laser emission. The laser diode shall include a saturable absorber and an external cavity whose length determines the microwave frequency. The wavelength of laser emission shall be in the 0.8 to 1.6 micron range, and the direct photo detection of the pulsating beam should produce a CW electronic signal with a

strong fundamental component at the desired microwave frequency. A feasibility demonstration of this laser device is required. The offerer should have in-house facilities for constructing appropriate laser diodes.

AF87-047 TITLE: Optical Switching Using Nonlinear Optical Properties of Polymeric Organic Materials

OBJECTIVE: To fabricate optical quality thin film and channel waveguides and to extend this technology to the development of waveguide modulation and switching devices.

DESCRIPTION: Optical switching is a prime requirement for future Air Force applications in communications and optical computing. Prior work in this area has relied on inorganic electro-optic materials computing. Prior work in this area has relied on inorganic electro-optic materials like lithium niobate and lithium tantalate which, however, suffer from fundamental limitations. A large and expanding range of organic materials offers the possibility of performing various optical functions including frequency doubling and switching. The immediate challenge lies in the optical waveguide and device fabrication techniques required to translate promising materials into working devices. Accordingly, this program will address the problem of fabricating optical quality thin film and channel waveguides and the extension of this technology to the development of waveguide modulation and switching devices. The approach will utilize the linear (Pockels) eletro-optic effect and hence will involve compounds exhibiting high second order nonlinear susceptibilities (Chi-squared) devices are of interest. The offeror will be expected to demonstrate wave guided structures and experimental switching devices.

AF87-048 TITLE: Super-Refractory Compounds

OBJECTIVE: To develop processes for the controlled deposition of alternating layers of refractory compounds, where each layer's thickness is less than 10 nanometer (nm) and the total number of layers exceeds 30,000.

DESCRIPTION: Ultra Structures of refractory metals and their carbides, nitrides and borides is a promising materials technology for creating unique electronic and structural parts. For example, it may be possible to incorporate electronic antennas and sensors into an aircraft skin using ultra structures of semi-conduction refractory compounds. The goal of this research is to develop processes for the controlled deposition of alternating layers of refractory compounds, where each layer's thickness is less than 10 nm and the total number of layers exceeds 30,000. The process must be automated with growth rates of 25 microns/hr. The technique must include mechanisms for controlling purity and grain size within each layer. This is not a project devoted to advancing coating technology, but seeks to exploit the bulk mechanical properties of a macroscopic array of layers with quantum well thicknesses.

AF87-049 TITLE: Sentient radio Receiver

OBJECTIVE: To design a sentient radio receiver using existing and new artificial intelligence technologies.

DESCRIPTION: A sentient radio receiver is one that applies advanced information theory and artificial intelligence to the detection and demodulation of received communications signals. The radio signal is most communications channels is distorted and/or perturbed by the propagation media and the addition of manmade or natural radio noise. The sentient receiver would be able to measure and build up a knowledge of recent past disturbances in the communications channel, and apply this knowledge along with historical and predicted statistics on the data/information flow over the radio system to extract the communications from the noisy received signal. The sentient receiver would thus be able to apply artificial intelligence technology to anticipate information that was transmitted, develop and acute awareness of propagation media and/or manmade distortions to the signal, and make expert judgment in correcting errors in the demodulated information to provide the best performance possible in high data transmission rates, anti-jam capability, and low probability of intercept within the communications system.

AF87-050 TITLE: Software for Non-Von Neumann Architectures

OBJECTIVE: To analyze non-von Neumann class architecture and determine how they can be utilized over weapon system and software life cycles.

DESCRIPTION: To date, software engineering technology has focused on the use of so called conventional high order languages and computer architectures. Since the von Neumann architecture is characterized by serial processing techniques, it is very successful when performing complex computations on relatively small amounts of data. However, for certain classes of problems where relatively simple computations are to be performed concurrently on large amounts of data, the von Neumann type architecture is severely limited by the data transfer capability between the memory and processor components. The objective of this SBIR program is to analyze non-von Neumann class architectures and determine how they can be utilized over the system and software life cycle. Emphasis is to be placed on the assessment and determination of software tools and techniques that are applicable to these architectures, to determine if new approaches to the life cycle are required, and to best match software engineering technology to these architectures when the problem domain cells for a mix of sequential processing.

AF87-051 TITLE: High Productivity Software Engineering Workstation

OBJECTIVE: To develop a design and implementation concept of a high productivity software engineering workstation to provide methodology enforcement and incremental analysis and feedback.

DESCRIPTION: The ever increasing cost and complexity of DoD software systems coupled with a labor intensive software life cycle process require the identification, development, and application of software engineering technology which provides significantly improved productivity and product quality. In particular, early life cycle activities associated with the requirements definition, specification, and validation processes may result increased software costs when accomplished in the present and relatively inefficient manner. Furthermore, current technology in this area requires the use of well trained and experienced people to be effective. This effort is intended to provide improvements by developing a design and implementation concept (with possible demonstration) of a high productivity software engineering workstation to provide methodology enforcement and incremental analysis and feedback. The techniques embodied in the workstation should support military standards and practices, rapid prototyping and high level requirements and design modeling. The design concept should address an open and extensible environment that will facilitate the subsequent incorporation of artificial intelligence and knowledge-based techniques as they evolve and mature.

AF87-052 TITLE: Expert System Integrated With Data Bases

OBJECTIVE: To demonstrate the ability of an expert system to use the currently maintained conventional order-of-battle files, installation files or terrain tables without manually intensive efforts.

DESCRIPTION: Many potential applications for expert systems are precluded by limitations in ability of conventional expert system technology to function in conjunction with data systems. Rudimentary expert systems which are conventional data based management system (DBMS) have become commercially available in the last year. Expert systems integrated with DBMS would be of value to perform many functions in the Command, Control, Communications, Intelligence (C31) domain. A reasonable demonstration of this capability would be the ability of an expert system to use the currently maintained conventional orders-of-battle files, installation files or terrain tables without manually intensive effort. A more valuable demonstration would be the ability to interface the Military Integrated Intelligence Data System (MIIDS) to an expert system without requiring manual intervention. This topic supports development of C31 Expert Systems containing integral DBMS.

AF87-053 TITLE: Profile Computer

OBJECTIVE: To develop a faster method to recompile the profile library.

DESCRIPTION: Profiles are information retrieval queries using Boolean Logic to disseminate information relevant to a user's needs. A set of these queries is compiled to established a profile library. Intelligence analysts rely on this profile library to retrieve message traffic for their review as it enters his analyst support system. Since user areas of interest are continually changing in the intelligence community, it is necessary to redefine portions of the profile library to accurately disseminate messages with the new required information. When profiles are changed, the set of queries must be recompiled to establish a new profile library. In many cases these libraries are very large and require as much as hour hours of computer processing time to be recompiled. This processing time is on the host computer and must be accomplished during slack periods. A faster method is needed to recompile the profile library. In addition, the profile compiler should be capable of verifying the syntactic structure of the new set of profiles to avoid an abort of the compilation process due to errors.

AF87-054 TITLE: Advanced Crucible Technology

OBJECTIVE: To develop processes for the deposition of thin films of refractory compounds.

DESCRIPTION: The inability to control unwanted impurity incorporation during all phases of electronic device fabrication establishes a fundamental limit to all phases of electronic device fabrication establishes a fundamental limit to device reliability and efficiency. Solving the containment contamination problem is essential to the production of superior opto-electronic devices.

All phases of electronic device production require crucibles and susceptors of the highest possible purity. Furthermore, these furnace elements must remain chemically inert with respect to all atomic and molecular species in a given reaction at elevated temperatures. Recent experiments with chemical vapor deposition indicate that ultra high purity layers of refractory compounds can be deposited on foreign substrates. These layers have also been observed to survive high temperature thermal cycling in spite of wide differences in thermal expansion coefficients. The goal of this project is to develop processes for the deposition of thin films of refractory compounds, such as pyrolitic boron nitride (PBN), titanium diboride (TiB2) and silica carbide (SiC) onto silica surfaces of various geometrical configurations. The coatings must include less than5 ppm metallic impurities and survive ten cycles from room temperature to 1300 degrees Celsius.

AF87-055 TITLE: Ultra Narrow Linewidth Optical Source

OBJECTIVE: To develop methods of implementing narrow linewidth semiconductor laser subsystems of small size.

DESCRIPTION: The trend to future all optical systems mandate the need for ultra stable optical components. Many passive electronic components, e.g., waveguide or cable are replaced by active components e.g., lasers, optical waveguides and detectors in optical systems. Ultra stable narrow line width sources are at this time some form of gas laser. Future integrated photonic systems, to be cost effective and of small size, will necessarily require semiconductors lasers. Stabilization to achieve narrow line width requires the use of large (10-20 centimeters) external cavities, which mitigate against small size. Work is necessary to develop methods of implementing narrow line width semiconductor laser subsystems of small size. Goals are line widths of 1 Hz, wavelengths in both visible and infrared (.6 micron, 1.3 micron) and ultra small physical dimensions with semiconductor lasers. Modulation rate capability of several Gigahertz is also necessary.

AF87-056 TITLE: Probability Computations of Upset in Device Due to Electromagnetic Effects

OBJECTIVE: To utilize state-of-the-art methods, all or in part, in a reverse engineering manner to develop an approach to compute the probability of upset due to electromagnetic effects.

DESCRIPTION: Current analyses, tests and predictive methods for complex, high speed, digital devices, qualify the operation of these devices under prescribed conditions. These methods include, for example, test vector generation stuck at fault analysis, built-in tests, and the use of simulation programs such as LISP, LOGLISP and PROLOG. The

objective of this proposed investigation is to utilize these methods, all or in part, in a reverse engineering manner, to develop an approach to compute the probability of upset due to electromagnetic effects. That is, normal device operation is impaired when extraneous signals from the electromagnetic environment are coupled to the input pins of complex high speed, digital devices. In one possible approach, each pin can be assigned a probability of upset as a figure of merit to determine possible degradation during subsequent applications. The investigation should consider the use of expert systems technology.

AF87-057 TITLE: Reliable Microwave Laser Diodes

OBJECTIVE: To concentrate on developing a microwave laser structure which has 20 gigahertz bandwidth and high reliability.

DESCRIPTION: Significant advances are being made in the development of semiconductor lasers which can be directly modulated at microwave frequencies. Work on these lasers has focused on structures which provide the highest bandwidth without concern for reliability. This effort should concentrate on developing a microwave laser structure which has 20 gigahertz bandwidth and high reliability. The wavelength of this laser should be 1.3 micrometers. It is desired to house the laser in a pigtailed microwave package which contains appropriate microwave and bias circuitry. This program is aimed at producing a useful transmitter module which can operate in a military environment. The offeror should have in-house facilities for fabricating high speed laser diodes.

AF87-058 TITLE: Improved Epitaxial Deposition techniques for III-V Compounds

OBJECTIVE: To design an epitaxial system that will combine the optimum operating parameters of both III-V Compounds.

DESCRIPTION: This project includes research on the epitaxial growth of compound semiconductor thin films that will serve as the basis for advanced C(3)I systems. Molecular beam Epitaxy (MBE) offers a high degree of control on layer thickness and uniformity, but suffers from limited throughput capability Band run-to-run reproducibility. Metal Organic Chemical Vapor Deposition (MOCVD) solves the throughout deficiency and operates in the same low temperature environment, but the control of layer thickness for quantum well structures is not as good as MBE's.

We are seeking innovative design solutions for an epitaxial system that will combine the optimum operating parameters of both of these techniques, while at the same time reducing the cost and complexity of operation. The design solutions must provide a cost effective, technically superior approach to growth of III-V materials having multiple Group V and Group III components.

AF87-059 TITLE: Fiber Optic Sensors of Electrical and Magnetic Fields

OBJECTIVE: To develop sensors capable of detecting very weak electrical/magnetic fields over a frequency range extending from Kilohertz to approximately 10 GHz.

DESCRIPTION: The application of fiber optic sensor technology to the problem of electromagnetic field detection promises to considerably exceed the sensitivity/bandwidth performance of conventional detectors and will, therefore, be of importance to a variety of DoD signal processing and intelligence programs. In particular, fiber optic sensors have the advantage of being non-metallic, thereby minimizing the perturbation of the field being measured, and theoretical calculations indicate usable sensitivity over a very large frequency range. Sensor concepts and technology capable of directing very weak electrical/magnetic fields over a frequency range extending from Kilohertz to approximately 10 GHz are being sought. Research and Development, Test and Evaluation (RDTE) in the following topical sensor via a material interface optimized for particular field parameters), novel sensor concepts and designs (interferometric/non-interferometeric, directional response, polarization sensitivity, etc.) and the realization of fiber optic sensors which are sufficiently rugged to withstand the operational environment while demonstrating sensitivity/frequency range/detection bandwidth performance superior to conventional electrical and

magnetic field detectors. Novel processing concepts which operate directly upon the optical output of such fiber optic sensors (e.g., optical correlators) will also be considered.

AF87-060 TITLE: Text Understanding

OBJECTIVE: To develop computer comprehension of natural language.

DESCRIPTION: At present, computer comprehension of natural language is in a very early stage. Even rudimentary "understanding" within limited domains for particular purposes, would be of value. For example, Key Word in Context (KWIC) document retrieval systems are well-known. Document indexing for retrieval using more sophisticated retrieval semantic processing would be of more value.

More sophisticated examples are to permit a system to react to the semantic content of documents; to automatically screen incoming text for items of interest; to perform initial matching of persons to jobs; to retrieve specific information from document data bases.

AF87-061 TITLE: AI and Ada for Decision Support Systems

OBJECTIVE: To define a hardware/software architecture and methodology, which link the aspects of Ada with the rapid prototyping development process associated with AI applications.

DESCRIPTION: This effort shall define a hardware/software development architecture and the methodologies, which link the aspects of the Ada development environment with the rapid prototyping development process associated with AI applications development. Capabilities sought are novel approaches to meld Artificial Intelligence and the constructs of the Ada language to create an environment for the development, integration, and configuration management of complex systems involving C3I Battle Management Decision Aids/Decision Support Systems. The pivotal technical questions are: 1)how can aspects of the Ada development environment be linked with a rapid prototyping development process associated with Artificial Intelligence applications development, and 2) how might these concepts and techniques be advanced to transform the Decision Aid development process into a creative change process consisting of configurable elements using reusable components.

AF87-062 TITLE: Network Schema Server

OBJECTIVE: To fabric and demonstrate a Local Area Network (LAN) resident network schema server.

DESCRIPTION: Perform an implementation study leading to the fabrication and demonstration of a Local Area Network (LAN) resident network schema server. The network schema is the aggregate of all LAN resident data base schemas. Each class of user is assigned a unique network subschema. Network sub schemas reside in a network resident server and are downloaded to the user's workstation upon sign-on/authentication. Users generate queries against their network subschema and the network schema server decomposes their query into sub queries, which are routed to specific databases. Each constituent Data Base Management System (DBMS) is responsible for their individual sub query response. Sub query responses are aggregated by the network schema server and forwarded to the user submitting the query.

Under SBIR Phase 2, a contractor would build a LAN resident network schema server and identify all resources required to support it. Data administration and distribution, as well as communication and manpower issues will be addressed. The result will be a capability which the government can then transition to operational users.

AF87-063 TITLE: Programmable Optical Spatial Filters

OBJECTIVE: To exploit device technologies for programmable optical spatial filters for purposes of optical excision.

DESCRIPTION: The complex signal environmental encountered on ELINT missions is placing increasingly stringent demands on automatic identification, wideband recording etc. Dynamic Range requirements in excess of 60 db, spurious and interfering signals, jamming signals, etc. are cluttering an already dense environment. One alternative to accommodate these interfering anomalies is the use of optical excision. This effort will exploit device technologies for programmable optical spatial filters for purposes of optical excision.

AF87-064 TITLE: Application of Modern Mathematics to Theater Air Warfare Intelligence

OBJECTIVE: To quantify the effectiveness of intelligence data, particularly as applied to combat situations.

DESCRIPTION: A need exists through the application of advanced mathematics to quantify the effectiveness of intelligence data, particularly as applied to combat situations. Effective intelligence has the attributes of maximum amount of information per data volume, completeness, accuracy, and validity. A number of new mathematical techniques may offer methods for quantifying the effectiveness of Intelligence Information. Consideration should be given to such techniques as information theory, fuzzy set theory, and methods for solving ill-posed inverse problem, etc.

AF87-065 TITLE: Analysis of Process Induced Damage in III-V Compounds

OBJECTIVE: To develop a method to characterize process induced damage in III-V Compounds.

DESCRIPTION: Advanced electro-optical devices composed of III-V and II-VI compounds are severely limited by the qualify of the bulk substrates. Wafer processing techniques, such as cutting, lapping, mechanical polishing and high temperature annealing that have been successful in silicon technology cannot be applied to these compounds without serious degradation. It has been reported that the damage incorporated during processing can be more significant than all the defects that accompany bulk crystal growth. Electronic devices produced from these improperly prepared substrates have limited efficiency and sharply reduced life expectancies.

The brittle nature and thermal volatility of these substrates demand a new approach to processing and characterization. The ability to characterize the process induced surface and sub-surface damage is critical to advanced device technology.

Two primary goal of this effort is to develop a rapid non-destructive method to characterize process induced damage.

AF87-066 TITLE: Hazard Response Modeling Uncertainty

OBJECTIVE: To develop methodologies to quantify the uncertainty associated with use of microcomputer-based hazard response models.

DESCRIPTION: The U.S. Air Force has a need to quantify the uncertainty associated with use of microcomputer-based hazard response models. In the event of an accidental release of toxic gases to the atmosphere, a “toxic corridor” is calculated, based on output from an atmospheric diffusion model. The toxic corridor delineates the area requiring protective action (such as evacuation) due to gas concentrations exceeding specified limits. Model users need to know the uncertainty associated with calculating the toxic corridor; interest will be contained within the calculated corridor. The current Air Force operational atmospheric diffusion model, the Ocean Breeze/Dry Gulch (OB/DG) equation, is an experimentally derived method on a large number of test releases of a neutrally buoyant tracter. Because it is based on a large number of releases, confidence factors can be determined for its use, assuming the equation is used with scenarios identical to the releases used in it’s development. Newer models, operated on microcomputers, have been developed as potential replacements for OB/DG, which can be calculated manually with nomograms. The newer models incorporated improved model physics and include evaporation algorithms and techniques for simulating the release of heavier than air gases, while OB/DG does not. Despite these improvements,

there is no straightforward way of calculating the uncertainty associated with these models. This uncertainty must be quantified before they can achieve widespread use within the US Air Force.

The effort envisioned would involve evaluating currently available microcomputer-based hazard response models. Based on this evaluation, methods would be developed to quantify the uncertainty could then be employed by Air Force personnel to evaluate other models for potential Air Force use.

AF87-067 TITLE: Modifiers for Asphalt Concrete

OBJECTIVE: To investigate these new materials for purposes of limiting distress due to high pressure tires and thrust vectoring.

DESCRIPTION: Current and future generation of aircraft require high pressure tires and thrust vectoring for short takeoff and landing (STOL) capability. The impact of these developments on asphaltic concrete airfield pavements will be detrimental. However, new technology has identified extenders, modifiers, and alternate binder materials which seemingly offer improvements over conventional asphalt cement. This task would investigate these new materials for purposes of limiting distress due to high pressure tires and thrust attention as their costs could become uneconomical.

AF87-068 TITLE: Fire Suppressants for Composite Materials

OBJECTIVE: To develop new or modified fire suppressants to effectively control and extinguish composite materials.

DESCRIPTION: New and planned aerospace aircraft are being constructed of composite materials which undergo uncommon reaction in fire incidents. Their decomposition presents potential damage capability to electronic components being exposed and a potential health danger to humans in the vicinity of the composite materials decomposition. Burning characteristics and fire suppression techniques may be different than those of known materials also. This effort shall identify the decomposition and burning characteristics of composite materials, evaluate effectiveness of current fire suppressants in suppressing fires involving composite materials and develop new or modified fire suppressants to effectively control and extinguish this type of fire and it's potential collateral damage.

AF87-069 TITLE: Stochastic Methods in Protective Structures

OBJECTIVE: To review and analyze current stochastic process methodologies for their applicability to protective structure designs.

DESCRIPTION: Current procedures for designing Air Force facilities to withstand non-nuclear weapons effects do not fully consider potential variations in loading mechanisms (delivery accuracy, weapon reliability, etc.), site characteristics, structural behavior, etc. Resulting designs tend to be very conservatively formulated, reducing opportunities to perform appropriate cost-benefit analyses. This effort shall provide a review and analyze current stochastic process methodologies for their applicability to protective structure designs and extend those basic methodologies to the unique load and response mechanisms associated with non nuclear weapons efforts. Follow-on work would extend the basic methodologies to developing appropriate algorithms for structural design procedures.

AF87-070 TITLE: Leak Detection by Acoustic Emission Monitoring

OBJECTIVE: To develop new methodology to detect leaks in underground storage tanks and pipelines.

DESCRIPTION: The Air Force needs methods to detect leaks in underground storage tanks and pipelines. The acoustic emission (AE) monitoring has already been tried for internal testing of underground storage tank (UST)

leak detection device for tanks and pipelines. This technique could replace current methods based on chemical tracing direction of migration and quantifying the leak, depending upon the liquid and the vessel material characteristics. The technique requires research on a variety of liquids, especially petroleum fuels, fuel tanks, and surrounding soil characteristics. Compared to conventional techniques, it is expected that AE techniques would be faster, safer, and could detect smaller leaks (less than 0.01 gal/hr) from any of tanks and pipes.

AF87-071 TITLE: Increase Throw Range of Gaseous Fire Suppression Agents

OBJECTIVE: To develop an effective means to increase the throw range and vapor concentration of the gaseous fire suppression agents.

DESCRIPTION: Currently gaseous fire suppression agents of the HALON family have limited throw range, usually less than 50 feet. This limitation is caused by their physical property in that they vaporize when discharged and are affected by wind conditions. These two factors result in undesirable limitations in the use of these agents. Developing an effective means to increase the throw range and vapor concentration of the gaseous fire suppression agents is the objective of this research project. Longer throw range, greater concentration of fire suppression agent on the fire, and overcoming the effects of the wind would greatly improve the fire suppression capabilities of the HALON fire suppression agents.

AF87-072 TITLE: Gravity Effects in Small Scale Structural Modeling

OBJECTIVE: Develop concepts and procedures that compensate for gravitational effects without using artificial-induced gravity.

DESCRIPTION: In development design criteria for structures designed to withstand nonnuclear weapons effects, the Air Force performs research through combining structural testing with weapons effects. This live testing may be either full-scale or at reduced scale; the reduced scale is more economical. Straightforward similitude analysis indicates that small scale structural dynamics tests should include artificially induced gravitational effects that vary inversely with the geometric scales used. Recent small scale structures tests with explosives in geotechnical centrifuges have shown gravitation effects to be influential on soil and structural responses. This effort shall analyze the many variables small scale structures (both buries and above ground) tests that use scaled nonnuclear weapons detonations; identify the variables most influenced by gravitational effects without using artificially-induced gravity (i.e., centrifuges). For example, soils used in models might be artificially stiffened in some manner. Follow-on efforts would test the procedures developed in the initial task and compare the test the procedures developed in the centrifuges and full scale tests.

AF87-073 TITLE: Helmet Mounted Eye Position/Orientation Sensing for Aircraft Cockpits

OBJECTIVE: To evaluate applicable technology and perform early development of a miniaturized, lightweight system that will accurately record eye position/orientation in both anticipated operational cockpit environments and the current Visually Coupled Airbourne Simulator System (VCASS).

DESCRIPTION: The AAMRL virtual cockpit concept includes three key features: 1) Use of eye line-of-sight to control aircraft functions, 2) use of eye movement and fixation data as indicators of acceptability of candidate cockpit displays, and 3) use of eye parameters to deduce “pilot state” and modify the pilot interface to controls and displays. Products will include evaluation of state of the art eye position/orientation systems, innovative algorithms for improving error/repeatability/resolution/processing rates, and design for transducers and compatible helmet display systems. The following steps should be considered in the development of an optimal technological approach to this problem: 1) Generate list of performance requirements and goals. 2) Review and categorize eye position sensing techniques. 3) Investigate current emitters and sensors. 4) Review processing algorithms. 5) Investigate required computer hardware/software. 6) Perform optical design integration study. 7) Identify functional and performance characteristics. 8) Separately document operational and VCASS designs.

AF87-074 TITLE: Rapid Measures of Brain Activity to Assess Operator State

OBJECTIVE: To develop methods whereby the response to single stimuli can be used or the ongoing activity from the brain can itself provide sensitive and accurate estimates of operator state.

DESCRIPTION: There is increasing need to develop sensitive predictors of impending decrements in operator performance before there is an impact on a mission. Methods of rapidly assessing operator state are becoming crucial as systems become more complex and require operators to handle increasingly large amounts of information and rapidly make decisions. The possibility of impending performance breakdown can be provided to the operator, the system or someone in the command structure so that appropriate actions may be taken. Physiological measures show some promise of providing such predictive information. Electrical activity from the brain has the potential to provide a sensitive measure of operator state. However, the currently available methods of measuring brain activity typically require a number of discrete stimuli in order to have enough data. Methods are required whereby the response to single stimuli can be used or the ongoing activity from the brain can itself provide sensitive and accurate estimates of operator state. These new techniques could also include novel ways of recording brain activity such as placing the electrode, amplifier and transmitter all in one very small unit. Analysis procedures in which evoking stimuli are not used could be especially valuable if reliable techniques were available to extract meaningful information from the ongoing brain waves. In order to gain acceptance these techniques would be required to be nonintrusive into the operator's primary task and be innovative in terms of hardware and/or software. Validity, reliability and field acceptance must be demonstrated.

AF87-075 TITLE: Pressure Suit Cooling Garment

OBJECTIVE: Develop an easily donned, lightweight garment which incorporates a cooling (or heating) device separated into body segments and an auto feedback mechanism for regulation of each segment independently.

DESCRIPTION: Many types of cooling garments exist, the most notable being the liquid-cooled type used inside space suits and under chemical protective clothing. Although these work reasonably well to prevent overheating, they fall short as regards user comfort. In a situation where workload and thermal load may vary, the system must be manually adjusted to regulate the appropriate amount of cooling. This cooling is delivered to all parts of the garment uniformity. Particularly in space suits, this design often results in one or more parts of the body (usually hands or feet) being too hot or too cold. The desired system would consist of an easily donned, lightweight garment which incorporates a cooling (or heating device) separated into body segments and an auto feedback mechanism for regulation of each segment independently. There must be a biomedical (? Skin temperature) sensor for each segment. A manual override or each segment is necessary. The system must be capable of interface with an external device or aircraft system which would act as a heat exchanger. Consideration of a non-vented system for heat exchange is desirable, as current sublimation techniques could contaminate sensitive on-orbit equipment.

AF87-076 TITLE: Lightweight Chiller Efficiency Improvements

OBJECTIVE: Develop more efficient lightweight chiller devices to reduce their weight and energy consumption.

DESCRIPTION: Vapor cycle refrigeration devices are being developed to chill a water-glycol mixture and air which circulates through a vest worn by personnel facing thermal burden due to their environment or heavy clothing they must wear. These devices are either worn on the back, app. 15 pounds, or stand on the ground and cool several users at a time; 25 to 150 pounds. More efficient devices are needed to reduce their weight and energy consumption. Several approaches may exist. 1) Rather than have a water-glycol mixture circulate through a vest, have the refrigerant go directly to the vest and thereby eliminate the refrigerant/water heat exchanger and water pump. This has been attempted, but when the system is shut off the refrigerant creates great pressures as it worms, damages the vest, and leaks out. Suggest either improved vest design or a pump-down sequence upon shutting the system off. 2) These devices are currently using refrigerant #12. Since the personal vest should never be colder than 60F, a different refrigerant may be the optimum type. 3) When these devices are used in high temperatures the refrigerant condensers are inherently less efficient. Suggest a condenser be developed which can employ both its normal air

convection cooling and optional evaporative water cooling, i.e., minimum cooling water. 4) Suggest benefit/cost determination of using a turbine rather than a capillary. This method is known as the reverse Brayton Cycle.

AF87-077 TITLE: Development of Helmet-Mounted EEG Transducer System

OBJECTIVE: To develop helmet-mounted transducer system to acquire recordings of EEG in humans during flight.

DESCRIPTION: Acquiring recordings of EEG in flight in humans presents several problems. Artifact presence in the record due to body movements, especially head movement, results in data records which border on the useless. Providing a stable base for recording transduces itself when using scalp electrodes requires firm placement of the electrodes on the head. Currently, a messy and only marginally acceptable method is used for this procedure. This entails using Collodian (removed by dissolution in acetone) gauze pads and tape. An inductive capacities system which positions the electrode near the scalp but does not require scalp contact is desirable. Incorporation of an array of electrodes and preamplifiers into the currently approved flight helmet is sought .

AF87-078 TITLE: Neuro-Magnetic Signal Processing

OBJECTIVE: Design an optimum neural0magnetic estimator.

DESCRIPTION: Monitoring the physiological behavior of a cognitive process opens many opportunities to study how the human brain processes information. To reliably identify and track a neuro-process through neuro-magnetic measurements, the measured field must be analyzed in both time and space. The signal processing of neuro-magnetic fields, however, is severely hindered by fundamental barriers. Time domain processing suffers from the classical problem of low signal-to-noise ratios. Although line filters, environmental shielding, and careful experimental techniques will eliminate much of the signal corruption, uncorrelated noise from within the brain tissue corrupts the desired response to an unacceptable level. The first part of the task is to describe the dynamics of the surrounding brain activity detection at fixed measuring positions over the scalp, and use this information to design an optimum neural-magnetic estimator. Both the desired signal and the noise must be described for optimal results. Even if perfect neuro-magnetic signals are measured outside the scalp, the task of completely describing the responsible source is impossible as a result of the fundamental law of superposition. Therefore, the second part of the task is to develop spacial processing techniques to logically estimate the location, shape and strength of the source responsible for the detected magnetic field. Required considerations include the size and shape of the human cranial cavity, anatomical structure of the cerebral cortex, and expected errors due to model inadequacies.

AF87-079 TITLE: Chemical Detection and Alerting Systems

OBJECTIVE: Develop fieldable, rugged, sensitive, selective, and inexpensive detection and alerting systems based on optical and chemically-electronically coupled analytical techniques.

DESCRIPTION: Defense against chemical warfare agents requires sophisticated sensors that quickly detect, identify, and monitor very small concentrations. The sensors require a short response time in order to minimize causalities and a low false alarm rate to maintain credibility. Specific needs are for fieldable, rugged, sensitive, selective, and inexpensive detection and alerting systems based on optical and chemically-electronically coupled analytical techniques. Sensor chemistry, coating development, and material science are of equal or greater importance than basic hardware design.

AF87-080 TITLE: Situational Awareness Training

OBJECTIVE: Develop a training program to enhance situational awareness in USAF operational pilots.

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine is seeking innovative development of a training program to enhance situational awareness in USAF operational pilots. Situational

awareness is that attribute of the superior pilot which allows him to have comprehensive, detailed and up-to-date knowledge of an engagement arena at all times without disrupting his focused attention on the task at hand. The taxonomy of situational awareness has been developed and will be provided to the successful bidder(s) for guidance. The effort will require a team with skills in the behavioral sciences, educational methodology, and graphics/display computer sciences as well as resource personnel with fighter pilot experience. The USAF application must facilities Aircrew Combat Mission Enhancement. The phase I proposal should address migration of the technology to the civilian marketplace. This announcement may result in multiple awards. In order to consider a phase II award based on competition.

AF87-081 TITLE: Characterization and Application of Quaternions for Enhanced Computer Processing Algorithms

OBJECTIVE: Develop a reference text for practicing DOD and contractor technical personnel.

DESCRIPTION: The problem of computing multiple coordinate transformations for rigid body motions in aircraft, for predictive missile and threat analysis algorithms, and for ground based simulation and terrain portrayal displays is one that is encountered time and again in Air Force operations. These processes are still performed using primarily Euler angle and direction cosine formulations which place significant runtime overhead on digital computers. Quaternion formulations of three-dimensional space significantly reduce computer processing time, need only four elements instead of the nine required for direction cosines and do not suffer from singularity problems encountered when using Euler angles. Given the potential wide application and benefits to be derived from the use of quaternion-based algorithms, it is highly desirable to develop a reference text for practicing DOD and contractor technical personnel. The text would cover both the theoretical aspects to allow the user to insert such analytical techniques into the initial concept formulation phase of applicable technical efforts as well as specific applications so that the merits of quaternion algorithms can be clearly understood and applied. In particular, the theoretical aspects of quaternions relating to their properties, algebraic structure, calculus (including derivative and differential concepts), and their geometric characteristics shall be covered. Liberal use of pictorial representations shall be made to facilitate efficient information transfer to the user. The reference text shall also include a thorough discussion of general application areas and several in-depth developments.

AF87-082 TITLE: 3-Dimensional Virtual Group Awareness (VIRGA) Workspaces for Battle Management

OBJECTIVE: Develop a 3-dimensional workspace that enhances the direct manipulation interface for the user

DESCRIPTION: There exists s need to create a 3-dimensional workspace that enhances the direct manipulation interface for the user. Inherent in the battle management situation is the need for distributed C3 between individual workspaces. Thus there must exist a means for communicating, fusing, and sharing pertinent information so as to network these integrated, yet geographically separated, workspaces. The 3-dimensionality of the workspace must come about by creating a visually recombinant of the i.e., an architecture, i.e., an architecture surround that is constructed by recombination of the graphical and holographic members that build up unique, dynamic workspaces for the battle management commander. By networking their individual workspace, commanders are provided with a Virtual Group Awareness (VIRGA). The technology that underlies this workspace initially would consist of an integrated mix of holographic displays, large flat panel displays, intelligent iconic software, information retrieval systems, computer animation, optical video disc systems, direct manipulation interfaces and advanced video teleconferencing/interactive television systems. The combinations of technology would allow the commander as well as icons, holographs, computer animations, auditory perceptions, and written materials to appear in other workspaces interactively. A series of tradeoff studies and evaluations must be conducted to assess the proper mix, usage, and development of the aforementioned technologies. Areas where technology does not support the VIRGA concept from these current research areas should be identified. Candidate technologies should be demonstrated to determine the feasibility of including them in workspaces. Results of these studies and demonstrations will initialize the first level concept of a VIRGA workspace. A prototype will be specified using currently available technology. Phase II of this effort will require that the prototype be constructed and demonstrated as an integral unit to justify the tradeoff study decisions in terms of an efficient human interface.

AF87-083 TITLE: Intelligent System Technology

OBJECTIVE: To develop modules and tools for the human-computer interface that will facilitate training and job-aiding applications.

DESCRIPTION: Artificial intelligence research is focusing on emerging technologies for applications in Air Force training. Intelligent Tutoring Systems (ITS) represent an ideal technique to train Air Force personnel in the future. An ITS requires designing and developing an intelligent tutor to demonstrate the capabilities of ITS for training. The deliverables include ITS design specifications, source code, and a demonstrable intelligent tutor, which should run on a Symbolics 3670 or a Xerox 1108. Another area of interest is to develop modules and tools for the human computer interface that will facilitate training and job-aiding applications. Specific objectives include: (1) the development of " dictionary" acquisitions from text software, (2) the development of a design for a simultaneous rule formalism, and (3) the exploration of designs for the interface between the simultaneous rule formalism and an object-oriented database system. All deliverables must run within the Symbolics 3670 or Xerox 1108 environments, and complete documentation must include exposition of the algorithms that are used.

AF87-084 TITLE: Improved Combustion Toxicology of New PF-11 Chemicals

OBJECTIVE: Develop methods to assess the toxicity of thermal degradation products from a multitude of new chemicals that may be developed under Project Forecast II(PFII).

DESCRIPTION: Improved methods are needed to assess the toxicity of thermal degradation products from a multitude of new chemicals that may be developed under Project Forecast II. Research is required that can validate improved techniques for accurately and rapidly evaluating the toxic hazard posed by human exposure to thermally decomposed materials. Current methods only measure a limited number of endpoints (usually lethality) and/or provide a less-than-comprehensive chemical analysis of combustion products that are difficult to interpret and relate to biological effects. Both approaches are usually time-consuming, relatively expensive, and provide suboptimal results to produce a confident risk assessment for human exposure to materials undergoing pyrolysis or flaming. Better combustion toxicity information and capacibility is needed to evaluate the hazard of many new chemicals and materials that are envisioned for use in the Air Force's Project Forecast II program. An NBS style combustion exposure chamber should provide the capability to measure as many relevant biological endpoints as possible. A real-time quantitative and qualitative chemical analysis such as FTIR should accompany the animal exposures.

AF87-085 TITLE: Night Vision Goggles for the Tactical Crewmember

OBJECTIVE: Development of night vision image-intensification goggle that is compatible with the tactical crewmember's environment.

DESCRIPTION: Because of the lack of a system to satisfy the fighter community's needs, certain nigh-time missions cannot be carried out safely. For this reason a need exists for the development of a night vision image intensification goggle that is compatible with the tactical crewmember's environment, specifically, a goggle which is ejection safe, windblast safe, high "G" safe, and compatible with the ACES II ejection
Seat. Additional requirements are that it be light weight to minimize fatigue and capable of ground operations, i.e., escape and evasion subsequent to ejection. Ideally, the system would be compatible with the Tactical Life Support System, an advanced development program managed at the Aerospace Medical Division, Brooks AFB TX. By doing so, the Air Force could procure a system which provides enhanced protection from hostile environmental conditions such as high "G" high altitude, high temperature, ;aser, and nuclear flash, as well as provide the added benefit of night vision.

AF87-086 TITLE: The Recovery of Depth Information in the Human Visual System

OBJECTIVE: Investigate specific signal processing concepts within the basic framework of the human information processing system.

DESCRIPTION: The purpose of this project is to investigate specific signal processing concepts within the basic framework of the human information processing concepts within the basic framework of then human information processing system. It is intended that this project be based upon recent research including the areas of modeling of human visual image processing and perception, computer vision, and signal processing. With this background, the project is intended to extend the model of the human visual background, the project is intended to extend the model of the human visual system somewhat into the cognitive realm. It is not intended that the human system be modeled entirely or even exactly. However, the basic interactions of the components of the human information processing system will be modeled to the extent that they affect the signal processing aspects of the problem. This can best be explained by example. The projects focus might be explained as investigating the algorithms to be used by a machine which is to identify objects in its sensory environment much like a machine which is to identify objects in its secondary environment much like a human might, as opposed to modeling exactly how a human would process that same sensory environment. The difference being that the design of the machine is not to be an identical copy of the human system, but uses aspects of the human system which enhance system performance. Specifically, this project shall investigate the signal processing aspects of the multi-sensor input of visual information to the human vision system with regards to the perception of stereopsis in static and dynamic environments. In a sense, this is a classical signal processing problem in that the human visual system may utilize two highly-correlated images sampled at the retina to generate one perceptual scene which contains an extracted information array of depth. The modeling of this process utilizing signal processing techniques is the objective of this research.

AF87-087 TITLE: Composite Materials for Manikin Skeletal Components

OBJECTIVE: Investigate the feasibility of using composite materials for specific structural elements of a manikin.

DESCRIPTION: Modern manikins, such as the Hybrid III, are fabricated of a skeleton of metal bones to provide the structural strength required for high accelerations and loads testing. Such metal structures considerably constrain the ability to achieve both proper segment inertial distribution properties as well as load-deformation properties of load transmitting members. This makes it more difficult to design manikins for biofidelic response. For this reason, it is highly desirable to investigate the feasibility of using composite materials for specific structural elements of a manikin. Such materials have a higher strength to weight ratio and have more bone-like deformation properties than currently used metal parts. The objective of this program is to develop prototype manikin skeletal components, such as the long bone, fabricated of composite materials. This will make it possible to achieve segment inertial distribution properties as well as overall biofidelic response. The approach will entail the selection of the appropriate composite materials, design of the skeletal components and their fabrication. These prototypes will be incorporated into an existing manikin on which dynamic testing will be performed. This program will demonstrate the use of skeletal components fabricated from composite materials in state-of-the-art manikins to provide improved biofidelic response.

AF87-088 TITLE: Diagnostic Rules Generator

OBJECTIVE: Develop expert system(s) for the generation of rules for the analysis of nuclear medicine, photographic camera, microfiche, etc., images and physiological analogue signals of medical diagnostic significance.

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine is seeking innovative research and/or engineering development of an expert system(s) for the generation of rules for the analysis of nuclear medicine, photographic camera, microfiche, etc., images and physiological analogue signals of medical diagnostic significance including but not limited to the electrocardiogram, blood pressure, respiration, electrogastrogasm, and electromyogram. Rule induction based on examples or analogies provided by physicians evaluating such images and physiologic signals should be a feature of such a system. Some artificial intelligence features or the capability to develop toward artificial intelligence downstream should be a feature. The objective is to capture and institutionalize the best diagnostic “rules” of the best clinicians over a period of several years, but is not to make diagnoses per se. The product of this effort should make a contribution to the larger R&D arena of

Knowledge Based Systems. The phase I proposal should address migration of the technology to the civilian marketplace.

AF87-089 TITLE: Chemical Agent Filter Test For Channeling

OBJECTIVE: Develop a test that can detect channeling before filter use but would not degrade the chemical agent protection.
DESCRIPTION: Chemical agent filters that develop channeling due to improper manufacturing or handling can have a reduced life span. Unless channeling can be detected before use, the protection time given by a filter becomes questionable. The results of this effort would be a test that can detect channeling before filter use but would not degrade the chemical agent protection

AF87-090 TITLE: Unified Life Cycle Engineering

OBJECTIVE: To develop supportability tools for United Life Cycle Engineering.

DESCRIPTION: The Air Force has initiated several efforts to develop an engineering environment in which all design related end-product attributes are integrated and optimized with computer-aiding engineering (CAE) tools during active design process. This process, termed Unified Cycle Engineering (ULCE), encompasses designing for performance, producibility/manufacturability, supportability (reliability, maintainability, testability, etc.), cost, schedule, etc.

The Air Force is interested in obtaining viable, yet innovative ideas in the form of Phase I proposals that specifically address the development of software and/or computer-related techniques to accelerate the defense industry's inclusion of supportability design considerations into ULCE processes. Among key technology thrusts are: (a) computerized design rules developed from authoritative sources as well as lessons learned from field experience; (b) dealing with distributed data bases in the collection, repository, distribution and application of design information and results of analyses to other users/computer programs; (c) tracking the rapidly evolving/integrating commercially available supportability related software with each other as well as with CAE developments: (d) computerized tools with which the Air Force can evaluate supportability attributes and specification compliance of a design during proposal evaluation and formal design reviews: (e) tools for assessing the applicability of military specifications to a particular development and assisting in their precise tailoring: (f) tools to assist in specifying design/performance attributes commensurate with supportability requirements and maintenance philosophy. Other applicable thrusts will be given equal consideration.

AF87-091 TITLE: Innovative Growth Techniques For Infrared Detector

OBJECTIVE: Develop improve/low cost infrared detectors through advancements in detector materials and processing technology.

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance at the highest possible temperature. Now concepts such as heterostructures and super lattice detectors are solicited. Detector arrays are being driven to larger numbers of elements which places increased emphasis on needs for materials uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

AF87-092 TITLE: Opto-Electronic Materials

OBJECTIVE: To develop concepts for obtaining materials with large interaction coefficients in useful configurations at low cost.

DESCRIPTION: Opto-electronic materials are required for optical image processing for radar and infrared systems and for optical computing. Concepts for obtaining materials with large interaction coefficients (i.e., highly non-linear) in useful configurations at low are sought. Inorganic and organic materials will be given consideration. Potential applications include elements such as waveguides for monolithic integration of sources, sensors and electronics on chip and spatial light modulators for input/output functions for optical computing.

AF87-093 TITLE: Fabrication of Microwave Device Materials

OBJECTIVE: To develop growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers.

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide materials that are used for device substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers. Epitaxial film growth processes are also included as important crystal growth areas requiring improvement. The latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance. Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

AF87-094 TITLE: Assessing Fatigue Crack Growth Predicting Programs

OBJECTIVE: To develop analytical and experimental techniques for assessing the accuracy of fatigue crack growth predicting programs.

DESCRIPTION:

a. Many software programs are available for predicting the growth of cracks in structures subjected to spectrum loading. Both government and private industry provide and use these programs. Quite often, for ease of computation, very simplistic models are used in building the software which makes the accuracy of the predictions questionable. Minimum requirements for spectrum fatigue crack growth predicting programs should be identified. These requirements should consider as a minimum the way constant amplitude data are handled, method of predicting stress ratio effects, and the model used to account for load interaction. Methods should be developed to assess the accuracy of any program and these assessment criteria/techniques should be made available to the technical community.

b. Advanced, innovative approaches are needed for the development of improved nondestructive inspection and evaluation (NDI/E) techniques for the detection and characterization of flaws in airframe and engine materials including metals, composites, and ceramics, and for use in the real-time monitoring of aircraft structure manufacturing processes. In particular, innovative technical approaches are needed for the detection and characterization of bulk and surface defects in both metallic and nonmetallic structures, for the evaluation of the integrity of bondlines in bonded structures, for the determination of the condition of the matrix and reinforcing substructures in advanced composite structures, for the quality of high-temperature material coatings, and for the inspection and evaluation of electronic device materials and components. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques or instrumentation currently being used in laboratory, factory and field inspections, or must identify new inspection and evaluation techniques which have the potential for ultimate use in realistic manufacturing or in-service environments. Proposals addressing significant technical advances in

all phases of the inspection procedure are solicited, from new sensors for the collection of inspection data is to advanced NDE signal processing concepts and methods.

AF87-095 TITLE: High Temperature Liquid Lubricants

OBJECTIVE: To synthesize and characterize monomolecular perflouroalkylether fluids as high temperature liquid lubricants.

DESCRIPTION: The work to be conducted consists of synthesizing pure monomolecular perflourinated polyalkylether fluids for which the structure and composition are well defined and their subsequent characterization for chemical and physical properties. Examples of the types of physical and chemical properties to be determined are: viscosity-temperature properties over the –54 to 316 C temperature range, thermal and oxidative stabilities using conventional ASTM and Federal Test Method Standard methods as well as new methods that are developed to determine a more thorough understanding of the behavior of these fluids under stress. Fluid samples of not less than 100 ml will have to be synthesized to provide adequate samples for property determinations.

AF87-096 TITLE: Properties of Materials at High Pressures

OBJECTIVE: To develop measuring techniques for chemical, physical and thermodynamic properties of solutions at pressures that are several hundred times higher than atmosphere pleasure

DESCRIPTION: The effort to be undertaken is to determine the feasibility of measuring chemical, physical and thermodynamic properties of solutions at pressures that are several hundred times higher than atmospheric pressure. Special emphasis would be placed on properties that affect solubility, surface activity on metal substrates and non-bonding interactions between compounds. In designing materials that will be effective is hydraulic fluids and lubricants, the properties of components and formulations are measured and studied at atmospheric pressures (14.7 lbs/sq. in.). Very little is known, however, about phase changes or other effects that may occur at pressures found in hydraulic systems where solutions are pumped at 3000 to 8000 lbs/sq. in. High pressure measurement of properties of some pure compounds have been measured using various spectroscopic techniques in conjunction with high pressure cells. However, the problem of determining the effectiveness of materials for corrosion inhibition, lubricity enhancement and viscosity improvement is not generally known except with the trial and error method of looking for possible degradation of the materials after load testing.

AF87-097 TITLE: High Temperature Solid Lubricant Technology

OBJECTIVE: To perform research of high temperature solid lubrication.

DESCRIPTION: The Air Force requires research in the following areas of high temperature solid lubrication:

a. Novel In-Situ Lubrication of Ceramics: Innovative approaches are sought for concepts which continually generate lubricious (low friction, low wear) species between the surfaces of ceramics moving relative to each other at high temperatures and high sliding speeds. Concepts for selection of ceramic compositions that provide beneficial surface reactions when brought together under these conditions or incorporated active species that migrate to the surface and react are examples of ideas that should be proposed.
b. High temperature Oxide-Based Solid Lubricants Research is needed to develop candidate high temperature solid lubricant materials for operation in the 1000 – 2000 F temperature range in oxidizing environments. Concepts for materials based on soft or lubricious oxides that are thermally and oxidatively stable, yet have relatively low coefficients of friction are sought. Other important properties for these solid lubricant materials are the ability to bond to both metal and ceramic substrates, exhibit low wear over 100 – 2000 F temperature range, and be capable of being applied to the substrates in an economical manner. The research should consider the use of single oxide materials as well as two or more materials which may react at high temperatures to produce low friction, low wear materials.

AF87-098 TITLE: Synthesis, Characterization and Processing of new High Performance Polymers

OBJECTIVE: To develop new polymeric materials tailored in molecular structures to provide performance advantages over state-of-the-art materials.

DESCRIPTION: Research and exploratory development is sought to discover new polymeric materials tailored in molecular structure to provide performance advantages over state of the art materials. Special interest is on new polymer systems with potential for the development of improved structural unique electro-optical and conductive materials. Polymers with exceptionally high use temperature and reasonably low energy requirements for curing and processing are needed. Areas of current emphasis include investigation of: (a) synthesis routes and methods to improve processing of rigid rod polymer molecular composite entailing the preparation of very thermally stable (600-700 F use temperatures) high polymer systems under reasonable processing conditions and without the evolution of impractical quantities of volatiles, (b) theoretical chemistry to provide fundamental understanding of the molecular requirements for achieving electro-optical and conductive processes in organic and semiorganic polymer polymer systems, (c) processing and morphology of rigid rod-like polymers to discover approaches for achieving superior compressive strengths, and (d) polymer structure-property correlations to elucidate processing options for achieving desired morphologies and mechanical properties. Other approaches to provide polymer systems with potential for exceeding state-of-the-art performance characteristics are of interest.

AF87-099 TITLE: Nosecaps, Leading Edge, and Sensor Windows for hypersonic Vehicles

OBJECTIVE: To develop low erosion, shape stable materials for maximum service temperatures of 4500 F.

DESCRIPTION: Future transatmospheric flight vehicles will be cyclic heated to high aero-temperatures and for long periods of time. Low erosion, shape stable materials will be required for maximum service temperatures to approximately 4500 F. Carbon and ceramic matrix composites based on new constituents and processing methods are required to be incorporated into innovative component designs. Primary uses include nosecaps, leading edges and sensors (antenna) windows of hypersonic flight vehicles. Phase I would define the conceptual materials and approaches, screening experiments, and the major technologies risks with an assessment of the probability of success. Phase II efforts would include reducing these materials compositions and constructions to practice in the form of composites and laminates (approximately; 1ft 2 each), high temperature constituent compatibility; iterative product development and evaluation to optimize composite properties and characteristics, and, selection of most promising composites for follow-on development. Follow-on efforts would fabricate multiple subscale articles, obtain engineering design data and conduct specialized testing to verify performance attributes and limitations.

AF87-100 TITLE: Lightweight, Aerostructural Composites

OBJECTIVE: Development of materials for 1800 F to 4000 F structural applications.

DESCRIPTION: Future Air Force hypersonic vehicles will require a variety of advanced composite materials for 1800 F to 4000 F structural applications. The development of these advanced composites would fulfill the high temperature, oxidation resistant, structural requirement. Phase I efforts would include both experimental and analytical investigations to examine fiber and matrix chemical and mechanical interactions; bulk components processing parameters and potential composite properties. Phase II would focus on fabrication of composite panels and specimens for mechanical and oxidation behavior evaluation at elevated temperatures and address potential payoffs/problems of large components to include thin wall and complex shape construction as well as material implications. Phase II would fabricate large, complex shape components representative of portions of a large aerovehicle that have critical structural and processing implications that could be structurally and environmentally evaluated for application identification.

AF87-101 TITLE: Structural Composite Processing and Properties

OBJECTIVE: Improved methodology for processing structural composites components.

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aerospace materials processing and design.

a. The Air Force Materials Laboratory is interested in pursuing activities that can lead to an innovative and improved methodology for processing structural composites (including molecular composites) components. Such activities can include new means of processing; fundamental research that can lead to improved quality and reliability of components; and computer aided systems, either for processing control or for simulation analysis of "ility" functions, in order to improve the "ilities" of the component during it's life cycle.
b. The Air Force is interested in research and development directed toward applications of biotechnology to aerospace materials requirements. The objective is either lower cost processes for advanced materials or improved materials designs not otherwise obtainable. Either process or design concepts should lead to a marketable product for Phase III. This activity can include the following areas:

    (1) Biosynthesis methods to provide state-of-the-art materials for Air Force applications utilizing resources that can be domestically produced. The biosynthetic methods may provide unique precursors which can be converted by conventional chemical methods to materials such as organic matrix resins for lightweight structural composites; carbonized matrix resins for carbon matrix composites, lubricants, elastometers, electro-optic materials, ceramic of ceramic precursors, and pure metals for structural or electronic applications.

    (2) Novel materials obtained from biological sources with properties that may satisfy current or future Air Force needs in areas such as those listed above. Examples would include carbonizable matrix resins with high theoretical char yield, modified ceramic exoskeletons which could be grown into a carbon matrix composite for oxidation protection, or materials with very rapid response to changes in light intensity.

    (3) Biodegradation techniques appropriate to applications such as polyurethane paint stripping or integrated circuit etching.

AF87-102 TITLE: Heat Resistant Films and Papers for Toughening Composites

OBJECTIVE: Development of heat resistant films and papers for toughening composites.

DESCRIPTION: The incorporation of thin layers of tough resin films and polymeric fiber papers between plies of graphite fiber plastic prereg greatly increases the impact resistance of the laminates. However, the temperature capability of such films and papers needs to be increased to approximately 500 F. the films and fibers should have the following room temperature physical and mechanical properties (in the ranges and with the characteristics indicated):

a. Tensile modulus: 0.5 to 2.0 (x10) psi
b. Ultimate tensile strength (minimum): 50 to 100 (x10) psi
c. Elongation at rupture (minimum): 40 to 50%
d. Thickness of film or paper: 0.0005 to 0.001 inch
e. Withstand composite fabrication temperatures up to 500 F
f. Adhere well to bismaleimide laminating resins
g. Resistant to fluids used in operating and maintaining aircraft

The work shall consist of preparing the films and papers by a prototype production process; determining properties of the films and papers and demonstration of feasibility of incorporating the films and paper in laboratory scale graphite fiber bismaleimide composites. Proposed may address either the films or paper requirements, or both, dependently on qualifications of the offeror.

AF87-103 TITLE: High Performance Aluminum Beryllium, Titanium, Magnesium

OBJECTIVE: To develop approaches resulting in new rapidly solidified aluminum, beryllium, magnesium and titanium alloys.

DESCRIPTION: Unique approaches to result in new rapidly solidified aluminum, beryllium, magnesium and titanium alloys are required. Incorporated are iltra high temperature aluminum alloys to replace titanium for applications to 900 F and ultra high temperature titanium alloys to replace superalloy applications to 1800 F. Utilizing rapid solidification (RS) technology environmentally stable, ultra light magnesium alloys and beryllium alloyed to alter the normally hexagonal close-packed structure, are desired. Included is the response of these alloys to secondary processing. Rapidly solidified titanium alloy requirements are directed for improvements in three areas: temperature stability to 1800 F, strength to 210 ksi, and higher modules/density ratio. Because of good specific strength and stiffness, magnesium alloys are potentially attractive for many aerospace applications. Research is now needed to explore property improvements, especially in the corrosion resistance of these alloys. Improvements in strength, stiffness, and a reduction in density may be possible using novel alloying additions. Approaches are needed in the following areas; low cost consolidation techniques, and characterization of microstructure/mechanical property interaction. Magnesium/graphite metal matrix composites offer considerable promise for space applications because of their strength to density ratio and zero coefficient of thermal expansion . Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Matrix materials considered should be rapidly solidified to take advantage of unique property improvements available.

AF87-104 TITLE: Determination of Constitutive Parameters of Materials Subjected to Severe Environments

OBJECTIVE: To develop methods to determine fracture, fatigue, and constitutive characteristics of newly developed materials for high performance turbine engines, and advanced structures for aeronautical and space applications.

DESCRIPTION: Advanced methods, including innovative test techniques and unique apparatus, are needed to determine fracture, fatigue, and constitutive characteristics of newly developed materials for high performance turbine engines, and advanced structures for aeronautical and space applications. Emphasis will be placed on the testing of small samples to determine characteristics, such as failure modes, crack growth, modulus, and damping, as a function of temperature and other environments under tensile, compression, and shear monotonic and cyclic loading. Typical materials systems include titanium aluminides, nickel aluminides, ceramic matrix composites, and metal matrix composites. Phase I activity will include demonstration of feasibility through assessment of correlating parameters on selected materials. This will lead to Phase II activities of final development of techniques and apparatus including validation of database for use for further material development and transition to advanced structural design.

AF87-105 TITLE: High Temperature Materials for Advanced Systems

OBJECTIVE: To develop approaches to the development and characterization of advanced ceramic and carbon matrix composites, advanced intermetallic materials and composites for advanced systems.

DESCRIPTION: New approaches to the development and characterization of advanced ceramic and carbon matrix composites, advanced intermetallic materials and composites, are needed for potential Air Force applications in space structures, advanced transatomospheric flight vehicles, and advanced gas turbine engines. New, unique high temperature matrix/reinforcement materials, configurations and oxidation protection systems must be developed and evaluations conducted to determine matrix/reinforcement interactions during manufacture and during application of the composites. Test systems must be developed and applied for use with small samples to determine mechanical and physical behavior, such as failure modes, crack and void growth, oxidation, stress strain and cyclic stress-strain of behavior as a function of temperature and loading histories. Modeling mechanical and physical behavior in terms of composite constituent materials must be implemented and applied to prediction of mechanical behavior, failure characteristics, and response to environmental exposure of structural concepts for potential application in future advanced system designs.

AF87-106 TITLE: Advanced Technology Materials for Electromagnetic Applications

OBJECTIVE: To develop new high performance materials for electromagnetic applications.

DESCRIPTION: The Air Force is interested in developing new high performance materials for electromagnetic applications such as advanced printed wiring boards and radomes. Specific materials of interest include:

a. Low electrical loss fibers. These fibers should have mechanical properties approaching current state-of-the-art graphite (AS-4) with the permittivity of astroquartz (megahertz to gigahertz range) at temperatures of at least 450 F and preferably to 2500 F.
b. High permeability magnetic materials. These soft magnetic materials should have low and high permeability properties in the megahertz to gigahertz frequency range and a tight hysteresis loop. The materials developed should be lightweight and possess magnetic properties comparable to current iron and cobalt systems at temperatures of 350 F and approaching 3000 F.

AF87-107 TITLE: Semantic Data Base

OBJECTIVE: To develop a data management technology capable of controlling and communicating data between several manufacturing processes.

DESCRIPTION: Computer Integrated Manufacturing (CIM) data management at the present time and in the foreseeable future can be characterized as collections of heterogeneous, generally incompatible, special purpose computer systems. Generally, automatic data manufacturing systems and devices on the factory floor have their own data management schemes and protocols; these data management systems reflect manufacturer application, age of development, and performance requirements of the specific task. Interfaces to the user and other data management systems is typically neglected in the development of these databases. In order to control and communicate data between several manufacturing processes it is necessary to develop a data management technology capable of:

Robust input and output
Data conversion /query translation
Automatic updating and integrity

This database not only stores the data efficiently for the application but acquires, interprets, converts, modifies, compiles, organizes, checks, translates and communicates data.

The development of this semantic database technology will process the input semantically rather than syntactically. It is suggested that this program address the development of a semantic database which will use relational object-oriented paradigms to model the manufacturing data. This database will have the capability to dynamically and autonomously develop or reorganize its own data structure without the syntactical bottleneck of contemporary databases.

AF87-108 TITLE: Expert System Development Tool for Manufacturing Application

OBJECTIVE: The development of production oriented manufacturing expert systems.

DESCRIPTION: An integral tool for the successful implementation of unified life cycle engineering is the development of production oriented manufacturing expert systems requires a methodology for knowledge elicited from the particular manufacturing expert and then should be organized into a format that is easily accessed and manipulated by the user. The knowledge that is used for the expert system is commonly known as the knowledge base. Subsequently the prototype knowledge base is exercised to extensively test the knowledge for its necessity, sufficiency, completeness, and consistency with respect to the manufacturing application. Case histories are built up which reflect the growth of the knowledge base and the ability of the expert system to address increasingly difficult problems. In applications such as manufacturing, individual knowledge bases are then combined into knowledge networks which are further refined to address problems of broader scope. To transition the test system to a real-time, production system the expert system program is tailored for efficiency by eliminating many of the utility programs

necessary during experimental development and often translated into a more efficient computer language. The use of expert systems in manufacturing will require automating and compressing this knowledge engineering process. It is suggested that the use of personal construct theory to develop an expert system tool would aid the knowledge engineering process. The expert system development tool would operate by suggesting rules as the knowledge engineering process is going. The development of this tools should significantly automate the development and integration of manufacturing expert systems.

AF87-109 TITLE: Strain Measurement Techniques for Testing High Temperature Structures

OBJECTIVE: To develop procedures for measuring strains in structures subjected to temperatures up to 4000 F.

DESCRIPTION: Current strain measurement techniques are limited to temperatures below 1000 F. As a result, strains in structures subjected to temperatures up to 4000 F cannot be experimentally determined with any degree of accuracy. The objective of this effort is to develop procedures for measuring strains in structures subjected to temperatures up to 4000 F. the suggested approach is to develop optical strain measurement procedures for use at very high temperatures.

AF87-110 TITLE: Automated Crack Measurement techniques for Fatigue Testing at Elevated Temperatures

OBJECTIVE: To develop an automated system to measure and record crack length and load cycle data from laboratory test specimens.

DESCRIPTION: Visual observation of the surface crack tip as it grows is very costly in terms of manpower and time. This problem is further complicated in elevated temperature by the presence of furnaces or heat lamp assemblies which make visual observations of the crack tip difficult. The materials property changes due to temperature also make traditional remote methods (e.g. compliance measurement, electrical resistance) difficult to calibrate and apply. The purpose of this program is to develop an automated system to measure and record crack length and edge-cracked panels, coupons containing cracked holes and notches, compact tension specimens, etc.) The system should be capable of measuring surface crack lengths from 2 mm to 80 mm in length with a precision of 0.025mm in a temperature field up to 2000 F and accuracy comparable to visual observation of the crack tip at room temperature.

AF87-111 TITLE: Finite-Element Models for the Supportability of United States Air Force (USAF) Aircraft Structures

OBJECTIVE: to establish the feasibility of a USAF-wide data base of finite-element models for the supportability of the structures of USAF aircraft.

DESCRIPTION: The purposes of this program is to establish the feasibility of a USAF-wide database of finite element models for the supportability of the structures of USAF aircraft. Structural and dynamic analysts and designers operate on the structures of USAF aircraft at many different sites (e.g. Wright-Patterson Air Force Base (AFB) Laboratories, Wright-Patterson AFB Aeronautical Systems Divison, Elgin AFB Laboratories, several Air Logistics Centers and several Air Force System Command Test Centers) and for many different purposes (e.g. ground loads, flight loads, preliminary design, stress analysis, vibrations, acoustics, fatigue, test planning and certification of structural integrity). All of these analyses require finite-element models of the aircraft structures. Usually each activity obtains or develops its own finite-element model, at the level of detail and sophistication that satisfies its specific mission.

The objective of the Phase I effort is to examine in detail the development and use of finite-element models of the aircraft structures. Usually each activity obtains or develops its own finite-element model, at the level of detail and sophistication that satisfies its specific mission.

The objective of the Phase I effort is to examine in detail the development and use of finite-element models of the structures of USAF aircraft and determine if it is feasible to organize a centralized function to obtain, develop, modify, evaluate, certify and apply those models in a efficient way throughout the USAF. Key features will be the development of methods to transfer data between models of varying detail, using a master model as a primary reference. The contractor shall also develop estimates of the cost of the currently dispersed procedures and the potential tangible benefits of developing the centralized system. If the Phase I effort shows the feasibility, subsequent SBIR Phases could demonstrate the program for one or more USAF fighter aircraft, paving the way for subsequent adoption throughout the USAF structures community.

AF87-112 TITLE: Fatigue Testing Techniques for High Temperature Structures

OBJECTIVE: Develop techniques for performing crack growth tests under combined thermal and mechanical loading.

DESCRIPTION: The current emphasis in structural integrity analyses is shifting toward high temperature structures for hyper velocity vehicles. In order to provide verification capability for these new analysis methods as well as demonstration of compliance with United States Air Force requirements for actual structures, techniques for performing crack growth tests under combined thermal and mechanical loading must be developed. Current technology can provide accelerated testing of loads and account for frequency effects. Similarity, temperature effects are accelerated using equivalent exposure times as calculated by Arrhenius' Law. The interactions between load and temperature effects have only been treated in real time.

This effort shall develop techniques for programming temperature profiles to combine with flight-by-flight load histories and to develop algorithms for calculating equivalent damage combined load/temperature histories which will permit accelerated testing with no loss in crack growth behavior simulation.

AF87-113 TITLE: Scaling of Large Space Structure Joints

OBJECTIVE: To develop accurate prediction or measurement techniques for fundamental system dynamics of future space systems.

DESCRIPTION: Air Force sponsored studies in recent years have identified a variety of future space system concepts which will require large deployable or erectable assemblies. A key requirement for all of these systems is the accurate prediction or measurement of the fundamental system dynamics. Problems of size, presence of gravity, and adequate suspension systems complicate the preflight testing of such structures. If sub-scale models could be used to accurately predict full scale system behavior, significant benefits could result (assuming gravity and suspension system interference can be adequately overcome or allowed for) – such as reduced testing facility requirements, lower testing costs, and greater flexibility to evaluate variations in system design. Since large space structures are literally joint dominated structure, an investigation and understanding of joint scaling is mandatory for such an approach. The initial Phase I program will explore joint characteristics and seek to develop scaling relationships and guidelines using simple, easily fabricated dynamic systems. A follow-on Phase II program could apply the relationships developed to more complex, realistic, large space structure examples.

AF87-114 TITLE: Run Flat/Low Vulnerability Aircraft Tire

OBJECTIVE: To develop designs and approaches for self repairing, improved puncture/pressure loss resistant, or run flat capability for capability for aircraft tires.

DESCRIPTION: During wartime, emergency or training operation, aircraft are either required to operate over airfield surfaces having foreign objects on them or operation on the airfield must await foreign object removal. In many instances, the urgency of the mission will demand operation on the debris covered surface. It has been established that severe tire damage can result from operation over these debris which causes failure or requires tire replacement. Innovative designs and approaches for self repairing, improved puncture/pressure loss resistant, or run

flat capability for aircraft tires are solicited. The innovative method taken must not degrade tire durability or performance during normal takeoff, landing, and taxi operations. External volume penalties are unacceptable. Additional weight, complexity, and installation/removal time must be minimal. The goal is to provide a back-up load carrying capability suitable for at least one takeoff and landing with load carrying capability suitable for at least one takeoff and landing with little loss of pneumatic characteristics once the tire casing has been violated.

AF87-115 TITLE: Cargo Aircraft Rapid Loading/Unloading

OBJECTIVE: To develop methods to rapidly load up and discharge cargo and troops from tactical military transport aircraft.

DESCRIPTION: Advanced technology application concepts are sought o implement a capability to rapidly load up and discharge cargo and troops from tactical military transport aircraft capable of landing on unprepared terrain behind forward battle front areas. Concepts should facilitate one or more of the following jobs:

a. Airdrop and recovery of personnel and cargo with emphasis on low linear ground dispersion.
b. Ground loading and unloading of material and personnel with emphasis on rapid turnaround concepts that support minimum contamination of cargo compartment by chemical warfare agents.

Concepts should consider materials handling equipment and design of cargo compartment, automation and robotics approaches.

AF87-116 TITLE: Integrated Test System-Aircraft Ground Operation

OBJECTIVE: To develop methodology for the conduct of Flight Dynamics Laboratory Landing Gear Development Facility (LGDF) landing gear tests as an integrated part of piloted Large Amplitude Aerospace Research Simulator (LAMARS) aircraft simulations.

DESCRIPTION: Future high performance aircraft will require landing gear which must perform in a much more severe operating environment than current aircraft. To provide suitable landing gear and reduce program risks, a much higher level of confidence must be achieved for landing gear laboratory test results. Currently, landing gear and their components are tested under simulated ground operating conditions in the LGDF. However, the degree of simulation is limited by lack of ability to adequately consider pilot inputs and other aircraft interactions. Located near the LGDF is FDL's large Amplitude Multimode Aerospace Research Simulator (LAMARS) Facility, in which very reliable piloted aircraft simulations are conducted. A much higher level of confidence could be established for landing gear tests if they and piloted LAMARS tests could be integrated to produce an optimum simulation of ground operating conditions during landing gear tests. The feasibility of and scope of work needs to be established for conducting LGDF landing gear tests as an integrated part of piloted LAMARS aircraft simulations. The Phase I effort includes determining modifications needed to various LGDF landing gear test machines and the LAMARS facilities, and how data should be transferred between the LGDF and LAMARS facilities. The anticipated improvement to the confidence level for landing gear test data will also be projected by the contractor.

AF87-117 TITLE: Fighter Cockpit Ingress in Chemical Warfare Environment

OBJECTIVE: To develop technology procedures and equipment to allow pilot ingress into aircraft cockpits while excluding the chemical agents and obviating the need for the protective garment.

DESCRIPTION: Measures for protecting he crew and insuring air purity within enclosed fighter cockpits during aircraft operations in a chemical warfare environment are under development. Because of the risk of introducing chemical contaminants from the atmosphere or carried on clothing during cockpit ingress, an encumbering protective garment is required in addition to collective onboard protection. A highly desirable goal is to permit crew functioning within sleeve environment. Accordingly, provisions employing applications of technology and appropriate procedures are sought to allow pilot ingress into fighter aircraft cockpit while excluding the chemical

agents and obviating the need for the protective garment. Concepts and primitive deominstration are solicited which should consider palatable modifications to aircraft and canopies, and other equipment and vehicles common to airports and airfields and, if necessary, new equipment concepts. Concepts should be compatible with the scenario, aircraft and personnel status starting from an alert status and proceeding rapidly to aircraft takeoff following a chemical airbase attack.

AF87-118 TITLE: Flow Field Separation Approximations for Hypersonic Aerodynamics

OBJECTIVE: To solve problems associated with complex flow fields, resulting in interference phenomena which produce flow separation.

DESCRIPTION: The development of advanced technology for hypersonic aeromechanics includes the solution of problems associated with complex flow fields, resulting in interference phenomena which often produce flow separation is a common occurrence on maneuvering aerospace vehicles. Analysis is pursued in two ways: a rigorous solution of the Navier-Stokes equations in a time dependent system for highly accurate point design data; and an approximate semi-empirical approach sufficiently accurate for preliminary evaluations. The purpose of this Phase I effort will be the development of more accurate approximations. The major types of flow separation to be addressed are the lee side areas during maneuvers, areas ahead of windward deflected controls, and regions of shock impingement for adjacent surfaces. The method will use boundary layer edge conditions and integral boundary layer properties as inputs. The outputs will be the dimensions of the separated region, the surface properties in the separated region, and the flow field properties from the surface to the inviscid edge of the region. Semi-empirical relations will be developed using experimental measurements and exact flow field computations as data. The result will be compiled in a report presenting graphical solutions and algebraic relations for preliminary design approximations.

AF87-119 TITLE: Nonintrusive Hypersonic Facility Diagnostics

OBJECTIVE: Develop a system which will provide accurate, off body velocity measurements in hypersonic flow facilities, and provide a suitable flow visualization capability.

DESCRIPTION: Current reemphasis on hypersonic flow measurements, as necessary for the design and development of hypersonic flight vehicles, has focused atteution on the need for modernizing and improving hypersonic flow diagnostics systems. With techniques being developed to improve the simulation quality, the need arises for new
Measurement systems. Current nonintrusive diagnostics in the hypersonic facilities include schlieren, interferometry, infrared scanning and limited Laser Doppler Velocimetry (LDV). LDV is limited by the high Doppler frequencies associated with very high velocities and small test volumes needed for high resolution measurements. Additionally, the seeding requirement for LDV in low density flows must be carefully considered where the mean free path is significant in relation to particle diameter (i.e., Knudsen number >> 1). The technique and type of seeding must also be examined in the development of advanced flow visualization to derive maximum benefit from this approach. What is needed is a system/technique, which at a minimum, will provide accurate, off body velocity measurements in hypersonic flow facilities, at least to Mach 14, and Also provide (not necessarily concurrently) a suitable flow visualization capability after minor reconfiguration. Accuracies for the velocity system should be comparable to LDV measurement currently being made at the lower Mach numbers.

AF87-120 TITLE: Turbulence Measurements in Hypersonic Flow

OBJECTIVE: To develop methods for obtaining turbulence measurements in hypersonic flow.

DESCRIPTION: The Flight Dynamics Laboratory (FDL) is interested in obtaining turbulence measurements in hypersonic flow. The objective of this Phase I effort is to develop the theory, approaches, techniques necessary to measure turbulence quantities that currently cannot be measured. Hot wire anemometry and laser Doppler velocimetry should be used in developing the data acquisition process. The diagnostic systems must be compatible

with FDL's High Reynolds Number Mach 6 wind tunnel and 20 inch Mach 12-14 wind tunnel facilities. The approach used must be capable of calculating Reynolds stresses and terms which involve density fluctuations. For example:

For low Mach numbers, the term p'u'v' is usually neglected, but at high Mach number it is not negligible and should be measured. The goal of this effort is to develop an experimental capability to perform the needed measurements. A Phase II effort could experimentally verify the Phase I methods in FDL's wind tunnel facilities.

AF87-121 TITLE: Configuration Analysis for Dynamic Maneuver Performance

OBJECTIVE: To develop conceptual design and analysis tools which allow evaluation of novel or unique aeromechanic technologies, which yield excellent aircraft transient performance.

DESCRIPTION: The intense battlefield environments of future conflicts will require advanced Air Force fighter aircraft to possess superior Vertical/Short Takeoff and Landing capability and maneuver agility. To achieve both of these qualities, conceptual design and analysis tools must be developed which allow evaluation of novel or unique aeromechanic technologies, which yield excellent aircraft transient performance. Current analysis of aircraft dynamic motions involves solving the equations of motion in terms of static and first order dynamic stability derivatives. This analyses is extremely cumbersome and of limited accuracy due to the numerous linearizing assumptions involved and the extremely difficulty in obtaining accurate dynamic stability derivations. The objective of this Phase I effort is to utilize advanced computational techniques to continuously calculate the time dependent forces and moments on a complete aircraft configuration, integrate these forces and moment, and obtaining the resulting aircraft trajectory. A modularized aircraft performance computer algorithm shall be developed which incorporates state-of-the-art dependent aerodynamic prediction routines with an accurate numerical performance integration to predict aircraft motions resulting from arbitrary control inputs. The modular aerodynamic analysis routine should be capable of being easily upgraded as computational needs are justified or advances in analytical fluid dynamics occur. The feasibility of this newly developed configuration analysis and performance comparisons with existing configurations.

AF87-122 TITLE: Digital Database Support for Tactical Situation Displays

OBJECTIVE: To developed digital database support for tactical situation displays.

DESCRIPTION: The advancements in digital storage and graphics processors, combined with the expansive Digital Landmass System (DLMS) databases from the Defense Mapping Agency (DMA), makes possible the development of plan view and pilot-perspective tactical situation displays. Such data-driven displays have application in simulators, mission planning stations, and airborne crew stations. The data would also be used for system integration of navigation, flight path control, fire control, and threat avoidance functions. A logistical link is required between the available DMA data and the target display processors. The DMA data would be augmented with tactical data from operation orders, intelligence, weather forecasts, etc., in the ground environment. In airborne applications, the above data would be supplemented with external data link and onboard sensors.

Several studies have been performed that have defined the data required to fly a tactical mission. Additional research is needed to define the logistical support for creation and maintenance of a computerized database and for pilot interaction with the database to compile the mission/flight plan. The Phase I effort should begin with identification of available technology and data sources; proceed to the definition of an operational concept to collect, merge, process, hardware, software, and data architecture for such a system. This conceptual design should link the flow of DMA and other data into an advanced squadron-level mission planning station. The mission planning station should provide for integration and preview of essential data elements and data output for transfer to the aircraft display processors. Configuration control of both ground and flight software should be included in the conceptual design.

AF87-123 TITLE: Abductive and inductive Reasoning in Maintenance Diagnostic Systems

OBJECTIVE: To determine whether the capabilities of abductive reasoning combined with inductively-synthesized hypothesis testing will aid in the development of flight control system maintenance diagnostic software.

DESCRIPTION: Research is needed to determine whether the capabilities of abductive reasoning combined with inductively-synthesized hypotheses testing will aid in the development of flight control system maintenance diagnostic software. Currently, maintenance diagnostics software for troubleshooting complex equipment such as aircraft flight control systems uses logical and statistical failure data. The limitation of this approach for new flight control systems stems from its dependence on statistical data. Abductive reasoning would improve the performance of the decision making process for new maintenance diagnostic systems. The abductive identification selects a small number of plausible hypotheses, and rank-orders them using a judgment based on their probability of occurrence. Then instead of automatically choosing the hypothesis having highest probability, the several most likely hypothesis are tested via an inductive reasoning process which is based on the designer's understanding of the system behavior. The diagnostics would proceed to the most likely fault. For this fault, a test is made using the appropriate system observable(s). the next most probable fault is then tested. The use of abductive reasoning combined with inductive reasoning will significantly benefit the development of future flight control maintenance diagnostic systems for advanced aerospace vehicles.

AF87-124 TITLE: Long Life, Multi-Megawatt Space Power Systems

OBJECTIVE: To develop improved long life, survivable multi-megawatt space power systems, while reducing weight and cost, and increasing life to a minimum of 5 years in low orbits and 10 years for high orbits.

DESCRIPTION: Near-term power requirements of military satellite power systems are 5 to 50 KW. Future power requirements extend to the multi-megawatt range. Survivability and long-life are required for all future missions. Technology needed to meet these requirements includes system and component technology in the 200 to 300 VDC range. Technology is needed to improve system performance, reduce weight and cost, and increase life to a minimum of 5 years in low orbits and 10 years for high orbits. The following developments are needed:

a. Research and development of high power solar cell array technology is needed to enhance the survivability of the array and improve end-of-life efficiency and performance. Techniques are sought to increase survivability at temperatures up to 600 C and provide protection from hostile environments. Techniques are needed to provide autonomous operation of the solar array as part of a power system on a space aircraft.
b. Fully packaged rechargeable satellite batteries are needed with the following characteristics: 1) a usable specific energy of 100 watt-hours per pound under the following conditions: charge-discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, change times of 5.25 to 22.8 hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 KW per pound and 2) a usable specific energy of 50 watt-hours per pound for 30,000 charge-discharge cycles.
c. Spacecraft power system thermal management research is required in the areas of 1) steady and unsteady 2-phase heat transfer for power electronic cooling in the 300-400K regime; 2) ultralight expandable radiator concepts and other heat rejection, transport and storage techniques; 3) flow stability and heat transfer phenomenology related to zero-gravity 2 phase, unsteady high flux heat transfer processes in cryogenic reactants; and 4) high temperature thermionic devices, high temperature thermal energy storage, and associated heat transfer mechanisms.

AF87-125 TITLE: High Power For Space Applications

OBJECTIVE: To develop high power component technology for space applications.

DESCRIPTION: Development of one or more of the following technologies is needed in the area of high power for space:

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than ten kilovolts, response time less than ten nanoseconds, and

lifetimes of greater than 1.0 million pulses per device. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 micro-seconds, and an indefinitely long lifetime.

b. Repetitive opening and closing switches for pulse power output of between 10 and 100 lkilovolts and 0.1 to 1.0 million amps. Response time must be less than or equal to 100 nanoseconds and lifetime must exceed one million events.
c. High temperature power semiconductor device with a maximum junction temperature of 3000 degrees centigrade, low power dissipation, and the ability to switch 10 amps at 1.5 KW per device.
d. High power, high voltage, high current density pulse conductors that are lightweight, high-strength, and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed as well as continuous high power without conductor failure. Intercalated graphite conductors must be lighter weight and higher strength than cooper and aluminum. Also, assembled intercalated graphite filaments; must be able to transmit pulsed as well as continuous high power without conductor failure. Superconducting conductors must be able to continuously carry 150 kiloamps per square centimeter at an operating temperature above 7.0 degrees Kelvin without going normal. Dielectric insulation for these conductors must be lightweight, thermally and chemically stable for the space environment and have a voltage withstand of 20 kilovolts per mil of thickness.

AF87-126 TITLE: Batteries For Aircraft And Missile Power

OBJECTIVE: To develop advanced electrochemical power source sysyems that offer increased life with improvements in energy and/or power density.

DESCRIPTION: Advanced electrochemical power source concepts are sought that offer revolutionary improvements in energy and/or power density. Batteries are needed with the following performance characteristics:

a. Rechargeable batteries that provide a gravimetric energy density of 100 watt-hour/pound, volumetric energy density of 8 watt-hours/cubic inch, power density of 300 watts/pound, 15-year life, 1000 charge/discharge cycles, energy efficiency of at least eighty percent, and a self-discharge rate of 10,000 hours or slower. The size range of interests from two through five thousand ampere-hours.
b. Active primary batteries for survival avionics that deliver thirty or more watt-hours/cubic inch and at least 100 watt-hours/pound at the ten-hour discharge rate with pulses at the twenty-minute rate near end of life. The batteries must operate over the temperature range from-65 to +210 degrees Fahrenheit. The size range of interest is from 0.5 to 30 ampere-hours.
c. Active primary batteries for ground and mobile power applications that provide over 400 watt-hours/pound, over 25 watt-hours/cubic inch. 100 hour or slower discharges, and 15 year shelf life.
d. High power density primary reserve batteries for airborne applications that can provide peak power densities of at power densities of at least, 10,000 watts/pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with shelf life of 25 years and no degradation. Other parameters of interest are: activation within one second or les by an electrical pulse, airborne environments, operation over the temperature range from –65 to +165 degrees Fahrenheit without any external heat source, gravinmetric energy of 50 or more watt-hours/pound, and volumetric energy density of one or more watt-hours/cubic inch.

AF87-127 TITLE: High Power Electrochemical Power Sources For Space

OBJECTIVE: To develop high power long life electrochemical power sources for space applications.

DESCRIPTION: High power and energy density rechargeable and non-rechargeable electrochemical power sources should not produce effluents during storage and/or operation. A calendar lifetime of at least ten years is desired with an active lifetime of 0.3 hours under random intermittent load conditions over the ten year lifetime. Instant on-instant off capability is desired. Peak power density goal is 0.1 ib/kwh including all reactant, case, seal, terminal, connector, structure and auxiliary weights. The power source must not produce any torque, thrust, moments, gyroscopic effects or vibration external to

AF87-128 TITLE: Test Techniques For Very High Mach Number Scremjets

OBJECTIVE: To develop advanced testing methods to extend the test times or to develop improved instrumentation, which can respond rapidly in the temperature environment of the flow.

DESCRIPTION: Theoretical studies indicate that supersonic combustion camjets (scramjets) can produce thrust up to Mach 25. Continuous flow or blow down facilities can simulate flow only up to Mach 8. Above that, shock tunnels or similar facilities must by used to obtain experimental data. Test times are of the order of milliseconds. The objectives of this program are to develop advanced testing methods to extend the test times or to develop improved instrumentation which can respond rapidly in the high temperature environment of the flow. Simulation of the total temperature and pressure of the flow with a large-scale model is necessary to understand the combustion phenomena made is the skin friction of the flow on the surface of the model.

AF87-129 TITLE: Advanced Air Separation Concepts

OBJECTIVE: To develop methodologies for in-flight collection of air by hypersonic, suborbital and orbital vehicles for the purpose of separating oxygen and storing it for use as in a rocket.

DESCRIPTION: Promising concepts are sought for in-flight collection of air by hypersonic, suborbital and orbital vehicles for the purpose of separating oxygen and storing it for use as in a rocket. Concepts of oxygen separation/enrichment for use in-flight must place a premium on lightweight, small volume devices/processes capable of very high air handling rates. Methods considered previously have included distillation, cycle oxidation-reduction, and membrane processes. New materials and new processes should be examined for potential application.

AF87-130 TITLE: Prevention of Freezing in Cryogenic Heat Exchangers

OBJECTIVE: To develop techniques by which flow blockage can be minimized in cryogenic heat exchangers.

DESCRIPTION: Atmospheric air when cooled to very low temperatures by heat exchange with cryogenic fluids will deposit water and CO2 on the heat transfer surfaces, reducing heat transfer efficiency and causing blockage of airflow passages. Techniques are sought by which flow blockage can be minimized. The water and Co2 may be actively removed or accommodated by features of the design. Active removal means should avoid great complexity should also be light and as small as possible.

AF87-131 TITLE: Combined Cycle Propulsion Technology

OBJECTIVE: To develop concepts and approaches for combined cycle propulsion systems which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations.

DESCRIPTION: New and novel concepts and approaches are sought for combined cycle propulsion systems which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations. Such propulsion systems would be capable of operating over a wide range of flight Mach numbers from 0 to 8 or above. Both manned and unmanned vehicles are involved. The aim of combined cycle propulsion systems is to maximize the overall system efficiency by exploiting the attributes of the various elements in their respective best operating speed regimes. In addition to maximum efficiency, emphasis is also placed on low weight, volume, and cost.

AF87-132 TITLE: Advanced Fuels For High Mach Aircraft

OBJECTIVE: Devise a separation scheme which can be easily performed that segregates typical aviation fuel to the extent that various classes of compounds can easily be determined.

DESCRIPTION: The complexity of aeropropulsion fuels presents strong challenges to current instrumental/analysis techniques. Usually, techniques involve costly instruments, impractical chemical preparation, and provide inaccurate data. Given the complex nature that segregates typical aviation fuel to the extent that the following classes of compounds can easily be determined: Paraffins (both normal and branched), alkylbenzenes, indanes and tetralins, mono-dicycloparaffins and tricycloparaffins, indanes and dihydronaphthalenes, naphthalenes, flourences, anthracences, acenaphthylenes, and olefins. Demonstrate using analytical chemical techniques that the scheme is more accurate and quantitative than current methods.

AF87-133 TITLE: Chemical Analyses of Advanced Fuels

OBJECTIVE: To develop fuels to power vehicles at speeds above Mach 10 which provide adequate heat sink, high heating values, good combustion characteristics, long-term stability and the necessary potential availability.

DESCRIPTION: Conventional liquid hydrocarbon distillate fuels cannot provide sufficient heat sink capacity to cool other aircraft and engine system components and tend to form deposits within critical portions of the engine fuel system when used at speeds above the Mach two to three range. Cryogenic fules, such as liquid hydrogen, have excellent heat sink capacities but have undesirable low volumetric energy characteristics and storage and handling problems. Special liquid hydrocarbons which undergo catalyzed dehydrogenation reactions and vaporization to provide additional heat sink capacity have also been studied. New fuels and fuel concepts are required to power vehicles at speeds above Mach ten. New, innovative fuels are needed to provide adequate heat sink, high heating values, good combustion characteristics, long-term stability and the necessary potential availability. New approaches to the synthesis and production of improved fuels through the application of selected combinations of chemicalcatalytic reactions and catalyst systems are required.

AF87-134 TITLE: Fuel Combustion Technology

OBJECTIVE: To demonstrate significant advances in combustion technology.

DESCRIPTION: Renewed interest in hypersonic flight and continued emphasis on improving the performance of conventional aircraft require significant advances in fuel combustion technology. Specific topics of interest include: (1) combustion enhancement concepts for use with conventional and advanced fuels in subsonic and supersonic combustors wherein the ignitability of laminar flame speed of the fuel is inadequate under some flight conditions; (2) new fuel/air mixing concepts for potential use in subsonic and supersonic combustors to increase combustion efficiency reduce pressure losses and permit the development of smaller, lighter combustors; (3) new or improved fuel combustion, mathematical models that accurately calculate fuel/air mixing in the presence of large-scale turbulent structures, include simplified but accurate fuel purolysis and oxidation kinetics and include two-phase flow capabilities for handling liquid fuel injection and atomization; and (4) new combustion diagnostics that can measure temperature, pressures, species concentrations and other parameters non-intrusively and with data rates exceeding 10,000/seconds.

AF87-135 TITLE: Novel Methods for Evaluation of Solid and Liquid Lubricants

OBJECTIVE: To develop methodologies/processes to efficiently and accurately assess the thermal, oxidative and tribological capabilities of candidate lubricant materials/formulations which may be available in very small quantities only.

DESCRIPTION: Novel methods of evaluation are required for advanced fluid and solid lubricants for potential high performance turbine engine applications. Advanced fluid operational temperatures in the range of 315 C or higher and solid lubricants at 540 C to 1000 C or higher are projected. The need is to efficiently and accurately assess the thermal, oxidative and tribological capabilities of candidate materials/formulations which may be available in very small quantities only

AF87-136 TITLE: Turbine Engine Bearing Concepts

OBJECTIVE: To design rolling element bearings for advanced turbine engines with higher rotor speeds.

DESCRIPTION: In order to meet thrust-to-weight ratio goals of advanced engines, it is predicted that rotor speeds will need to increase in the order of twenty-five percent over current state-of-the-art production military engines. Innovative approaches are needed for the design of rolling element bearings to obtain the life of current engine systems while operating at these higher speeds. Previous approaches have included: Series-Hybrid Thrust Bearings, Dual Diameter Roller Bearings, hollow rolling elements and high-speed tapered roller bearings. Additional innovative concepts should be conceived and analyzed in this research effort for their application to, and suitability for, turbine engine mainshaft support.

AF87-137 TITLE: Angular Weaving for Turbine Engine Composite Components

OBJECTIVE: To reduce the fabrication costs and inherent flaws associated with components made from composite reinforced materials using angle ply hand layups and woven filament mats.

DESCRIPTION: Fiber reinforced composite materials offer design alternatives which will enable the designer of gas turbine engine components the ability to develop lightweight, low cost, high performance engine components. The purpose of this effort is to reduce the fabrication costs and inherent flaws associated with components made from composite reinforced materials using angle ply hand layups and woven filament mats. Critical to efforts such as utilizing metal matrix composite materials in a gas turbine engine low-pressure spool shaft application, are uniformly spaced woven filament mats at fiber weaving effort shall address the costs of the angle weaving process and will compare this to current fiber weaving methods and layup operations. An assessment will be made to determine if the angular weaving process will provide a reduction in fabrication costs. It will be determined if an increased capability to fabricate components from composite materials is obtained and whether any limitations are imposed by the fiber on the weaving process.

AF87-138 TITLE: Turbine Engine Test Instrumentation Techniques

OBJECTIVE: To develop new sensors/systems for the accurate determination of the strains and temperatures under which engine components must operate.

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state-of-the-art of structural instrumentation has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is commonly temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor.

For these reasons, new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding 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 parameters and gas flow path.

AF87-139 TITLE: Compression System Design Methodology

OBJECTIVE: To develop enhanced and advanced compression system and secondary flow design methodologies.

DESCRIPTION: This is to be achieved by numerous theoretical and experimental efforts including such work as computer modeling, cascade testing, bench rig tests, etc., all adequately documented as to be acceptable to the

technical community. A major trend in compression system hardware is the increased utilization of low aspect ratio blading, blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two dimensional must be extended fully into three dimensions to adequately exploit these trends. Adequate documentation of this work and its influence on turbomachinery is needed as in a comprehensive background document on turbomachinery. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation, trenching, labyrinth seals, and disc pumping), time unsteady features of the turbomachinery gas path, and secondary flow systems.

AF87-140 TITLE: On-Wafer Testing of MMICs

OBJECTIVE: To improve screening and testing methods to better characterize the circuits and to eliminate chips as early in the fabrication sequence as possible to reduce overall chip cost.

DESCRIPTION: The development of gallium arsenide (GaAs) monolithic microwave integrated circuits (MMICs) has progressed rapidly during the last five years. Laboratory demonstrations of single and multiple circuit functions in the same chip have been very impressive. A number of companies have built pilot-line production facilities or make use of foundry services to produce small to medium quantities of MMICs. Problems of variations in DC and RF performance and low yield fabrication processes plague MMICs. Improved screening and testing methods are needed to better characterize the circuits and to eliminate chips as early in the fabrication sequence as possible to reduce overall chip cost. The objective of the subject program is to develop on-wafer testing equipment, methods and procedures for GaAs Field Effect Transistor (FET) based MMICs that are fabricated on 3” diameter semi-insulating substrates. Such equipment and techniques will be capable of performing automatic or manual DC and RF probing of discrete and MMICs on the wafer. On-wafer calibration will be part of the measurement sequence. DC parameters such as saturation current, pinchoff voltage, transconductance, contact resistance, and fat FET will be measured; RF parameters such as S-parameters, return loss, and gain will be measured in conjunction with an automatic vector network analyzer as a function of frequency in the 0.1 to 26 Ghz frequency range. The contractor shall explore both contacting and noncontacting probing of MMIC wafers. Emphasis shall be placed on developing probing equipment and techniques that are directly applicable to high volume, high rate production of GaAs MMICs.

AF87-141 TITLE: Processor for Artifical Intelligence/Ada Applications

OBJECTIVE: To investigate and develop a 32-bit militarized processing module with an instruction set architecture that will efficiency perform both AI and Ada-type processing and compatibility with applicable backpanel bus standards.

DESCRIPTION: The Avionics Laboratory is presently developing 16-bit Very High Speed Integrated Circuit (VHSIC) data processor modules for both embedded and standalone applications and VHSIC common signal processor modules which are compatible with the advanced system avionics architecture currently being developed. A standard backpanel bus system to interconnect these modules is also being developed in order to achieve module-level interoperability and to support the two-level maintenance concept. These processing elements are being developed based upon a conventional (Von-Neuman) computer architecture with JOVIAL as the high order language (HOL). Several new items have surfaced which, if incorporated into the design, would significantly enhance the capability of the system. Artificial intelligence (AI) is an emerging technology which involves rule-based processing versus conventional “number crunching.” Also, Ada has been adopted as the Air Force standard HOL for avionics data processing and will impose it’s own set of unique processor architecture considerations. These factors, coupled with the improved performance offered by 32-bit processors, present the opportunity to investigate advanced 32 bit processor instruction set architectures which efficiently execute either AI or Ada based software in a single processing element. Such as processor represents the next step in the development of the avionics architecture.

This effort will investigate the feasibility of a 32 bit militarized processing module with an instruction set architecture that will efficiently perform with an instruction set architecture that will efficiently perform both AI and

Ada type processing and compatibility with applicable back panel bus standards to support integration into future systems. Available 32-bit processors will be evaluated with respect to unique Ada and AI processing requirements. This research will provide the basis for a common module specification for an AI/Ada processor element and its associated bus system as well as a common 32 bit instruction set for processor operation.

AF87-142 TITLE: Biomass Adaptive Network

OBJECTIVE: To demonstrate an ability to train a biomass culture, thus simulating motor output for the network with feedback.

DESCRIPTION: This research will involve coupling organic cells with adaptive networks (e.g. Hopfield nets) which will interact with and control the organic activity. Specifically cultured neuronal cells will be surgically customized to reside on a dense array o microelectrodes photoetched onto a glass substrate. The objective will be to demonstrate an ability to train the culture, thus simulating a motor output for the network with feedback. The culture will be connected via a cable to an adaptive network which will interact with and provide stimulus signals to the neuronal array. Specific aims for research include paralleled high speed data acquisition and correlation among channels, development of statistical procedures to analyze cellular electrical activity patterns, computer storage of cell morphological data, network monitoring ad control of biological activity, and identification of biological pattern generation circuits. This project will substantially accelerate investigations of biological networks and begin to disclose basic principles of neuronal network architecture and function. Advances in understanding these functions can lead to true machine intelligence, reliable autonomous vehicles, adaptable control circuits which learn from experience, natural language understand and gracefully reconfigurable command and control structures. The network is the simplest operational level for the study of signal processing and storage, the phenomena which form the basis of memory learning and behavior. Progress in this area could have a profound effect on future computer design and programming.

AF87-143 TITLE: Design Automation Knowledge Representation

OBJECTIVE: Formal representation of design knowledge for embedded electronic systems.

DESCRIPTION: The design of complex embedded electronic systems requires design automation systems with sophisticated internal representations of symbolic and numeric design knowledge. Ideally, design fact domains and design rule domains should be formalized, complete, orthogonal, consistent, and validated; they should generate successful designs efficiently, or quickly determine that none exist. They should describe logical and physical design components, and analog and digital ones they should support query/answer transactions and tutorial design explanations. Good design knowledge representation can make the difference between quickly synthesizing a low-cost high performance design, and not being able to find one at all (even though it exists). To implement good internal design knowledge representations, creative research is required in all areas of design knowledge representation for embedded electronic systems. The upper bound of this research is the formal representation of system requirements for the many current perceptions of “system” the lower bound is formal expression of knowledge for design primitives, “ the lowest-level indivisible design components. This research includes knowledge representation for Mil Specs and Mil Standards; it includes electrical and physical design, as well as electronic design. Proposals should focus on a well-defined internal design knowledge domain relevant to embedded military electronic systems. Efficient hardware implementations of available design knowledge models are not excluded. This research will eventually result in prototype demonstration of design knowledge representations on a workstation, mainframe, or otherappropriate design automation computer system.

AF87-144 TITLE: Computer-Aided Design of MMICs

OBJECTIVE: Develop circuit design and layout procedures that are applicable to the high volume, high rate MMIC production environment.

DESCRIPTION: Historically gallium arsenide (GaAs) monolithic microwave integrated circuits (MMICs) have been developed based upon hybrid microwave integrated circuit concepts, fabrication techniques, and design procedures, This approach suffers from large variations in MMICs possess unique processing and circuit design opportunities that physically and electrically do not exist for hybrid Ics. The objective of this program is to exploit these opportunities to develop MMICs that perform to specification and are affordable. The contractor shall develop computer-aided design techniques that permit the adjustment of circuit topologies and configurations, based upon in process test results, to enhance the final circuit performance and yield. Emphasis shall be placed on circuit design and layout procedures that are applicable to the high volume, high rate MMIC production environment. Concepts such as reconfigurable MMIC analog arrays shall be investigated for such components as low noise and power amplifiers, phase shifters, and transmit/receive switches operating in the I-20 GHz frequency range. Materials, computer-aided design, fabrication, assembly and testing factors will be considered as the design approaches are investigated and refined.

AF87-145 TITLE: Communication Requirement for the Hypervelocity Vehicle

OBJECTIVE: To define and develop the communications requirements for the Hypervelocity Vehicle.

DESCRIPTION: The Hypervelocity Vehicle will be a vehicle that can operate as an airplane at hypersonic velocities (4000 to 8000 miles per hour) in the upper atmosphere or as a space launch vehicle capable of accelerating directly into orbit.

This effort shall define the communications requirements for the Hypervelocity Vehicle given certain defined mission scenarios for the vehicle. Driving technical problems are imposed by the mission, vehicle dynamics and the environment, Room if the primary communications technology areas of concerns are:

a. High data rate jam resistant communications
b. Laser communications
c. Integrated Multifunction Antennas
d. Doppler effects
e. Low probability of Intercept
f. Communications during blackout on re-entry from space into the earth's atmosphere

AF87-146 TITLE: Electro-Optical Sensors on Hypervelocity Platforms

OBJECTIVE: Quantify problems associated with use of active and passive electro-optical (EO) sensors in the visible and infrared bands from hypervelocity platforms and necessary technology developments specified.

DESCRIPTION: Problems associated with use of active and passive electro-optical (EO) sensors in the visible and infrared bands (5-1.0 um, 3-5 um, 8-12 um) from hypervelocity platforms need to be quantified and necessary technology developments specified. The range of window temperatures, near window turbulence, and any other near windows atmospheric affects need to be specified. Window materials and protection and protection techniques should be discussed. Calculations of potential sensor performance looking through a hot window need to be performed for various background suppression techniques. Methods of handling near window turbulence be discussed with consideration given to mechanical methods of reducing turbulence and methods of digitally compensating for turbulence. Adaptive optics methods of compensating for turbulence should be avoided unless simple methods, possibly using phase conjugation effects, can be found. Phase I results should include recommendations for specific developments needed to make future use of EO – systems from hypervelocity platforms practical. A Phase II demonstration of needed technology should also be defined at the conclusion of Phase I.

AF87-147 TITLE: Layered Semiconductors Devices

OBJECTIVE: To develop methods for assessing the viability of layered semiconductor devices.

DESCRIPTION: Semiconductor device structures composed of thin layers separated by atomically sharp interfaces have become the basis of a rapid expanding technology. The unique physical properties of such ultra-structured material devices have already resulted in significant improvements in performance of a variety of devices and new concepts are constantly being considered. These new structures are necessary for the continued advancement in the state of the art of digital, electro-optical and micro/millimeter wave technology. Areas which must be considered in assessing the viability of such devices include material growth device processing, physics and device performance. There is interest in addressing these areas separately or in concert. Efforts designed to improve the understanding of the unique physical properties of these structures, especially those which address electro-optical and/or high-speed phenomena are of great interest. Computer or mathematical models of transport or crystal growth are needed and novel device concepts verification is strongly encouraged. Development of the processes that are specific to the fabrication of these structures and associated devices such as ways of selectively contacting specific layers, ways of growing complementary structures on the same substrate or ways of achieving high device density will be given consideration. Gallum Arsenide-Aluminum Gallium Arsenide system is the one that is presently of highest interest but other materials combinations that would enhance some aspects of performances are also considered important.

AF87-148 TITLE: High Speed Random Access Camera

OBJECTIVE: To develop high speed random access camera

DESCRIPTION: The development of optical processors is limited due to devices that require relatively g times to get information into and out of the system. In order to generalize an optical processor to perform more than one function (a step toward an optical computer), the physical hardware of the system usually has to be reconfigured. These two problems can be decreased by system usually has to be reconfigured. These two problems can be decreased by the development of a high speed random access camera (RAC). The RAC is an array of detectors that can be randomly addressed electrically or optically by pixel as opposed to reading the entire frame serially. This would result in significant time savings for addressing selected portions of a scene and would be especially useful when combined with prior knowledge of the information in the system. The RAC could also address different areas of the array for different processor operations which would permit programmable operation through reconfiguration of the optical system interconnects. A silicon based RAC operating in the visible to near-infrared wavelength band with individual pixel access times of 1 microseconds or less is a much needed device for optical processor operation.

AF87-149 TITLE: Dynamic Holography Cockpit Display

OBJECTIVE: To provide research towards solution to Air Force systems requirements for more effective coupling of operators to advanced systems.

DESCRIPTION: We are seeking solutions to Air Force systems requirements for more effective coupling of operators to advanced systems. One primary concern in these virtual man-machine interactions is the exploitation of new and creative approaches to presentation of situation awareness and other information to the pilot. It is our intention to explore the feasibility and benefits of dynamic holograms as a pilot to aircraft systems interface device. The need for improved situation awareness involves informing the pilot of other aircraft, ground threats and terrain in his area and their spatial relationship to his aircraft. A three-dimensional display would be ideally suited for this purpose, however, it would have to be generated for display in real-time. I.e., to 30 times per second depending on aircraft dynamics. Dynamic holograms have previously been accomplished through the use of motion picture film. The film medium, however, is not capable of responding to the pilot's actions or to changing external conditions and is therefore unsuitable for application in a fighter cockpit. This research would involve a number of areas including holographic media materials, holographic generation, optical processing and dynamic holography applications. There are many applications for this technology. This technology could provide 3-D virtual imagery in the cockpit of future aircraft without the weight vs. display field of view and scene complexity constraints currently encountered with helmet display technology. Airborne situation awareness, threat response, target recognition and identification, mission effectiveness and survivability should be improved using this technology. This technology could also support ground be improved using this technology. This technology could also support ground based applications including mobile and laboratory flight simulators, rapid cockpit prototyping, pilot-aiding artificial intelligence knowledge base development and avionics development workstation environments.

AF87-150 TITLE: Transfer Alignment Techniques for Hypersonic Weapon Applications

OBJECTIVE: To model and simulate alignment techniques for hypervelocity weapon applications.

DESCRIPTION: For a number of aircraft, the alignment transfer from the aircraft's inertial navigation systems (INS) to the weapon's INS differ in the following manner: 1) the data that is transferred between the aircraft and weapon and 2) the excitation requirements levied upon the aircraft to create weapon inertial navigation unit (INU) measurement observability. Hypersonic endoatmospheric flight (Mach 5-20) will have to address issues which are not necessarily key drivers for subsonic weapons initialization. Considering today's transfer alignment techniques, an effort must be performed to identify technical deficiencies relative to hypersonic applications. The Phase I objective of this effort is the examination of current weapon INU alignment techniques and proposed hypersonic applications to identify short falls in the current methodologies. This program will be partitioned into two major tasks as follows:

a. Research current bomber fighter-carried weapons INU transfer alignment techniques/requirements and determine applicability for hypersonic weapon environments.
b. Investigate potential hypersonic weapon delivery concepts and postulate weapon INU alignment requirements.

At the conclusion of the Phase I effort, the contractor will produce a final report, which (1) documents current weapon alignment methods for both bomber and fighter aircraft, (2) postulates alignment requirements for hypersonic weapons, (3) recommends current alignment techniques or proposes potential alternate approaches for hypersonic weapon applications, and (4) proposes a follow-on effort to model and simulate alignment techniques for hypervelocity weapon applications.

AF87-151 TITLE: Ada for Embedded Systems

OBJECTIVE: To develop a packaging processor dependent code which is practical and feasible for embedded systems.

DESCRIPTION: Recently, the Ada programming language has been mandated for use in all software programs in the DoD. Along with Ada's ability to divide programs into logical blocks (packages) came the idea that one could design programs for embedded systems using any Ada compiler. This would be done by keeping the processor dependent sections separate from the rest of the code. The logic of the program could then be debugged and the machine dependent part of the code modified for any particular processor. Using this method much code could be reused, resulting in large productivity gains and improvements in code quality and maintainability. The idea sounds good; however, there is some skepticism as to how the program will behave in a highly parallel or embedded environment as opposed to the single processor environment on which it was developed. The objective of this effort is to develop a packaging processor dependent code separately as mentioned which is practical and feasible for embedded systems.

AF87-152 TITLE: High Linear Electro-Optics Effect Film Development

OBJECTIVE: To develop a high linear electro-optics effectfilm material with properties that can operate at frequencies up to 100 GHz.

DESCRIPTION: Future Air Force electronic and current microwave devices are hampered by the limited number of techniques available to test their operation without adversely affecting them. The electro-optics techniques pursued at Stanford and Rochester show promise for non-invasive testing. Non-invasive testing is a photonic/nonlinear optical technique that can significantly enhance electronics repair and avionics maintenance and expand diagnostic options for VHSIC. In order for non-invasive circuit testing to be useful as a general technique, a general needs to be developed which has a very high linear electro-optical effect like merocyanine dyes. The material should be one that could be developed in place mush like polyimide photoresist, and one which would orient the active pendent either during deposition through techniques like spinning or by surface tension. The objective of this program is to

develop a material with the above properties that can operate at frequencies up to 100 GHz. The development of such a coating would allow electro-optical sampling of high speed electronics without the need for direct contact with the device under test.

AF87-153 TITLE: Intelligent Ada Compiler

OBJECTIVE: Research to find ways of producing super optimized Ada code.

DESCRIPTION: Research is needed to find ways of producing super optimized Ada code. Currently a skilled programmer can write an assembly language program which is faster and takes up less space than an Ada compiler can. Some of today's Ada compilers have as many as thirty optimizations, but these optimizations detect only the most simple of pattern in Ada source code. The ability of an Ada compiler to generate object code more efficiently than a human being would be a major turning point in our ability to build more complex software systems. With such an intelligent compiler in place, considerations of program size and efficiency could reasonably be ignored in most of the software development process allowing the designers to spend more time designing and organizing the system itself.

AF87-154 TITLE: Multi-Functional Device Integration

OBJECTIVE: Explore areas of device, circuit and interconnect technology which will lead to the ultimate goal of full wafer union.

DESCRIPTION: The objective of this technical effort is to explore areas of device, circuit and interconnect technology which will lead to the ultimate goal of full water union. This is defined as the successful integration of microwave, digital, analog and electro optical devices on a common substrate for the purpose of increased performance and system reliability. To accomplish this will require dedicated efforts in such areas as a) transmission of high speed data and high frequency information from point to point on the wafer; b) development of selected area crystal growth techniques for producing non-lattice matched material systems which will allow the fabrication of different device structures in close proximity; c) investigation of optimized interconnect concepts which can provide the means for combining varied functions or building blocks into a complex functional unit; d) modeling techniques which accurately predict the advantages and limitations of the wafer level union concept and can be used to lower the risks associated with design and implementation. Additional areas which will require attention if wafer level union is to become a reality include fault tolerance, redundancy, testability, yield improvement and packaging. The above description defines a broad area of interest and packaging. The above description defines a broad area of interest and proposals addressing individual or combined areas are encouraged as long as they clearly focus on the final objective.

AF87-155 TITLE: Compact, High Efficiency Multi-Aperture Broad Spectrum Sensor

OBJECTIVE: Demonstrate the feasibility of producing a compact, high efficiency multi-aperture broad spectrum sensor.
DESCRIPTION: This is a three-phase effort to determine the feasibility of building a broad spectrum sensor sufficiently compact to fit into a hypersonic interceptor aircraft. This sensor could detect and identify vehicles employing stealth technology. Phase I will study the sensor technologies and project the size, weight, and power requirements for the sensor technology if used in a broad spectrum sensor to identify stealth vehicles. Phase II will make component tradeoffs and select a set of sensors that can realistically be combined to produce a compact, high efficiency multi-aperture broad spectrum sensor. During this phase a hypothetical design shall be proposed by the contractor. During Phase III the contractor will procure available "of-the-shelf" sensors and demonstrate the feasibility of the system.

AF87-156 TITLE: Smart Communications

OBJECTIVE: Explore the potential of Artificial Intelligence (AI) techniques for providing the decisions and control required to effect optimum employment of aircraft on-board communications resources.

DESCRIPTION: The highly complex electromagnetic environment projected for battlefields of the year 2000 and beyond offers exceptional challenges to the communication system designers. The complexity and dynamic nature of the communications threat severely limit the utility of preplanned strategies for employment of the on-board communications systems. The avionics system must sense the electromagnetic environment in which it is operating and in real time devise optimum strategies for employment of the available communications assets. System frequencies, modulation, power levels, cycle time, low probability of intercept (LPI) techniques, and antenna control are representative of the decision parameters to be considered in finding this optimum solution. The number of alternatives to be considered, the dynamic nature of the environment, extent of analyses required, and the demand for real time response exceed the capabilities of the already burdened pilot and conventional computational approaches. The objective of this effort is to explore the potential of Artificial Intelligence (AI) techniques for providing the decisions and control required to effect optimum employment of aircraft on-board communications resources. Phase I will provide concept definition, evaluation/feasibility demonstration of technology alternatives and specific requirements for technology demonstration in Phase II.

AF87-157 TITLE: Avionics Integrity Program (AVIP)

OBJECTIVE: To develop engineering techniques, methodologies, method of work and criteria which support durability oriented design, manufacturing, repair and modification of avionics hardware/equipment systems and failure free life.

DESCRIPTION: The following programs are of specific interest:

a. Environmental Reliability of Electronics Equipment. Environmental part stress screening is used during the production phase to transform latent part and workmanship defects in equipment into detectable failures for their elimination prior to delivery to the ultimate users of the equipment. Current practice is to establish the proper stress types, levels and durations by trial and error, experience, company policy and/or negotiations. If the environmental stress is too severe, too much useful life is consumed by the stress screening process. Weak stress screen will identify some latent defect allowing products containing defects to be delivered to the ultimate user. The net effect of current environmental stress screening techniques is that the shipped equipment contains fewer latent defects and displays a lower failure rate as the result of having been screened. Unfortunately, there exists no means of knowing how much useful life exists in the shipped equipment (useful life is the number of or amount of exposure time to critical environmental stress conditions until the occurrence of the first failure in an item). Ideas and concepts are being sought for an environmental proof test or process for electronic equipment which would: (1) be used as a 100% screening process, (2) consume only small amount of the equipment's useful life, (3) provide insight into the amount of useful life available for usage, and (4) provide results in a short period of time.
b. Instrumentation of Printed Circuit Boards/Integrated Circuits. Instrumentation is presently used to measure the environment and stresses in gross area of aircraft electronic systems. High density packing of electronic systems on operational military aircraft requires that system reliability have the highest standards. Increasing and predicting the failure free operating period of these systems is imperative to extend the operational status of combat aircraft and to reduce associated cost of ownership. Localized stress environment within a system be monitored and analyzed to give an accurate picture of conditional probability. Ideas and concepts are being sought for using micro-miniature stress sensors, as they become available, to measure environmental induced stresses on small, individual components of major weapons systems. Methods are also being sought for instrumenting critical areas of aircraft sensor systems and the recording of the data. The developed technology will be used to instrument systems leading to the AVIP failure free operating period prediction model validation tests.

AF87-158 TITLE: Electro-Optical Control Devices

OBJECTIVE: To design and fabricate an electro-optical mechanism for use in a ten turn potentiometer, optical shaft encoder or optical synchro which provides conductive conductive contact and a conductive surface.

DESCRIPTION: Optical synchros and electro-optical mechanism for use in a ten turn potentiometers are devices that normally operate by having contact between a conductive contact and a conductive surface. This produces noise and wear which lower the reliability and shorten the life of the instrument. Also, because of system requirements (i.e. low noise, linearity, temperature compensation, vibration, humidity), these items are very costly. Using advances that have been made in solid state lighting(i.e. lasers, light emitting diodes, electroluminescense, etc), it should be possible to produce a mechanism that would be stable and durable enough to be used in a ten turn potentiometer, an optical shaft encoder or an optical synchro. It is, therefore, required that an electro-optical mechanism be designed and built that demonstrates its adaptability, durability, and stability over a wide temperature range (40F to 160F) for use in the aforementioned devices.

AF87-159 TITLE: Enhanced Thermal Energy Storage in Clothing

OBJECTIVE: To develop and demonstrate an enhanced thermal energy storage fabric.

DESCRIPTION: Present techniques for producing arctic or cold weather protective clothing involve the use of layers of insulting materials. It is obvious that there is a limit to the effectiveness of this technique. As the layers increase in thickness, the bulk and surface area of the material increases, thus the heat loss due to the increase in surface area exceeds the insulating properties of the materials. Also, the increase in bulk makes it virtually impossible to accomplish any meaningful tasks while wearing the materials.

There is at present a requirement for development of gloves and/or socks that can be used to keep a person comfortable for up to four (4) hours at –55F. The only way this may be accomplished is the development of a method of enhanced thermal energy storage in the fabric. The technique to be used shall be safe for the wearer even if there is a breakdown in the material. Also, the fabric that touches the skin of the person shall be of the type that is known to cause few, if any, allergic reactions (i.e., cotton or cotton/polyester or some other natural or hypo-allergenic material). The object of this feasibility demonstration is to show that a low-bulk layered fabric can be produced that has enhanced thermal energy storage that is durable, stable, waterproof and cleanable. The fabric must be amenable to the manufacture of articles of clothing without the development of new technology to implement the use of the fabrics.

AF87-160 TITLE: Aeronautical Systems/Subsystems Research

OBJECTIVE: To develop new concepts and innovations for aeronautical systems/subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical systems/subsystem research, development, and procurement. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, transatmospherics, etc). Emphasis is placed on potential Long Term Planning Concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, innovative research and development organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF87-161 TITLE: Investigation of “Smart Skin” Technology/Effects on Aircraft Design

OBJECTIVE: To investigate the impact of using increased areas of the aircraft surface as sensor/processor avionic elements.

DESCRIPTION: Gallium arsenide (GaAs) technology coupled with efforts in the microwave integrated circuits (MICs) technology and signal processing areas will result in increased use of skin line avionics. Future aircraft will have increased thermal and mechanical stresses, as well as increased use of composites structures, which will require integrated structure/avionics design considerations. The total radiating/processing elements of the smart skin sensors may be less than 1-inch thick. This integration will present major design problems in the consideration of thermal, mechanical and electromagnetic interference (EMI) design factors.

AF87-162 TITLE: Artificial Intelligence Applied to Aeronautical Systems

OBJECTIVE: To develop Artificial Intelligence Applied to Aeronautical Systems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of artificial intelligence (AI) as applied to aeronautical systems. This topic is meant to provide the innovator with latitude to include Air Force mission areas of AI application not addressed by other specific aeronautical topics. Areas of special interest include knowledge based systems applications to integrated sensor data fusion, cockpit/air battle management, diagnostic/repair, etc.

AF87-163 TITLE: Systems/Subsystems in Support of Special Operations Forces (SOF) Missions

OBJECTIVE: To develop Systems/Subsystems in support of SOF.

DESCRIPTION: Special emphasis should be placed on the requirements of sensors, defensive systems, and special support equipment in support of the SOF missions. These missions would cover the spectrum of local counter insurgency to global SOF deployments. In the systems area, emphasis is placed or developing different vehicle's performing various SOF missions.

AF87-164 TITLE: Multi-Role Global Range Aircraft

OBJECTIVE: To develop methodologies for the evaluation of Mutli-Role Global Aircraft.

DESCRIPTION: An analysis/synthesis of a Multi-Role Global Range Aircraft for strategic offense missions is required. The missions would include quick response transport, stand-off Cruise Missile Carrier, command, control, communications and intelligence (C3I) platforms, stand-off reconnaissance platform, tanker, etc. The proposal could cover one or two of the above mission areas for analysis/synthesis with the results providing parametric trade-off data which can be evaluated in the context of contributing to the synthesis of a Multi-Role Global Range Aircraft. Trade-off parameters would include speed, range, capacity, survivability, etc. The Multi-Role Global Aircraft would be projected for deployment in the 21$^{st}$ century.

AF87-165 TITLE: Electronic Warfare Effectiveness Displays

OBJECTIVE: To develop electronic warfare effectiveness displays for integration into a battle management workstation.

DESCRIPTION: Interactions among electronic warfare elements within a high threat environment has become increasingly complex with different radars, jammers, weapons, and warning devices. Any battle management workstation, used for simulations or for combat, would require that these interactions be visible to the user. A display methodology is needed which will (1) help the user cope with the complexity of electronic warfare interactions, (2) focus his attention on global effectiveness of Air Force systems, and (3) support the user's decision processes. The methodology should be based on practical knowledge and experience with electronic warfare systems rather than theoretical models, and on the user's point of view rather than the programmer's. The display should minimally show the effects of signal propagations, threat signal processing, fire control, and weapons guidance .Color and three-dimensional enhancements should be considered. For simulated environment would be

known the display should support countermeasures design and analysis with a methodology structured to support the user's needs. It should be adaptable to different simulations programs and data inputs from combat situations.

AF87-166 TITLE: Internally Mounted Space Suit Heads-Up Display

OBJECTIVE: To develop designs and advanced concepts for an internal helmet-mounted display, electronic documentation software for on-orbit tasks, and voice activation.

DESCRIPTION: YMX is developing designs and advanced concepts for an internal helmet mounted display, electronic documentation software for on-orbit tasks, buoyant tasks to test its practical applications.

A helmet-mounted display for electronic documentation will (1) reduce training time for complex extra-vehicular activity (EVA) tasks by providing real-time images of next steps in complex sequences (forward looking to competition), (2) increase productivity of expensive EVA time, (3) aid fault isolation and trouble shooting, (4) give the ability to see "other" sides of spacecraft thereby reducing the need for translation, (5) provide access to detailed maintenance data without large mass and volume, (6) display environment control and life support (ECLS) and manned maneuvering unit (MMU) data to EVA astronauts or intra-vehicular personnel, and (7) enable hands-free operation of the system via voice control. SD/YMX requires that an underwater video display be built. The display shall attach to the outside of an Extravehicular Mobility Unit Helmet and shall not obstruct the normal forward field of view. The display shall include a 100 foot umbilical for video signal and electrical power. Video signals and power will be supplied by the government. The display shall operate at depths up to 40 feet (fresh water).

AF87-167 TITLE: Innovative Technologies/Methodologies to Reduce Space system costs.

OBJECTIVE: To develop innovative technologies/methodologies to reduce space system costs.

DESCRIPTION: The cost of space systems and access to space must be reduced. Technologies and methodologies should be studied which have the promise of reducing costs for launch processing, launch operations, satellite design and construction and satellite on-orbit control.

Phase I should be trade studies and analysis of cost saving proposals or technologies. Studies should be top level tradeoffs between current processes or technologies compared to potential cost saving processes or technologies. Top level implementation and development plans should also be proposed.

In launch processing, possible aspects to be studied include: paper systems, processing procedures, horizontal vs. vertical etc. In launch vehicles, technologies leading to lighter, stronger structures and more efficient engine and fuel designs are of interest. Also, the launch operations manpower requirements, possible cost savings in the launch configuration and stack on pad vs. move to pad after stack are possible topics. The best mix of manned vs. unmanned lift vehicles and their optimal cargo capacities is another candidate for study. In satellite design, tradeoffs between expensive long life satellites and cheaper shorter life configurations can be reviewed. Satellite construction could be reviewed for more efficient methods of construction, greater long lead procurement authority, multiple buys, greater emphasis on robotics, etc. In satellite control, modeling to determine the optimal mix of ground based and space based data processing is an area of interest. All concepts for data processing, including artificial intelligence, are possible topic areas. New hardware, e.g. VLSI (Very Large Scale Integration) could be studied for satellite control and design. All study work must lead to reducing the cost of the use of space.

Phase II is dependent on Phase I. Phase II will development and proving of technologies and processes, from the Phase I effort, for their cost saving potential.

AF87-168 TITLE: Remote Sensing of Meterological Parameters

OBJECTIVE: To develop spaceborne sensors to measure meteorological parameters.

DESCRIPTION: The purpose of this effort is to develop spaceborne sensors to measure meteorological parameters to the accuracy required by the Air Force. The sensors in use by the Defense Meteorological Satellite Program (DMSP) meet the primary requirement for cloud cover imagery. The sensors provide much useful data, but improvement in their capability is desired. New measurement techniques and approaches, improvements in critical sensor components, subsystems and proof of concepts sensors for use on future DMSP spacecraft are desired. These improvements must be consistent with the limited power and size onboard the spacecraft. Examples of the parameters desired are clear air turbulence, surface temperature, snow and landlocked ice cover, soil moisture and sea state. Snow and Landlocked ice cover are qualitatively measured using imagery from the optical line scanner. It can be determined snow cover under cloud free conditions only (resolution 0.3 nautical mile).

AF87-169 TITLE: Cleaning, Alignment and Calibration of Large Space-Based Antennas

OBJECTIVE: To develop and demonstrate methodology for cleaning, aligning, and calibrating large space-based antennas to reach their true resolution capability.

DESCRIPTION: NASA has already demonstrated significant manned on-orbit capabilities in the support of civilian space activities and plans still greater use of extra-vehicular activity (EVA) in future programs. EVA allows space assembly of precision surfaces, such as optical and millimeter wave reflectors, with very large apertures without constraint from launch vehicle volume and mass limits. This results in increased resolution of electromagnetic sensing systems and a huge cost avoidance by eliminating the requirement for development of a heavy lift launch vehicle and elaborate ground handling systems.

The technology exists for assembly of these large systems, but we still need to demonstrate the ability to clean, align, and calibrate large space-based antenna to reach their true resolution capability. Methods should be proposed for accomplishing these tasks for various wavelength regions with named EVA or machine systems. Also, describe the technical feasibility of demonstrating each of the methods on the ground or in a manned neutral buoyancy facility.

AF87-170 TITLE: Space Systems Logistics Capabilities Assessment Model

OBJECTIVE: To develop a formal modeling system for assessing the planned support capabilities of current space systems to insure there is satisfactory system integration.

DESCRIPTION: There is no formal modeling system for assessing the planned support capabilities of current space systems to measure the adequacy of each logistics element or to test the interaction between operations and support functions to insure there is satisfactory system integration. Program managers cannot currently “tax” their developing systems through simulation modeling to anticipate support shortfalls or to flag supportability cost drivers. Program managers need the means to predict the adequacy of selected support options and relate those advantages/disadvantages to the overall assessment of the system’s viability. Space Division planners need an interactive model which will assign representative values to operational and support parameters and permit a top-down assessment of system operating vulnerabilities as well as O&M cost drivers. Such a modeling system should also allow planners to ask “what if” questions and work around uncertainties.

AF87-171 TITLE: Doppler Lidar Wind Sensors and Differential Absorption Lidar (DIAL) Sensors

OBJECTIVE: To develop active Lidar sensors for Defense Meteorological Satellite Program (DMSP) space craft capable of satisfying validated requirements for wind, temperature, moisture, and visibility.

DESCRIPTION: Spaceborne Lidar sensors have the proven potential of measuring global horizontal wind velocities by measuring the Doppler frequency shift of laser radiation backscattered from atmospheric aerosols. Spaceborne DIAL sensors have the potential of measuring temperature and moisture profiles with great accuracy and vertical of measuring temperature and moisture profiles with great accuracy and vertical resolution using the absorption bands of o3 and H2O respectively. There is also potential for quantified measurement of visibility using Lidar sensors. The

goal is to develop active Lidar sensors for Defense Meteorological Satellite Program (DMSP) spacecraft capable of satisfying validated requirements for wind, temperature, moisture, and visibility.

The difficulty lies in the development of laser sensors with the necessary lifetime (two to three years at a 10Hz repetition rate), wavelengths (tunable for DIAL), energy (2-10 joules/pulse), laser efficiency, lightweight optics, efficient detectors, and accurate data processing algorithms.

AF87-172 TITLE: Autonomous Control System for Low Orbital Transfer Vehicle (OTV) for Global Positioning System (GPS)

OBJECTIVE: To develop techniques for low cost control of the OTV attitude and engine firing during its spiral orbit transfer.

DESCRIPTION: The GPS Program Office is considering the use of an Electric OTV to deliver replenishment satellites in a timely manner to their operational orbits. The Electric OTV shows promise of significant cost savings over conventional chemical upper stages. However, before the vehicle can be deployed an autonomous control system must be developed.

Innovative techniques are sought for low cost control of the OTV attitude and engine firing during it's spiral orbit transfer. This assessment should include hardware, software, operational strategies and system configuration trade-offs to minimize both change in velocity and eclipsing during orbit transfer from low earth orbits (of inclinations between 28.5 and 57) to a geosynchronous). The design shall consider the following:

a. Sensor and computing capability
b. Ability to provide continuous control
c. Ability to orient a one-axis degree of freedom solar array normal to the solar flux utilizing sun sensors mounted on the array and the on-board controller to provide yaw motion.
d. Trade-offs in the use of additional hardware including a rare gyro assembly, GPS receiver and reaction control system.
e. Modifications to system which will allow on-orbit rendezvous and docking via telepresence.
f. Estimate of subsystem masses and configurations necessary to support an electric OTV.

AF87-173 TITLE: Beam Synchronization and Coherence Techniques for a Distributed Sparse Array (USA) of Spacecraft

OBJECTIVE: To investigate options for and assess beam synchronization and coherence techniques for a distributed sparse array system for follow-on development.

DESCRIPTION: DSA is a space-based, thinned phased array radar system in which each array element is a separate spacecraft. These spacecraft, called mini radars, cooperate to form a single coherent radar beam. DSA has a number of desirable characteristics, which include very fine angular resolution, ASATsurvviability, mainlobe jammer nulling, and possible lower total system cost than a monolithic space-based radar. Two of the key technical issues for DSA are the synchronization and coherence techniques for a DSA system. Beam synchronization techniques to be investigated should include the use of internal timing references (e.g. atomic clocks) and external sources (e.g. timing signals from ground station). The use of ground targets with known radar cross section (e.g. corner reflectors and transponders to act as focusing targets should be investigated as a means of achieving beam coherence.

AF87-174 TITLE: Determination of Countermeasures to Bistatic Radar

OBJECTIVE: To determine if effective countermeasures to Bistatic Radars are possible, and develop design options/approaches for countermeasure devices.

DESCRIPTION: A bistatic radar system is generally considered ECM resistant because the receiver is radio –silent, and jamming directed towards the transmitter does not affect the receiver. The purpose of this research effort is to determine if effective countermeasures to bistatic are possible. Emphasis should be placed on countermeasures to hybrid bistatic radar systems (i.e. bistatic radar using a space-based transmitter and airborne receivers).

AF87-175 TITLE: On-Orbit Costs Between a Disturbed Sparse Array Radar System and a Monolithic Space-Based Radar System

OBJECTIVE: To develop methodology for the comparative analysis of the cost of operation of space based radar systems.

DESCRIPTION: The concept of a disturbed sparse array addresses the two basic concerns of space systems, cost and survivability: cost by use of production line techniques in producing simple, single string satellites; survivability by collectively act as a single system. An attack is therefore more likely to degrade rather than destroy mission capability. This effort shall develop analytical models which will be used so accurately compare the total on-orbit costs between a disturbed sparse array (DSA) radar system and a monolithic space-based radar (SBR) system. Specialized knowledge is required in the area of space-based radar and, In particular, in cost modeling. A cost savings is expected because the DSA breaks down the function of the satellite into smaller portions which can be handled by a greater number of satellites. By decreasing the size and complexity of the satellite and by increasing the number of satellites, production line techniques can be utilized and so production costs could decrease. However, the increased total system weight of a DSA system over a monolithic SBR system will result in increased transportation charges, which may offset the decreased production cost.

AF87-176 TITLE: Ultraviolet Linear Array Detector

OBJECTIVE: To develop an ultraviolet linear array detector.

DESCRIPTION: Defense Meteorological Satellite Program (DMSP) anticipates flying a sensor to obtain ionspheric characteristics by measuring electron densityprofiles. The ionsphere's geographic mapping comes from these measurements as inferred from UV radiation intensities at wavelengths of 1356 Angstrom and in a band from 1500 to 1700 Angstroms. Phase I consists of an assessment of the state-of-the-art for UV-sensitive detectors, including solid state devices vacuum tubes, etc. Include sensitive detectors, including solid state devices vacuum tubes , etc. Include sensitivity detectors, including solid state devices, vacuum tubes, etc. Include sensitivity, geometry, repeatability of devices capability and manufacturability in the considered issues. Phase I deliverables would be in the form of a concept study and a Phase II proposal for pilot fabrication of a device array.

AF87-177 TITLE: Signal Processing Architecture for a Distributed Sparse Array Radar System

OBJECTIVE: To develop signal processing architecture for a Distributed Sparse Array Radar System.

DESCRIPTION: DSA radar is a space-based, thinned phased array radar system in which each array element is a separate spacecraft. These spacecraft, called mini-radars, cooperate to forma single coherent radar beam. DSA radar has a number of desirable characteristics, which include very fine angular resolution ASAT survivability, minilobe jammer nulling, and possible lower total system cost than a monolithic space-based radar. The purpose of this effort (is to develop potential signal processing architectures that emphasize the distribution of signal processing throughout the mini-radars and will allow processing reconfiguration in the event of a single mini-radar failure or destruction.

AF87-178 TITLE: Transmitter/Receiver Coordination Techniques for a Bistatic Radar System

OBJECTIVE: To develop and provide techniques for providing transmitter/receiver coordination for a hybrid bistatic radar system.

DESCRIPTION: Bistatic radar has recently received considered attention as a way to enhance radar cross section, to provide covert operation of the receiver, and allow the transmitter to operate in a safe, defensible location. One of the technology issues for bistatic radar is the coordination between transmitter and receiver. Target position errors will occur if a timing mismatch exists between transmitter and receiver, and also if the receiver miscalculates the relative transmitter position. The purpose of this study is to develop and provide techniques for providing transmitter/receiver coordination for a hybrid bistatic radar system i.e. bistatic radar using a space-based transmitter and airborne receivers). Possible synchronization techniques to be investigated include the use of atomic clocks and the transmission of a timing reference to the transmitter and/or receiver. The use of various navigational techniques (e.g. inertial, TACAN, and CPS for providing accurate airborne receiver position information should be investigated. Techniques for providing space-based transmitter position information to the airborne receivers should also be developed.

AF87-179 TITLE: Nitrogen Tetroxide, Monomethyl Hydrazine Compatibility With Nickel

OBJECTIVE: To provide reliable information of the interaction between N2O and MMH propellants and their products of combustion with nickel and nickel-based alloys.

DESCRIPTION: An advanced development thruster design having an electroformed nickel injector is exhibiting injector flow passage erosion on the discharge face. Thruster durability/life requirements are being degraded.

High-performance space engines are being developed which use non-cryogenic fuels and oxidizers such as nitrogen tetroxide (N2O4) and monomethyl hydrazine (MMH). Increased use of N2O4 and MMH for space applications emphasizes the need for better knowledge of these propellants' materials compatibilities, especially at elevated temperatures. Existing qualitative data in the propellant handbooks suggest that nickel is not compatible with N2O4 and is also incompatible with hydrazine. A research effort is proposed to conduct a thorough search and review of current literature. The objective of the study will be to provide reliable information of the interactions between N2O4 and MMH propellants and their products of combustion with nickel and nickel-based alloys. The results obtained shall be useful for selection of injector fabrication materials. Efforts shall be conducted to established the effects of various mechanisms of corrosion and material behavior associated with temperature environment, propellant composition and impurity levels. Investigation shall include, but not limited to: study of chemical interactions between N2O4 MMH and their combustion products with nickel;/mickel-based alloys, etc. Inhibition techniques, surface treatments, thermodynamic properties of reaction products, and nitridation processes which may be useful in understanding and preventing the degradation phenomena should be included. The effort should also identify additional laboratory tests and test equipment for follow-on effort required to acquire data not previously available for comprehensive evaluation of the problem.

AF87-180 TITLE: Advanced Fuel Cells

OBJECTIVE: To design a 45-volt DC fuel cell and to assess the cost and schedule to construct and space-qualify it.

DESCRIPTION: One of the greatest constraints in the upcoming Neutral Particle Beam Integrated Experiment is weight and one of the largest weight drivers is the Radio Frequency (RF) power supply. A preliminary study has shown that the weight of the power supply could be cut nearly in half if instead of using the current Space Shuttle 28-volt DC fuel cell, a 45-volt DC fuel cell could be used. The proposed work would be to design a 45-volt DC fuel cell and to assess the cost and schedule to construct and space-quality it. Volume for such a fuel cell design will be defined by the Neutral Particle Beam Integrated Experiment prime contractors. In addition, the proposed fuel cell must operate in the pulsed mode with 27,000 amp pulses down to 350 microseconds with only a 2-3% voltage drop.

AF87-181 TITLE: Solid State Laser Sources for Eye-safe Coherent Lidar

OBJECTIVE: To develop solid state laser sources for eye-safe coherent lidars.

DESCRIPTION: Although Air Force plans for space based wind sensing Doppler Lidar have included the use of a carbon dioxide TEA laser, rapidly advancing technology in the fields of solid state and diode lasers makes the development of an eye-safe solid state coherent source for this application appear a realistic possibility. The term of size and weight, such a system would have definite advantages. However unless diode laser pumping capability is developed in conjunction with the solid state rod or slab laser source, the carbon dioxide laser will have a significant advantage in efficiently and lifetime. On a spacecraft with an extremely limited power budget efficiency is of overriding concern. Operation at a wavelength greater than 1.45 micron is desired for reasons of eye safety since a space based Lidar by nature will illuminate populated regions on the surface. Such an eye-safe laser would also have potential application in certain ground and aircraft systems such as target designators near troop concentrations and for optical communications. In order to be considered for space based applications, the laser and its pump must have lifetimes capable of supporting operations for at least two unserviced years and be space qualifiable. Efficiency should be greater than 2%. Identification of most promising laser materials and their relevant characteristics along with recommendations on potential system configurations are sought under contractual effort.

AF87-182 TITLE: Scanning Transceiver System for Space Based Lidar

OBJECTIVE: To develop space wind sensing Doppler Lidar systems.

DESCRIPTION: Development of space based wind sensing Doppler Lidar systems requires the investigation of possible scanning coaxial transceiver designs compatible for use abroad free-flying spacecraft. The Doppler Lidar will utilize heterodyne detection and therefore require diffraction limited optics at the transmitter wavelength, taken to be 9 micron for the purpose of this effort. The optical telescope will be of the one-meter class with less than 10% obscuration of the primary. An evaluation shall be made of the relative merits between on- and off-axis systems as well as continuous and step scanning techniques. In addition the investigation should include other system and spacecraft related concerns including, but not limited to: long and short term pointing errors; alignment; size; weight; power requirements; lag angle compensation; momentum compensation, and thermal stability. Where appropriate, trade off analysis should be accomplished.

AF87-183 TITLE: Electric Fields and Plasma Structure in the Solar Corona

OBJECTIVE: To perform research to measure and model macroscopic electric fields in solar flares, loops, prominences and spicules.

DESCRIPTION: The primary objective of this work area is to obtain information on the heating mechanisms in solar flares and on the mechanisms by which mass is ejected from the sun—leading to disturbance in the interplanetary space and terrestrial environments. This work will lead to improved understanding of the energetics of flare loops and coronal heating which will provide physical mechanisms for processes that eject mass from he sun. This in turn will support the efforts of Air Force Geophysics Laboratory's Solar Research Branch to improve forecasts of the solar activity that creates hazards for Air Force systems and personnel operating inspace and upsets AF C3I activities. Little work has been done to measure and model macroscopic electric fields in solar flares, loops, prominences and spicules. Knowledge of magnitude and morphology of these fields will place critical constraints on models of solar activity processes and permit the development of models for the heating of the solar coronal plasma.

AF87-184 TITLE: Rugged Precise Mirror Position Translation and Controller

OBJECTIVE: To develop a Michelson interferometer to study ultra-violet atmospheric radiation from space platforms

DESCRIPTION: Interferometer spectrometers have been flown in space, both on free flying satellites and on the Space Shuttle, but their application has been limited to the infrared region. The throughput and multiplex advantages of the Michelson interferometer could be of great value in improving our ability to study ultraviolet atmospheric radiation from space platforms. The implications for doing so for wavelengths down close to 0.1 micrometer are a

formidable degree of control of the placement of a moving mirror which must be positioned and translated with precision, repeatability and with adequate freedom from tilt and shear.

In Phase I it is not required that this general capability be demonstrated with radiation of wavelengths as short as 0.1 micrometer. Rather, it is recommended that components be selected so that, with some convenient ultraviolet wavelength, a clear and convincing demonstration is made that the desired interferometer spectrometer performance at vacuum ultraviolet wavelength (at least 5 Angstrom resolution at 0.1 micrometers) is readily achievable with the proposed mirror drive and control for 25 mm optics. The Phase I deliverable should include sufficient hardware and software items to demonstrate, test and quantify that performance. Finally, vendors must keep in mind that the intended application may involve free flying or shuttle borne space flight. At this stage flight qualified piece parts and end products are not required, but size, weight and power needs should be kept small; it should be plausible to proceed from as demonstrated on the ground.

Assuming that the Phase I product is acceptable, in Phase 2 the desired deliverable is a full up laboratory prototype instrument which does demonstrate the performance specified in the interferometer mode, at wavelengths as short as allowed by lithium fluoride optics (about 0.11 micrometers). During Phase 2, major milestones will include adequate performance following what amounts to space qualification testing of major assemblies and the entire end product, but the actual deliverable is not expected to be fully qualified.

AF87-185 TITLE: Flowing Afterglow Design

OBJECTIVE: To design and construct a flowing afterglow apparatus.

DESCRIPTION: Proposals are requested for the design (Phase I) and construction (Phase II) of a flowing afterglow apparatus. The design of the instrument should allow for the following: (1) generation of metastable species through either discharge or laser excitation, (2) the introduction of secondary species to allow the study of excited state reactions, (3) multiple window ports along the length of the chamber to allow concentration and lifetime measurements, (4) an interchangeable detection method allowing either mass spectrometry or spectroscopic detection.

AF87-186 TITLE: Application Optimized Dual Energy Digital Tomosynthesis/ Computer Tomography

OBJECTIVE: To develop improvement in X-ray digital tmosynthesis.

DESCRIPTION: Current work in X-ray digital tomosynthesis is general in nature as opposed to application specific. Carbon-carbon and filament wound composites offer unique hardware and software inspection challenges, since they are layered thin wall porous structures. Defects may consist of variations in density and chemical species as well as voids and cracks. Several areas of advancement in hardware configuration, sensor technology, and software are envisioned which will improve the spatial resolution of density and chemical specie variations that are undetectable with current inspection techniques. One means of accomplishing this is through the use of dual energy digital tomosynthesis. This program will assess the feasibility of making significant improvements in X-ray digital tomosynthesis as applied specifically to thin walled carbon-carbon and filament wound composite structures. It is envisioned that an assessment of the current digital tomosynthesis capabilities be made by scanning actual composite parts that will be supplied to the contractor by the Air Force Rocket Propulsion Laboratory(AFRPL). The results will be studied and a digital tomosynthesis machine will be designed that is application specific to composite materials. A program plan should be prepared and submitted for Phase II approval. In Phase II, an application specific prototype digital tomosynthesis machine will be delivered to the AFRPL at the end of the project.

AF87-187 TITLE: Optimize Ammonium Nitrate for Solid Rocket Propellants.

OBJECTIVE: To formulate and characterize ammonium nitrate with many different additives to improve combustion efficiency and burn rate, without degrading performance.

DESCRIPTION: Ammonium nitrate (AN) is an attractive oxidizer for boosterpropellants because it is low-cost and "clean," i.e. produces no HCI as an exhaust product. Also, because no HCI is produced, secondary smoke, which results from water vapor condensation is eliminated. This is especially important in minimum smoke tactical missile applications. The problems with AN are that undergoes a phase change in the operating temperature range, aluminum combustion efficiency is poor, and propellant burn rates are low. Commercially available phase stabilized ammonium nitrates, (PSANs) do not address combustion or ballistic problems. In addition, the stabilizing agents are usually inert and, therefore, degrade performance. The objectives of this program are to formulate and characterize ammonium nitrate with many different additives; inorganic, organic, or energetic. In addition to providing phase stabilization, these additives should be selected based on their ability to improve combustion efficiency and burn rate, without degrading performance. Small samples will be prepared and characterized. Phase II efforts may include preparation of kilogram quantities of the most promising formulations for Air Force evaluation.

AF87-188 TITLE: New Concepts to Enhance Future Spacecraft Survivability

OBJECTIVE: To provide adequate protection for spacecraft from hostile sensors and weapon threats.

DESCRIPTION: Future U.S. spacecraft will face various hostile threats including directed energy (DEW) and kinetic energy (KEW) weapons. Original concepts and enabling technologies are sought to provide adequate protection for spacecraft from hostile sensors and weapon threats. New concepts can include lightweight, compact shields that can be quickly generated or deployed to protect the spacecraft. Concepts may also include spacecraft hardening or spacecraft stealth technologies. Proposed ideas should consider spacecraft protection/shielding from threats such as sensor detection and tracking, KEW and DEW weapons, electromagnetic pulse (EMP) and close range nuclear bursts. Concepts must include ideas beyond simply proposing new spacecraft materials. Proposed concepts can incorporate unique application of technologies currently under development.

AF87-189 TITLE: Robotics for Solid Propellant Mixing Laboratories

OBJECTIVE: To investigate the use of robotics and other automated processing techniques as a means of reducing the cost and improving the safety for solid propellant mixing.

DESCRIPTION: Mixing of novel solid rocket propellants in R&D laboratories requires extensive safety precautions due to the explosive nature and, in some cases, unknown hazards of the materials. Current operations used throughout the industry involve elaborate facilities, are very labor intensive, and still contain an element of risk to the personnel involved. This program will investigate the use of robotics and other automated processing techniques as a means of reducing the cost and improving the safety of these operations. Specifically, the contractor shall develop, or modify existing equipment to automate a one-pint solid propellant mixing operation. Operational steps that should be considered for automation include ingredient weighing and pre-batching, ingredient addition, on-line monitoring of relevant mix parameter that minimize human intervention and enhance safety. Modifications to the mixing equipment are acceptable if necessary.

AF87-190 TITLE: Thermodynamic Vent System (TVS) Optimization

OBJECTIVE: To develop analytical effort that is required to identify solutions to optimizing the thermodynamic vent system for use in long life space systems.

DESCRIPTION: Long term storage of cryogenic fluids in space has been identified as a critical requirement for many military space systems of the 1990's. The results of the Forecast II technology plan and of past Air Force Rocket Propulsion Laboratory (AFRPL) studies, Long Term Cryogenic Storage and Compact LOX Feed System, have indicated that an optimized thermodynamic vent system, which is well integrated with passive thermal insulation components, would provide the capability to store cryogenic fluids in space for periods of up to ten years. An analytical effort is required to identify solutions to optimizing the thermodynamic vent system for use in long life space systems. Technical interests are duty cycles and flow rates of the TVS, its location within the multilayer insulation surrounding the tank, para-to-ortho hydrogen conversion trade offs, Joule-Thomson valves requirements,

heat transfer have broad applications to the long term cryogenic fluid storage systems will be identified for follow up demonstration programs.

AF87-191 TITLE: Sensors and Actuators for Fine Shape Control

OBJECTIVE: To develop concepts for lightweight, high bandwidth sensors and actuators capable of detecting and correcting low frequency structural vibration as well as maintaining correct shape configuration.

DESCRIPTION: Future Air Force space missions will be unprecedented in both their size and flexibility. As a result, greater reliance will be placed on active control to maintain the shape of the structure and reduce vibrations in the presence of disturbances such as attitude control, temperature variations, power system noise, and exhaust noise. Sensors and actuators that can detect and compensate for these disturbances are needed. The size of these structures makes the use of many sensors and actuators prohibitive from a cost, weight and complexity standpoint. Consequently, lightweight, high bandwidth actuators and sensors are necessary in order for mission requirements to be met. Investigations into the possibility of using disturbed actuators and sensors to overcome the shortcomings of discrete systems would be advantageous to the Air Force. Disturbed systems would provide more exacted information as to location and magnitude of a deflection while reducing overall system weight and complexity.

The Air Force Rocket Propulsion Laboratory is interested in investigating concepts for lightweight, high bandwidth sensors and actuators capable of detecting and correcting low frequency structural vibration as well as maintaining correct shape configuration.

AF87-192 TITLE: Twenty-First Century Propulsion Concepts

OBJECTIVE: To develop new non-conventional propulsion concepts are solicited for launching and maneuvering payloads in space.

DESCRIPTION: Bold, new-conventional propulsion concepts are solicited for launching and maneuvering payloads in space. Twenty-first century propulsion includes all propulsion concepts other than conventional chemical rocket propulsion which is presently used by the Air Force and NASA. More specifically, revolutionary concepts are sought in each of the following major categories (1) solar propulsion, (2) electric propulsion, (3) nuclear propulsion including both fission and fusion, and (4) Esoteric concepts which could include theoretical developments of zero point quantum dynamic energy of vacuum space and multidimensional theories which predict the current paradigm of physics plus new phenomenology which would be of benefit to space based on sound scientific principles offering quantum increases in performance and mission capability.

AF87-193 TITLE: Innovative Aperture Concepts for Optical Imaging

OBJECTIVE: To identify innovative aperture concepts for co-optical imaging techniques, which provide superior image quality while at the same time reducing the total collecting area of the optics to a minimum.

DESCRIPTION: Various coded aperture techniques (e.g., random arrays, non-redundant, and uniformity redundant arrays) have been proposed to provide high quality imagery in the microwave, optical, and x-ray electromagnetic regimes. Since these techniques collect radiation over small subareas of a larger effective aperture, application of such techniques to optical imaging may provide novel means of achieving high-resolution imagery at low cost compared to systems with fully-filled apertures. The purpose of this effort is to identify innovative imaging techniques which provide superior image quality while at the same time reducing the total collecting area of the optics to a minimum. Under this effort, the awardee shall propose and evaluate one or more sparse/coded aperturing concepts for application to optical imaging. For this effort, we will assume that each elemental subaperture of the collecting array is many hundreds of wavelengths in size. To evaluate the imaging performance of these aperturing schemes, the awardee shall propose specific and well-defined image quality measures (eg., two-point resolution criterion, some defined image quality measures (e.g., a two point resolution critierion, some measure of reduced edge-ringing, mean-square image error). For this study, the awardee may considered the imaging system to operate

under any (coherent, partially coherent, or incoherent) object illumination condition he deems appropriate to the aperturing concept(s) considered.

AF87-194 TITLE: An Expert System for Satellite Survivability Analysis

OBJECTIVE: To develop applications of Artificial Intelligence (AI) for satellite survivability/vulnerability analysis

DESCRIPTION: Application of artificial intelligence (AI) for satellite survivability/vulnerability analysis may be feasible through the use of knowledge-based expert systems. The Air Force Weapons Laboratory is currently using solid models with radiation transport codes or other or other applications codes to analyze system and subsystem vulnerability and radiation susceptibility. A knowledge base needs to be able to store the collective scientific, engineering, and design expertise in addition to being integrated into an expert system with an intelligent computer–aided-design (CAD) interface. Most engineering analysis depends on the availability of a geometric computer model of the system. Once developed, a single model can be used for all subsequent design analysis, and manufacturing tasks. CAD systems, more specifically solid modeling systems, can be used effectively in many different types of analysis including structural analysis with discrete components, kinetic and kinetic analysis of mechanisms, mass properties analysis, static loading and dynamic analysis, thermal analysis, power distribution analysis, radiation shielding analysis, and stability analysis. The feasibility of such an expert system which integrates an intelligent solid modeling system with the necessary engineering analysis software needs to be investigated. We also need to determine whether the knowledge base of the expert system could contain, in one place a satellite model and geometrical descriptions, design descriptions, test data, operating data, and analytical results. It should also contain all the specific and judgment knowledge of satellite design experts. Data input required by the analysis results should be displayed accordingly by the expert system.

AF87-195 TITLE: Applications of Nonlinear Optics for Phase and Image Retrieval Through Aberrating Media

OBJECTIVE: To develop applications of nonlinear optics for Phase and image retrieval through aberrating media.

DESCRIPTION: Optical phase conjugation has been used to reconstruct aberrated images by double passing the distorting medium. Recently, phase conjugate techniques have been suggested and demonstrated for single pass aberration correction. This effort will assess several facets of the issue. First, how well do the currently published techniques of single pass image reconstruction work, i.e., what is the fidelity of reconstruction and what are the limits to the process. Second, alternative methods of single pass image reconstruction via phase conjugation should be explored. Four wave mixing, phase print through on two beams coupling, and stimulated scattering are candidate technologies. Also, the applicability of each method of image reconstruction for tactical (short range, endoatmospheric) surveillance and strategic (long range, exoatmospheric) imaging should be addressed. This effort should address wavelength limits, materials, detection, and image processing; resulting in proposed applications for Phase II development.

AF87-196 TITLE: High Power Microwave (HPM) Integrated Circuit Screening Criteria

OBJECTIVE: To develop a screening process, or chip design criteria, to produce integrated circuits hardened to HPM.

DESCRIPTION: A need exists to better understand the failure mechanism of integrated circuits to HPM radiation. Using that understanding, develop a screening process, chip design criteria, to produce integrated circuits hardened to HPM. The proposed effort involves three phases:

Phase I: Analyze and study failed components to develop a fundamental understanding of the failure processes and a theoretical hardening approach.

Phase II: Screen pr produce a prototype batch of hardened chips. Test to determine the degree of hardness improvement.

Phase III: Commercially produce the hardened chips.

AF87-197 TITLE: Material Optical Properties Measurement for Repetitive

OBJECTIVE: To develop new methods for measuring material optical properties that are needed to evaluate pulse laser effects.

DESCRIPTION: New methods for measuring material optical properties that are needed for repetitive pulse laser effects studies. The principal optical properties of interest are depth absorptivity, plume absorptivity, and temporal surface absorptivity and reflectivity. Problems involved include the separation of small measurement signals from the strong scatter noise in the same bandwidth. Once the problems are solved, the new measurement methods will be integrated into a repetitive pulse laser effects diagnostic package.

AF87-198 TITLE: Low Noise Optical Amplifiers Using Nonlinear Optics for Phase Control

OBJECTIVE: Examine Low Noise Optical Amplifiers Using Nonlinear Optics for Phase Controls.

DESCRIPTION: This effort will examine two families of nonlinear optics effects for low noise optical amplifiers: Stimulated Scattering and wave mixing. It should involve a broad literature search and analysis of the applicability beam, noise issued, and scaleability. Raman amplifiers use Stimulated Raman Scattering to imprint the phase of a seed stokes beam onto a powerful pump beam. Backseeded Stimulated Brillouin Scattering imprints seed phase onto the backscattered power beam.

Wave mixing processes include four wave mixing, which under the right conditions has a phase conjugate reflectivity of much greater than unity, and hence acts as a phase preserving amplifier. Two beam coupling has recently been introduced as a method of switching intensityfrom one beam to another, while preserving phase. Parametric mixing, up-conversion, and down-conversation may also prove useful as nonlinear optics phase preserving amplifiers.

The end product of Phase I will be a conceptual analysis and computer model of the effectiveness of several key technologies for optical amplification (including models of phase and image fidelity). Technologies analyzed shall include, but not be limited to, those listed in the second and third paragraphs, above.

The end product of Phase II will be experimental hardware and data from a selected, optimized key technology for optical amplification. The data shall include conclusions for the applicability of the technique for Air Force applications, including amplified images for surveillance and amplified, phase preserved optical beams for target designation.

AF87-199 TITLE: Conceptual Development of Survivable Networking for the Distributed Sparse Array of Spacecraft

OBJECTIVE: To develop a survivable adaptive network for a distributed Sparse Array f Spacecraft.

DESCRIPTION: Air Force has a need for developing a survivable adaptive network concept for the innovative space system concept called Distributed Sparse Array of Spacecraft. This is a concept consisting of small, inexpensive satellites that work in unison to provide the capability for a survivable mission function. For this system to be implemented, it is essential that a survivable adaptive network concept be developed. This adaptive network concept is essential in order that the proposed constellation can work with any one satellite being the master. In addition, it is essential that they maintain time synchronism such that high data rate traffic can be accommodated with the capability of each spacecraft having the capability to be a master. This system might be used as

communication or sensor platforms. Link performance in stressed environments, interconnectivity of links, and multimedia transmission are essential ingredients of this system.

AF87-200 TITLE: Two Phase Flow and Heat Transfer in Microgravity

OBJECTIVE: To perform research in two phase flow and heat transfer in microgravity.

DESCRIPTION: Thermal management will be a crucial part of many Air Force space operations. A boiling/condensing (two phase) power cycle or heat transport loop maybe necessary to fulfill mission objectives. The contractor shall perform complete literature review to determine the status of research in two phase flow and heat transfer in microgravity. At the end of Phase I the contractor shall provide a plan for an experimental program to extend and clarify knowledge of important parameters in this field. The aim of the program shall be the development of design correlations for determining pressure drops and heat transfer coefficients. At the conclusion of Phase II the contractor shall deliver the experimental hardware to be tested in microgravity.

AF87-201 TITLE: Innovative Data System Inertial Components

OBJECTIVE: To develop a stand-alone system to handle large quantities of classified data for inertial components.

DESCRIPTION: Inertial component reliability tracking and performance analysis systems require expeditious handling and manipulation of large quantities of classified data. Current performance and capacities of readily available microprocessor equipment and software offer viable alternatives to existing mainframe systems. A design utilizing proven hardware and devices that will provide stand-alone capability with network options needs to be developed. The effort shall provide a complete design, identifying hardware and software that will handle the present inertial components evaluation data and provide for economical expansion to satisfy future requirements. Automated transfer of data from existing systems is mandatory. Cost of the system must be scoped.

AF87-202 TITLE: Hemispherical Resonating Gyro (HRG) Evaluation

OBJECTIVE: To develop an HRG for ICBM inertial guidance.

DESCRIPTION: Inertial guidance system cost, accuracy, mechanization and reliability are largely a function of the instruments. The HRG shows promise of a high performance gyro that could simplify system mechanizations and improve reliability and Life Cycle Cost. An evaluation of the HRG is desired. The evaluation should include an error budget analysis, analyses of available data to establish accuracy potential, and a reliability assessment. System integration requirements should be scoped to include effects on overall system performance, reliability and cost. Phase 2 effort shall include the design, fabrication and test of an HRG.

AF87-203 TITLE: Mobile Missile TEL Analysis

OBJECTIVE: To develop methodologies for analysis of ground vehicle capabilities.

DESCRIPTION: Investigate and develop methodology for accurately determining the payload and performance of foreign ground vehicles, particularly transporter-erector-launchers (TELs). Data available is limited and past estimates have always had large uncertainties. If successful, this effort shall advance the state-of-the-art for estimating ground system capabilities and provide analysis to enhance the design process for domestic military and commercial vehicles.

AF87-204 TITLE: Advanced Basing System Concept Definition Assessment

OBJECTIVE: To develop the analytical tools to assess concept definition and performance characteristics of various basing modes for land-based ICBMs.

DESCRIPTION: The Advanced Basing Division addresses a variety of single mode and multimode concepts. In order to evaluate the feasibility and cost effectiveness of these concepts, the system effectiveness, survivability, and operational effectiveness must be determined. The contractor will develop the analytical tool to assess concept definition and performance characteristics of various basing modes for land-based ICBMs, including Peacekeeper and Small ICBM. Contractor must have extensive experience in system effectiveness studies and system effectiveness analytical tools. As a minimum, concepts to be addressed should include a hardened launch portal deep base/shallow tunnel complex, as well as other possible ICBM basing variants.

AF87-205 TITLE: "SAFETY/COMPUTER" for Nuclear Weapons/Power and Safety Critical Computer Controlled Systems

OBJECTIVE: To develop a computer system to permit safety critical software to operate in an environment resistant to hardware faults and failures.

DESCRIPTION: Methods are needed to allow complete read capability of all memory locations for load verification. Furthermore, the hardware should be capable of tolerating multiple internal failures without affecting the operation of the verified Nuclear Safety Cross-Check Analysis (NSCCA) software. The computer hardware should also be able to detect transient failures during software execution. The hardware should be based in a high reliability, high production yield, computer-on-a-chip (or other highly integrated type) technology. The system should allow for fault isolation and should be maintainable; but should not require maintenance during five-year operating cycles with a predicted reliability of .9999 and a probability of a single bit/register error of less than 1 x 10-9 during each five-year operating cycle. The computer will have application in Nuclear Weapons Systems, Nuclear Power Plants, Hazardous Operations. Strategic Defense Initiative and numerous commercial safety critical computer controlled systems.

AF87-206 TITLE: Low Cost Alternate Launch System for Flight Testing

OBJECTIVE: To develop low cost alternatives to launch systems for flight testing.

DESCRIPTION: In order to flight test small ballistic Reentry Vehicles (RVs), the Air Force is forced to use a complete missile system retired from the active inventory. In many cases, payloads of less than 50 pounds cost more than three million dollars to launch on a ballistic trajectory into the Kwajelein atoll. For research and development programs, this cost can be prohibitive, leading to a minimum of actual flight testing and great uncertainty in the final performance of a fielded system. Under this topic the contractor would do the following:

a. Examine other methods of placing small RVs into a ballistic trajectory (e.g., ground-based electromagnetic rail guns).
b. Determine the cost and feasibility of building a system.
c. Prepare a phase II hardware development and test program plan

The successful contractor must demonstrate an understanding of the requirements for a ballistic trajectory and the expected launch loads and ascent environments.

AF87-207 TITLE: Stress Analysis of Hypervelocity Models Under High G-loads

OBJECTIVE: To develop methodologies for a three-dimensional analysis of the stress waves produced in a hypervelocity model.

DESCRIPTION: A three-dimensional analysis of the stress waves that are produced in a hypervelocity model that undergoes the high g-loads present in the Range G facility at the Arnold Engineering Development Center. These models are subjected to accelerations as high as 150,000 g's for a short time. The length of time that the model is accelerated can vary but is generally on the order of 50 to 70 milliseconds. The acceleration history starts with a series of short duration (fractions of a millisecond) pulses produced by shock waves, rises to its peak shortly after start, and then decays until muzzle exit. The models are complex with a Lucite base, aluminum and copper necks, yielding threads, and a carbon/carbon nosetip.

AF87-208 TITLE: ICBM Deep Fire Protection System

OBJECTIVE: To develop an ICBM deep base fire protection system definition.

DESCRIPTION: An ICBM deep base could consist of several hundred miles of interconnected underground tunnels which might contain a wide variety of hazardous, toxic, radioactive items. Fuel cells or other chemical power sources could require large volumes of liquid oxygen, chlorine, methane, or other flammable or corrosive liquids and gases. A nuclear power plant may also be used. Handling of ICBMs will require storage of nuclear materials as well as highly volatile rocket propellants. In addition, site geologies may introduce a variety of flammable gases including methane.

To alleviate the danger of explosions and fire, as well as mitigate damage should an accident occur, an integrated fire protection system must be defined. This system should address active as well as passive measures. Emphasis on innovative approaches to damage control is imperative. Energy demands and toxic by-products must be minimized since the entire base will be self contained after a large scale attack. Analysis of current concepts should address points of failure as well as possible solutions.

AF87-209 TITLE: Egress Boring Machine (EBM) Disc Cutter Development

OBJECTIVE: To develop a new disc cutter specifically for the egress scenario.

DESCRIPTION: The current, baseline deep basing concepts use $15^{ft}$ diameter, disc cutter equipped EBMs to bore an egres shaft to the surface at an advance rate of 80 feet per hour. The shafts would be bored from an underground base to the surface at angles of between 45 and 90 degrees from the horizontal for a total length of 1000 to 2000 feet through 10-20 ksi unconfined compressive strength rock. Current EBM development is using state-of-the-art, 17 inch diameter, constant cross section disc cutters as a baseline. The objective of this program is to develop a new disc cutter specifically for the egress scenario. Taking advantage of the limited boring distance, and the medium strength rock, the principal requirement for no maintenance replacement of the cutters suggest an EBM disc cutter be developed to provide penetrations of greater than 1.5 inches and simultaneously allow for larger bearing capacity to take greater thrust loads. Innovative development and test programs are sought to improve and demonstrate cutter and bearing life.

AF87-210 TITLE: Optimal Design of a Smaller Reentry System

OBJECTIVE: To develop a design for a new ballistic reentry vehicle carrying a 50-200 kiloton warhead for use on ICBMs.

DESCRIPTION: Payload and volumetrics of existing and protected US ICBM system should be considered. Materials, sizing, cost drivers, and required technology should be addressed. Product should include cost and schedule estimates for follow-on detailed design and development work.

AF87-211 TITLE: High Lift to Drag Vehicle Design

OBJECTIVE: To develop a reentry vehicle taking advantage of high lift to drag vehicle designs and conventional maneuvering reentry vehicles.

DESCRIPTION: Investigate potential advantages and disadvantages of high lift to drag vehicles vs conventional maneuvering reentry vehicles. Technical areas should include energy management, maneuver capability, payload capability, aerothermodynamics, structures, guidance and propulsion systems. Compatibility with ballistic missile delivery system is a must.

AF87-212 TITLE: ICBM Electronics Hardening Analysis

OBJECTIVE: To develop improvements in hardening ICBM electronic components.
DESCRIPTION: Advanced Ballistic Missile Defenses (BMD) may utilize a variety of weapons to inflict lethal damage on ICBMs. These weapons can include Neutral Particle Beams, Nuclear Pumped Lasers as well as conventional nuclear weapons. While a variety of kill mechanisms may exist for these weapons, electronic destruction or upset is the principal concern of this topic. Due to the nature of the weapon characteristics, the electronics associated with the reentry vehicles and post-boost vehicles are the principal component to be considered (i.e., guidance, arming, and fuzing). The offeror should identify the components susceptible to these environments and levels needed to cause upset or destruction, and finally innovative methods and approaches to solutions. The solutions can encompass circumvention techniques as well as hardening.

AF87-213 TITLE: Acceleration Hardened 84 GHz Transmitter

OBJECTIVE: To develop a .894 GHz microwave transmitter that can be launched in a hypervelocity model.

DESCRIPTION: The transmitter should be designed so that it can be installed in a conical model which has a length of about 4 inches. The transmitter should be designed to withstand launch accelerations up to 100,000 g's.

AF87-214 TITLE: Measuring Electron Densities in Boundary Layers and Wakes.

OBJECTIVE: To develop measuring techniques for electron densities in boundary layers and wakes.

DESCRIPTION: Measurement techniques are needed to determine the electron densities in laminar and turbulent boundary layers and near wakes (free shear layer) on a hypersonic model. These models are sphere-cones which are about 4 inches long with a base diameter of 2.5 inches and which have velocities up to 22 kft/sec. Typical boundary layer dimensions are on the order of 0.01 to 0.2 cm. The range of electron densities for which measurements are needed is approximately 108 electrons/cm3 in the near wake to 1017 electrons/cm3 in the boundary layer. Model view times are short, on the order of nanoseconds. The technique developed should be verified under actual conditions in a hypervelocity range facility.

AF87-215 TITLE: Monte-Carlo vs Navier-Stokes Model

OBJECTIVE: To determine the validity of the Navier-Stokes model at low Reynolds number and low density rarified flow regimes.

DESCRIPTION: The validity of Navier-Stokes model at low Reynolds number and low density rarified flow regimes has not been carefully and clearly defined. Even when the shock-slip (i.e., the non-Rankine-Hugoniot condition) and the body-slip (e.g., the velocity and temperature slip) effects are included, the Navier-Stokes calculations gradually deviate from the measured data as the altitude becomes higher. On the other hand, Monte Carlo analysis usually gives reasonably accurate results at high altitude but calculations become too time consuming as the altitude becomes lower. The altitude at which one can switch from one formulation to another is not clear.

Currently, it is not certain that the results from the two models would overlap. Innovative analysis is sought to identify the domain of validity of the Navier-Stokes model and to ascertain the reliability of the Monte- Carlo formulation. Specifically the effects of Koudsen layer and the collision models (specular vs diffusive) should be addressed in the Monte-Carlo analyses. Comparisons of numerical results with flight data and ground measurements are required.

AF87-216 TITLE: Anti-Ballistic Missile (ABM) Defense Radar Jammers on Deployment Ballistic Upper Stages (BUS)

OBJECTIVE: To design and develop a radar jammer on the fourth stage deployment BUS.

DESCRIPTION: The ability of reentry vehicles to penetrate through an ABM environment is directly associated with the quality of the radar track available to the defense. Radar jammers have the ability to degrade this information. At present, programs have been started to investigate jammers accompanying the reentry vehicle throughout its trajectory. In all tradeoff studies, however, the fourth state deployment BUS has been ignored as a site for a potential jammer. The contractor will do the following in phase I:

(1) Determine feasibility through power allocation requirement studies, initial antenna calculations, and threat
(2) Perform an initial packaging study
(3) Prepare a Phase II hardware development and test program plan.

AF87-217 TITLE: Target Damage Assessment by Ballistically Delivered Sensors

OBJECTIVE: To design and develop a sensor for target damage assessment.

DESCRIPTION: Accurate damage assessment is critical for targeting second wave launches. Properly delivered sensors can provide needed information for this purpose. One method worth exploring is the use of an RV to dispense sensors in the target area after the remaining RVs have penetrated.

AF87-218 TITLE: Anti-Simulation Devices

OBJECTIVE: To develop anti-simulation devices.

DESCRIPTION: To develop approaches, techniques, and investigate payoffs for anti-simulation of radar, optical and combined radar/optical signatures of reentry vehicles and decoys in penetration of anti-ballistic missile defenses.

AF87-219 TITLE: Trajectory Optimization

OBJECTIVE: To develop numerical methods for complex trajectory problems.

DESCRIPTION: New and innovative numerical methods are needed to solve complex trajectory problems. Current methods require end-to-end simulation which is costly and time consuming. Methods are needed to quickly optimize eng game trajectories for maneuvering reentry vehicles with alternative terminal fix constraints against a given set of defenses. The optimacity criteria will be “miss distance.”

AF87-220 TITLE: Muck Disposal System for Multiple High Speed Tunneling Operations

OBJECTIVE: To develop muck disposal system for multiple high speed tunneling operations.

DESCRIPTION: Construction of an ICBM deep base will consist of separate, simultaneous, high advance rate tunneling operations. A system of removing and spoiling the large amount o generated muck must be developed.

The system should be capable of following individual tunneling operations as well as merge with that of other systems to remove and waste the muck from the underground construction area.

AF87-221 TITLE: Ultra High Effectiveness Heat Exchangers and Ultra High Efficiency Heat Pumps

OBJECTIVE: To develop ultra high effectiveness heat exchangers and ultra high efficiency heat pumps.

DESCRIPTION: The ICBM Deep Basing program is considering the use of heat transfer to rock strata for cooling. In order to cool the underground habitat, a heat pump with extremely high efficiency is desired to minimize use of electrical power and provide the highest possible heat pump temperature. Heat exchangers (air-to-water, condensers, and evaporators) of extremely high effectiveness would also contribute to reaching this goal.

The SBIR contractor should develop innovative concepts for such equipment and demonstrate sub-scale models.

AF87-222 TITLE: Passive Sensor Array Design

OBJECTIVE: To design and construct a new innovative passive sensor array.

DESCRIPTION: Sensor will use either seismic or acoustic information to accurately locate multiple events in time and space. The Phase I effort will concentrate on developing theory and identifying power requirement, reliability problems and technology gaps.

AF87-223 TITLE: Hybrid Communications Satellite Design

OBJECTIVE: To design and construct a new innovative passive sensor array.

DESCRIPTION: Using innovative solutions to complex design techniques, provide a conceptual design of a hybrid, multi-frequency band communications satellite. Identify power requirements, boost requirements, reliability problems and any new technologies which need to be developed.

AF87-224 TITLE: Expulsion Techniques

OBJECTIVE: To develop expulsion mechanisms for reentry vehicles.

DESCRIPTION: There is a need to develop a method of expelling up to 300 small objects of approximately ten pounds total weight from a small reentry vehicle from high
endoatmospheric to low altitudes. The effort is needed to define various feasible concepts such as expelling the objects from the base of the vehicle clearing the wake. The effort must address the aerothermodyanmic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

AF87-225 TITLE: Solid Propellant Ballistic and Mehanical Property Modeling

OBJECTIVE: To develop modeling techniques for solid propellant ballistics and mechanical properties.

DESCRIPTION: Advanced missiles designs subject the missile structure and propellants to severe stresses well beyond those of current designs. The combination of ballistic and mechanical properties required far exceed those of the state-of-the-art. This effort would focus on developing a model of solid propellants consisting of energetic binders and various filler materials of varying geometry. The thermo-mechanical properties to be considered include stiffness, creep, relaxation moduli thermal expansion and thermal conductivity.

AF87-226 TITLE: Post-Boost Vehicle (PBV) Master/Slave Guidance

OBJECTIVE: To design and develop a post-boost vehicle (PBV) master/slave guidance.

DESCRIPTION: Provide conceptual designs for master/slave guidance concepts as applied to single ICBMs carrying multiple PBVs with the booster having the master guidance system for boost and the individual PBVs providing a maximum of 350 feet per second delta velocities.

AF87-227 TITLE: Impurity Ions in Heatshields

OBJECTIVE: To develop analytical models for predicting the rate that impurity ions are injected into the boundary layer.

DESCRIPTION: The plasma sheathing and wake signature of a reentry vehicle (RV) is dependent on the electrons produced in the boundary layer of the vehicle. A major source of these electrons in certain altitude regimes are the impurity ions present in the heatshield. Of particular interest is when the flow in the boundary layer becomes turbulent. There is some evidence that indicates the release of impurity ions may be temperature sensitive rather than simply proportional to the ablation rate. An analysis is required to determine the characteristics of these impurity ions as they are injected into the boundary layer. This analysis should determine if it is possible to predict, via an analytical model, the rate that impurity ions are injected into the boundy layer and the effect it has on the plasma sheathing and wake signature of the vehicle. An assessment to determine if ground tests can be performed to validate the analytical model should also be included in this analysis.

AF87-228 TITLE: Parabolized Navier-Stokes (PNS) Code Upgrade

OBJECTIVE: To upgrade Navier-Stokes codes for computing reentry flow fields

DESCRIPTION: Innovative methods are sought to upgrade the existing PNS (parabilized Navier-Stokes) codes for computing the high speed three-dimensional reentry flowfields. Specifically, the new formulations should not be sensitive to marching step size and can calculate the surface laminar and turbulent heat transfer accurately. Numerical viscosity should be avoided if possible. Analysis must also address the selections of optimum grid/coordinate for the geometries. Numerical algorithm must be able to handle internal for imbedded shocks or contact surface. Finally, the formulation must have the potential to extend to chemical/thermal nonequilibrium flows.

AF87-229 TITLE: Maneuvering Reentry Vehicle (MaRV) Sizing Analysis

OBJECTIVE: To develop computer adaptable innovative designs and engineering analyses for maneuvering reentry vehicles (MaRV).

DESCRIPTION: Development of computer adaptable innovative designs and engineering analyses are sought for preliminary estimates of maneuvering reentry vehicles (MaRV) (e.g., weights, center-of-gravity locations, and size and shape). The algorithms should evaluate the vehicle configuration (e.g., nose geometry, multi-conic body, etc.) control concepts and control size requirements for particular trajectories. The methodology should employ efficient but accurate aerodynamics, static stability analyses, nose overhang calculations, heatshield thickness estimates and trajectory computations. The analyses should address both bank-to-turn and skid-to-turn concepts.

AF87-230 TITLE: Radar Frequency (RF) Propagation Prediction Through Nuclear Clouds

OBJECTIVE: To develop an analytic model which can be used to calculate propagation of electromagnetic radiation at radar frequencies (RF) through nuclear clouds.

DESCRIPTION: Target detection through nuclear clouds at frequencies of 1.0 to 35 GHz is of interest. An electromagnetic model of the nuclear cloud in the RF should be done for middle and high altitude bursts. Existing RF data for nuclear bursts and simulated bursts should be reviewed and factored into the model.

AF87-231 TITLE: Optical Processing for Ballistic Missile Defense

OBJECTIVE: Applications of optical processing techniques for ballistic missile defense.

DESCRIPTION: Areas of interest include:

a. Applications of optical processing systems for RV discrimination. Systems which use infrared, visible (reflected laser or natural) light or radar signals as input are of interest.
b. Optimal use of optical signal processing in a BMD radar system design. Effective hybrid optical-digital system for reducing or conditioning radar return signals as well as configurations capable of background and noise suppressions, target feature enhancement and directional filtering are among those of interest. Waveform, architecture and internal implications are to be assessed.

AF87-232 TITLE: Wind Tunnel Shear Stress Gauge Development

OBJECTIVE: To develop instrumentation for measuring hypersonic boundary layer shear stress on smooth and rough walls.

DESCRIPTION: This gauge should have sensitivity and accuracy in both laminar and turbulent flow. The wind tunnels under consideration are the Arnold Engineering Development Center tunnels under consideration are the Arnold Engineering Development Center tunnels A, B, and C. One potential application is to measure the two components of surface shears which are usable to define the local limiting streamline direction. This gauge should be robust enough to operate in the continuous wind tunnel and hot environments (e.g., adiabatic wall). Also, it should be sensitive enough to measure the cross flow (secondary flow) shear.

AF87-233 TITLE: Kinetic Kill Countermeasures

OBJECTIVE: To develop ICBM evasion techniques/maneuver mechanisms.

DESCRIPTION: Advanced Ballistic Missile Defenses may utilize a variety of weapons to inflict lethal damage on ICBMs. These weaponscan include Directed Energy Weapons and Kinetic Energy Weapons(KEW). This effort shall focus on negating KEW threats. Previous studies have determined that conventional hardening is impractical due to severe weight penalties, however, evasion tactics appear promising. Due to the nature of the threat, ICBM boosters and post-boost vehicles are the principal concern. Evasion maneuvers against KE vehicles with velocities of 1 to 30 km/sec (with and without homing) are of interest. The offeror should be able to determine the magnitude of the maneuvers required, the effects of the maneuvers on the systems, and innovative methods or techniques to initiate and control the maneuvers.

AF87-234 TITLE: Heatshield/Structure Attachment

OBJECTIVE: Develop methods for heatshield/structure attachment.

DESCRIPTION: The size of cutouts for future antennas windows has the potential to increase to a point where simply bonding the heatshield to the substructure may not be adequate for tape-wrapped heatshields, particularly with high maneuvering loads. Alternative thermal protection systems, which may include specialty segments which can survive, are desired which will survive the loads and not severely constrain the vehicle weight, size, etc.

AF87-235 TITLE: Nuclear vs Conventional Weapons Effectiveness Model

OBJECTIVE: To develop a methodology/model comparing the lethality effectiveness of nuclear and conventional weapons.

DESCRIPTION: Develop a methodology/model comparing the lethality effectiveness of nuclear and conventional weapons that have the same payload (weight and volume) constraints. Then, with the physical damage parameters listed in the Physical Vulnerability Handbook – Nuclear Weapons and the Joint Munitions Effectiveness Manuals (JMEM), Identify what conditions it would be best to use one weapon type over the other to ensure the highest probability of target kill while keeping collateral damage to a minimum.

AF87-236 TITLE: ICBM Control Analysis

OBJECTIVE: To develop variable stability controls for ICBMs.

DESCRIPTION: Determine the utility of incorporating variable stability control equations into ICBM controls instead of flying fixed gain equations with variable switching) for enhanced stability. Phase 2 follow-on efforts will focus on the most promising methods for further development.

AF87-237 TITLE: Brilliant Guidance for ICBMs

OBJECTIVE: To develop brilliant guidance systems for ICBMs.

DESCRIPTION: Analysis of the integration of advanced acquisition and tracking algorithms, passive and active sensors, monolithic millimeter wave integrated circuits, compact fusing algorithms to future ICBM missions is sought. Advanced sensors, processors, algorithms and software are needed to enable the development of reentry systems with autonomous capabilities to perform updates for accuracy improvements or to find, recognize and home-in on relocatable targets.

AF87-238 TITLE: High Energy Density Propellants for ICBMs

OBJECTIVE: To develop high energy density propellants for ICBMs.

DESCRIPTION: Analysis of the use of chemically stable elements whose electrons reside in a higher energy state than occurring naturally for use in advanced ICBM designs is sought. Availability of propellants having 10 times the energy density of conventional propellants will support the development of smaller missiles, larger payload capability or both. To support this analysis, an analytic tool used to evaluate the payoffs and characteristics desired include specific impulse, burn time, throw weight, lift off weight, range and environmental impact but are not limited to these.

AF87-239 TITLE: Synthetic Aperture Radars

OBJECTIVE: To reduce synthetic aperture radar requirements for large amounts of computer processing.

DESCRIPTION: Synthetic aperture radars require large amounts of computer processing (millions of floating point operations per second) to obtain real time images. Identify methods to reduce this requirement and check the validity of those methods. Quantify the image degradation (i.e., false alarms, missed images) versus the reduction of competition requirements.

AF87-240 TITLE: Antenna Window Ablation

OBJECTIVE: To develop an analysis tool to calculate the three dimensional ablation histories on the antenna windows of maneuvering reentry vehicles.

DESCRIPTION: The window configurations can be either mutli-element phase array button geometry or a large monolithic element. The formulation must address the streamwise as well as spanwide (azimuthal) ablation variations. The interactions between the heat shield and window ablation are the essential features of the models. Internal conduction and radiation should be included. The window materials can be melting adaptors and/or sublimators. The windows can be located at any location on the vehicle and the flowfields must include the angle of attack effects.

AF87-241 TITLE: Research Instrumentation

OBJECTIVE: To stimulate the development of new scientific instruments for laboratory and industrial applications.

DESCRIPTION: Progress in fundamental research often depends on use or invention of new diagnostic techniques which can provide better insight into the fundamental processes or phenomena under study. Development of improved and novel scientific instrumentation will enable researchers to make more useful measurements per unit of time, to make measurements to a greater degree of accuracy, and to make measurements in places and under conditions not now possible. It may also permit quality instruments to cost less and be more reliable. This effort seeks to improve the basic function of scientific instruments, and to reduce the cost and improve the reliability of instruments which would enhance the scientific productivity of this country. Areas of interest include, but are not limited to, laser combustion diagnostic testing, vision testing equipment, advanced biogenetic tests for toxicity, new mathematical algorithms allowing improved computer program performance, optical information processing, accelerator mass spectroscopy, aerodynamic flow measurement devices, and improved material and process diagnostic systems. The Phase I effort should provide a review of various concepts and design options for the proposed type of instrumentation. The Phase II effort would then develop a prototype or prototypes of the best concept/design alternatives, leading to Phase III commercialization of the instrument. Evaluation of proposals will include the following factors:

a. Potential value to the Air Force Research program.
b. Potential for transition to Air Force Laboratories
c. Potential to aid the scientific community.