AIR FORCE SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals on Air Force Topics

Topic AF86-001 to AF86-015

AFOSR/XOT
Building 410, Room A113
Bolling AFB, Washington DC 20332-5000

Topics AF86-016 to AF86-036

AD/PMR
Room 428, Building 350
Eglin AFB FL 32542-5000

Topic AF86-037 to AF86-046

ESD/XRCT
SBIR Program Manager
Mitre D Building Room 1D237
Hanscom AFB, MA 01731

Topics AF86-047 to AF86-057

RADC/DOR
Building 106, Room A112
(Attn. Mr. M. Donovan)
Griffis AFB NY 13441

Topic AF86-058 to AF86-069

WCO/AFSTC
P.O. Box 92960
Los Angeles, CA 90009

Topics AF86-070 to AF86-071

HQ AFSTC/XN
Attn. Lt. Steele
Building 497, Room 205
Kirtland AFB NM 87117-6008

Topic AF86-072 to AF86-075

AFGL/XOP
Building 1107, Room 200
Hanscom AFB, MA 01731

Topics AF86-076 to AF86-080

AFRPL/TSPR
Building 3853, Room 115
Edwards AFB CA 93523

Topic AF86-081 to AF86-086

AFWL/PRC
Building 413, Room 261
Kirtland AFB, NM 87117-6008

Topics AF86-087 to AF86-091

Special Assistant for Program Coordination
ASD/AE
Building 57, Bay 1
Wright-Patterson AFB OH 45433

Topic AF86-092 to AF86-093

ASD/ENO
Engineering Operations Office
Building 14, Room 208
Wright-Patterson AFB, OH 45433

Topics AF86-094 to AF86-102

Directorate of Concepts & Innovation
ASD/XRX
Building 11A, Room 201
Wright-Patterson AFB OH 45433

Topic AF86-103

ASD/YWB
Building 11, Room 014
Wright-Patterson AFB, OH 45433

Topics AF86-104 to AF86-105

Deputy for Propulsion
ASD/YZYD
Building, Post B-14
Wright-Patterson AFB OH 45433

Topic AF86-106 to AF86-123

Avionics Program Office
AFWAL/GLXPA
Building 22, Room S110
Wright-Patterson AFB, OH 45433

Topics AF86-124 to AF86-146

AFWAL/GLXPF
Area “B” Building 45, Room 149
Wright-Patterson AFB, OH 45433

Topic AF86-147 to AF86-172

AFWAL/GLXPM
Area “B”, Building 653, Room 406
Wright-Patterson AFB, OH 45433

Topics AF86-173 to AF86-187

AFWAL/GLXPP
Programs Group
Building 18A, Room A-103
Wright-Patterson AFB OH 45433

Topic AF86-188 to AF86-272

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

Topics AF86-273 to AF86-287

HG Aerospace Medical Division
AMD/RDO
(Attn. B. Williams)
Directorate of Resources and Operations
Building 150, Room 224
Brooks AFB TX 78235

Topic AF86-288 to AF86-293

AEDC/DOT
Building 900, Mail Stop 900
Arnold AFS TN 37389

Topics AF86-294 to AF86-300

HQ AFESC/RDXP
Building 1120
Tyndall AFB FL 32403

Topic AF86-301 to AF86-304

AFWAL/GLXPF
Area “B” Building 45, Room 149
Wright-Patterson AFB, OH 45433

Please note that, because of unique circumstances, proposal deliveries to the Wright-Patterson AFB OH complex will require additional time (about one day) for processing to the correct office. Accordingly, bidders should plan an additional time allowance for proposal delivery to the correct office as stated in this solicitation.

AF86-001 TITLE: Investigate Fluid Flow Phenomena to Improve the Performance of Flight Vehicles

DESCRIPTION: This project support research in external aerodynamics, turbulent and unsteady flows, and internal fluid dynamics. The objective is to investigate the fluid flow phenomena that strongly influence the aerodynamic performance and efficiency of current and future flight vehicles, to understand the structure of turbulence in shear flows, and to improve our understanding of and capability to predict three-dimensional flow past geometrically complicated configurations. We are interested in methods for automatically generating solution-adaptive computational grids; exploiting the unsteady flow characteristics that will improve aerodynamic efficiency and enhance performance; improving experimental and theoretical modeling capability for deflected engine exhaust jets that may interact with solid surface and encounter cross flows; numerically simulating time-evolving turbulence features; passively, actively, and interactively controlling turbulence characteristics; numerically computing on- and off-design flows in low aspect ratio and high pressure ratio compressor blade passages. Proposals should be in one or more of the following areas: Effects of viscosity, turbulence, pressure and temperature gradients, compressibility, and non-steadiness of flows; interactions of the shock wave-turbulent boundary layer for a range of Mach numbers; severe separation from wings and wing and body configurations; turbulent structures and their interactions in free and bounded shear layers; the behavior of attached and separated unsteady shear layers affected by time-dependent boundary conditions; generic characteristics of driven, unsteady separated flows; flows in internal passages in lasers; compression system instability; dynamic stall on two and three dimensional lifting surfaces; aerodynamically forced response of stator blades; and effective active cooling for turbine blades.

AF86-002 TITLE: Improve the Long-Term Durability and Reliability of Aerospace Structural Systems

DESCRIPTION: This project supports research in structural mechanics, structural durability, and civil engineering. The objective is to explore the behavior of aerospace structural systems in a variety of environments, the long-term durability and reliability of those structures, and the properties and behavior of new materials to be used for strategic and tactical structures. We are interested in developing structural response models, models for predicting damage growth and structural life, and constitutive models for geo-technical and construction materials; studying the strength and fracture characteristics of brittle materials; investigating explosion-induced soil liquefaction; and developing, identifying, and measuring in-situ soil properties. Proposals should be in one or more of the following areas: The role of internal and external non-linearities of structures; ways in which to control the behavior of the structures; interactions between flexible aerospace systems and their on-board controllers; ways in which fatigue and fracture damage structures, especially composite structures; new materials or approaches that will lead to the survivability of strategic structures in a nuclear weapons environment, the survivability of strategic and tactical structures in a conventional weapons environment, and rapid repair of tactical and logistical aircraft launch and recovery surfaces.

AF86-003 TITLE: Enhance the Performance of Flight Vehicles by Improving Air Breathing and Rocket Combustion and Plasma Energetics

DESCRIPTION: This project supports research in air breathing combustion, diagnostics in reacting media, rocket combustion dynamics, and plasma energetics. The objective is to study the physical and chemical processes of combustion in an air breathing propulsion system; develop techniques for sensing temperatures, concentrations, and velocities in energy conversion systems; understand combustion and reacting flow processes; and study advanced space propulsion. We are interested in models of turbulent fluid transport processes, photochemical and catalytic methods for more stable ignition and enhanced combustion of present fuels and future alternatives, noninvasive sensing and diagnostic techniques and strategies, methods for analyzing the stress of nonlinear visco-elastic materials, thermal protection techniques for isolating plasma from inert components, and noninterference techniques for measuring plasma. Proposals should be in one or more of the following areas: Fluid transport processes; stable ignition and enhanced combustion of present and future fuels, control of the rate of combustion, and reduction of undesirable combustion products; the combustion of liquid fuel and high energy slurry fuels; reacting flows in the hostile environments of high performance systems; combustion instability problems in solid and liquid rocket systems; instability phenomena that degrade the performance of ramjet combustors; role of advanced energetic ingredients in solid propellant burning; state of combustion products in plumes; thermodynamic, kinetic, and transport properties of pure substances used for propellants; sources of physical (non-chemical) energy, such as

electrically conductive flowing gases or plasmas; the mechanism of release of that energy; and the devices for converting that energy; the phenomena of energy coupling and transfer of energy flows in electrode and electrodeless concepts under plasmadynamic environments and conditions that orbiting plasmadynamic systems encounter; pulsed and steady-state equilibrium and non-equilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, electrode, magnetic, and electric fields; energy losses to inert parts; plasmas generated at high magnetic fields and pressures; and characteristics of advanced refractory materials exposed to working fluids and life-limiting mechanisms.

AF86-004 TITLE: Chemical Science

DESCRIPTION: This topic includes five principal sub areas: chemical techniques, structural chemistry, surface chemistry, molecular dynamics, and chemical reactivity and synthesis. Research in chemical techniques focuses on developing new and improved analytical instrumentation and methods in electrochemistry and detection (specifically the nature of electrodes and electrochemical reactions). Research in structural chemistry encompasses programs in polymer science, glass, and advanced structural ceramics and ceramic composites. Research in surface chemistry investigates gas and solid surface interactions, surface characterization, surface reaction kinetics and mechanisms, the characterization of thin films, the interaction and reactivity of gases with thin films, the stability of substrate and thin film interfaces, film nucleation and growth, and interactions of intense light and thin films. Research in molecular dynamics examines well defined microscopic molecular systems in reactive and non-reactive molecular collisions by using selected energy states of reactants and analyzing the energy through available molecular energy levels or through emission of radiation. Research in chemical reactivity and synthesis seeks to explore new and better methods for characterizing and synthesizing new organic, inorganic, organo-metallic, and organo-metalloid compounds (particularly organo-silicon and fluorocarbon substances), pre-ceramic polymers, and novel approaches for making reaction intermediates that can be used to tailor chemical structures with desirable properties.

AF86-005 TITLE: Atmospheric Physical Processes.

DESCRIPTION: Basic research in this area includes studies of Atmospheric transmission and absorption to understand molecular absorption/emission line widths and shapes, and field and laboratory comparisons; Optical Aerosol Modeling to increase understanding of atmospheric aerosols and their effect; Remote Sensing of Atmospheric Quantities to illuminate knowledge of radiative transfer; Neutral Upper Atmosphere Dynamics to determine and model motion and chemistry above the stratosphere; Ionospheric Physics to understand global ionospheric dynamics and electron density variations; Ionospheric – Magnetosphere Modeling to define interactions and responses of the global atmospheric system; Large-Scale Dynamics to understand interactions between the troposphere and the upper atmosphere; Meso-scale Dynamics to produce new knowledge about the interplay between meso and macro scale systems and convective elements; Cloud and Aerosol Microphysics to understand molecular and particle-scale physics of cloud and precipitation systems; Atmospheric Electricity to understand characteristics of atmospheric charge separation and electrical discharges; Climate Physics to understand the fundamental physics underlying climate and climate change.

AF86-006 TITLE: Improvement in the Technology of Monolithic Microwave and Millimeter Wave Integrated Circuits

DESCRIPTION: This project includes three topics: monolithic microwave and millimeter wave integrated circuits, super conducting analog signal processing, and process modeling for compound semiconductor technology. The research in monolithic microwave and millimeter wave integrated circuits seeks to identify improvements in materials, processing techniques that can be automated, and device designs. Monolithic refers to the fabrication on a single semiconductor chip of active and passive components, such as transistors, capacitors, inductors, and interconnections. Needed research includes work on substrates, active layers, device modeling, millimeter wave device designs, and monolithic integration. Implementation will be in gallium arsenide or indium phosphide or related ternary compounds at frequencies up to 100 GHz.

One promising approach for future signal processing applications is the use of circuits based on super conducting analog elements. The basic functional needs to high speed, wide bandwidth signal processing are delay (compact structure), tapping (accurate), multiplication (dynamic range), and summation (phase coherence). Candidate research topics include more reproducible and uniform tunnel oxides; discrete devices, such as convolvers and correlators; more complex circuitry, such as programmable matched filters and time-integrating correlators; a combination of super conducting and cooled-semiconductor devices; and photo-introduction of signals into the cryostat to avoid wires.
Silicon device and integrated circuit technologies have been greatly fostered by the availability of computer simulation tools, such as SUPREM and SPICE. Under the topic of process modeling for compound semiconductor technology, we are seeking suitable process models for compound semiconductor materials, such as gallium arsenide and indium phosphide. We are interested in research that proposes models for bulk materials processing, such as liquid encapsulated Czochralski (LEC) and horizontal or vertical Bridgeman. Other areas of interest include device and/or integrated circuit models that incorporate the standard fabrication steps, including implantation, thermal annealing, dielectric formation, metalization, etc.

AF86-007 TITLE: Development of Novel Thin Film Deposition Techniques

DESCRIPTION: This project includes research in novel thin film deposition techniques. Currently, Air Force optical systems are limited in performance by thin film properties. Existing deposition techniques, such as thermal evaporation and sputtering, result in films with a microstructure described by the structure zone model. Thin film performance could be improved with deposition techniques, such as energetically enhanced chemical vapor deposition, molecular beam epitaxy, ionized cluster beam deposition, or other ultrahigh vacuum epitaxial techniques, that permit more control over film morphologies. The ultimate goal of investigating these techniques is to find a technique for the deposition of a perfectly amorphous or a perfectly single crystal optical film that has thin film properties approaching those of the bulk material. We are interested in research that proposes to characterize novel deposition techniques or to model growth and deposition phenomena.

AF86-008 TITLE: Ceramic and Cement-Matrix Composite Materials

DESCRIPTION: This project supports research leading to the creation of new non-metallic structural materials in two categories: ceramic composites and cement-matrix composites. The new ceramic composite materials must possess mechanical properties of strength, toughness, and durability which would permit their use as structural materials in oxidizing environments from 1600-2200 degrees C. The new cement-matrix composites must possess strength, stiffness and toughness property values significantly greater than those of ordinary portland cement concretes while retaining the ability to be processed at low temperature.

AF86-009 TITLE: Research in Neuroscience

DESCRIPTION: There are two programs in neuroscience. Bioreactivity examines the mechanisms that control neuronal activity. The current focus is on neuronal regulation and adaptation, including control of neurotransmitter release and postsynaptic response, activation of second messengers and ion channels, and influence of neurohormones. We are particularly interested in studies that relate events at the different levels of organization involved in regulating the state of responsiveness of the intact organism. Research in adaptive network architectures explores the neural mechanisms of learning and memory and attempts to relate them to intelligent machine architectures. The roles of positive and negative reinforcement in neuronal adaptation and goal-seeking behavior in neurons and neural ensembles are emphasized.

AF86-010 TITLE: Research in Experimental Psychology

DESCRIPTION: A program in sensory information processing focuses on attempts to describe quantitatively the capabilities and limits of the human visual and auditory systems in complex, dynamic environments. Spatial and temporal interactions, perception of patterns, and the effects of memory, attention, expectations, the other senses,

and eye movements are included. Also supported is experimental and theoretical work on the mechanisms by which humans recognize complex sound patterns. A program in mental workload supports fundamental behavioral and physiological research on stages of information processing and allocation of mental resources involved in performing complex demanding tasks.

AF86-011 TITLE: Research in Toxicology

DESCRIPTION: Air Force operations may result in the release of physical and chemical agents that may be harmful to Air Force personnel and the environment. The objective of research in bioenvironmental hazards is to obtain data on the biological effects of exposure to electromagnetic radiations from pulsed and continuous wave sources and to clarify how Air Force relevant chemical produce their toxic effects. Fundamental research on mechanisms of action is supported, but not studies that simply screen for toxicity.

AF86-012 TITLE: Research in Mathematics

DESCRIPTION: Basic research in mathematics covers the mathematics of computation, mathematics of dynamics and control, applied mathematics, computer science, and probability and statistics. Research in the mathematics of computation seeks to develop algorithms that can be coded reliably, efficiently, robustly, or automatically for serial, vector, and parallel computers with emphasis on ways to numerically solve partial differential equations and algebraic equations. Research in the mathematics of dynamics and control includes robust control, adaptive control; stability theory, optimal control, stochastic control, filtering, nonlinear control and identification, and optimization of lumped and distributed parameter systems. Research in applied mathematics includes the creation of new mathematical models and methods for solving physical, chemical, and biological systems; signal processing and communication; mathematical optimization; applied analysis; and finite mathematics. Research in computer science focuses on distributed and parallel processing, programming theory, artificial intelligence, and data management systems. Research in probability and statistics addresses new methods and the expansion and generalization of existing methods in probability theory, statistics, stochastic processes, statistical communication theory, and reliability for real systems.

AF86-013 TITLE: Research on Physical Processes of Plasmas, Lasers, Microwave Devices, Space Prime Power, and Directed Energy Concepts

DESCRIPTION: This project supports research in optical physics, pulsed power, atomic and molecular physics, particle beam technology, and the physics of collective phenomena. Optical physics addresses research in the vacuum ultra-light to the near millimeter range of the spectrum. Emphasis is on coherent light and its interactions with matter. Pulsed power investigations center on electron beam, laser triggered, and sustained switching, the spectroscopy of switch plasmas, an understanding of high power repetitive opening switches, and an understanding of the ways switch electrodes and insulators break down and erode. Research in atomic and molecular physics concerns the properties and interactions of atoms and molecules. Research in particle beam physics includes investigations of intense, high energy, charged and neutral beams and studies of negative ion sources. Studies of the physics of collective phenomena examine the collective effects of low temperatures and the physical processes associated with producing radiation at X-ray, soft X-ray, millimeter wave, and microwave frequencies.

AF86-014 TITLE: Study Near-Earth Space Conditions to Prevent Degradation of Military Systems Operating in Space

DESCRIPTION: Space environmental conditions produced by radiation and atomic particles can endanger the mission and degrade the performance of military spacecraft, disrupt the detection and tracking of missiles and satellites, distort communications, and interfere with surveillance operations. The objective of research in this project is to study the particles, electric and magnetic fields, and radiation that affect the environment of near earth space. Studies should be designed to examine the following topics: Ways to specify and forecast solar wind and magnetospheric conditions with ground based measurements, such as radio star scintillations and geomagnetic

pulsations; celestial background radiation; ways to improve the resolution of space object images; distribution of plasma and magnetic fields within the magnetosphere; and the earth's radiation belts and their responses to natural and artificial disturbances.

AF86-015 TITLE: Improve the Accuracy of Locating Geographical Positions and Establish Methods to Reliably Differentiate Between Earthquakes and Underground Detonations

DESCRIPTION: The research in this project I stimulated by the need to guide and control missile systems, conduct advanced tests of components, site silos, discriminate among the sources of nuclear explosions, and conduct reconnaissance and surveillance missions. The scientific disciplines involved are geodesy, gravity, geology, and seismology. Research in geodesy defines the exact position of targets with respect to missile launch sites. Research in gravity examines the effect of gravity on missile guidance systems along flight paths. Research in seismology studies the effects of earthquakes, nuclear explosions, and other natural or system generated noise on the degradation of missile guidance systems before launch.

AF86-016 TITLE: RF/Millimeter Wave Phenomenology Investigations

DESCRIPTION: The Air Force is currently in he process of developing a variety of RF and millimeter wave (MMW) seekers for both air-to-air and air-to-surface guided weapon systems. A program to understand and model the phenomenology on which these seeker designs are based is needed. In previous programs, both target and clutter data for a number of scenarios has been collected. Information gained from these data collection programs has been useful in understanding sensor performance in high clutter environments; however, the in depth analysis of millimeter-wave phenomenology necessary to achieve optimum, or in some cases even acceptable solutions to the target acquisition/discrimination problem has not been performed. With a better understanding of the basic phenomenology and advances in seeker technology, it is imperative that the data collection, analysis and modeling be refined to better understand the critical phenomenology issues. This phenomenology includes target radar cross section signatures, background clutter backscatter characteristics, polarization signature of targets and clutter, high resolution imaging characteristics, clutter back scatter spatial correlation characteristics, countermeasures and counter countermeasures.

The objective of this program is to model these signatures from first principles, physical models of target and clutter, and validate these models with data which currently exists. The first principles approach shall make the models independent of the data base used to validate models and shall facilitate the evaluation of a large variety of seeker design concepts. In addition to validating the models with existing data, the program must identify deficiencies in the current data base, and interface with the Joint-Weather Seeker (JAWS) program to attempt to overcome these deficiencies.

AF86-017 TITLE: Gallium Arsenide Solid State Accelerometer (GASSA)

DESCRIPTION: Acceleration (deceleration) is always present during the launch and/or terminal engagement of air-launched weapons. Various devices, mainly mechanical, have been utilized to provide inputs to arm subsystem and fuzing logic for safe separation and/or detonation decisions. Due to the low sensitivity and poor accuracy of existing economical devices these fuzing decisions have of necessity been gross, limiting effectiveness parameters such as launch envelope and warhead detonation point. Previous development programs on the silicon solid state accelerometers have demonstrated the technology necessary to batch fabricate single chip accelerometers in the range from .01g to 10,000g with sensitivity versus natural frequency equal to or better than commercially available discretely fabricated accelerometers in the $100 to $300 price range. Although considerable progress has been made, the desired level of accelerometer sensitivity has not been achieved. Recent advancements in the use of gallium arsenide devices suggest that this technology can be applied to accelerometers with the potential of a sensitivity factor improvement of 5 to 20 over that of silicon.

The objective of this program will be to investigate the theoretical potential of gallium arsenide accelerometers to improve sensitivity levels. This program will concentrate on improvement in areas to include: temperature stability;

yield, packaging for environmental survivability; reliability; and ease of interfacing with decision logic circuit. One of the main efforts will involve placement of all temperature compensation and amplifier circuitry on the accelerometer die instead of on a separate substrate as in the earlier development program.

AF86-018 TITLE: MMW Terminal Homing Sensors

DESCRIPTION: Strategic defense studies have consistently shown that due to limitation in sensor accuracy, a terminal homing sensor will be required on a hit to kill projectile. Furthermore, those studies have all identified MMW techniques as a potential solution, but the present technology limits its usefulness. Revolutionary improvements in the size, weight, speed, and accuracy of phased array antennas in the 60-300 GHz range are needed to mature MMW technology to where it can be useful in Electro magnetically Launched Guided Projectiles.

The objective of this program is to investigate innovative techniques to facilitate the development of monolithic phased array antennas. Small high speed phase shifters, which are required for beam steering, is one area of interest. Another area of interest is in insular wave guide techniques. For example, insular guide integrated monopulse antennas and pulse transceivers, and wide-band circulators.

AF86-019 TITLE: Non-Nuclear Weapon System Performance Measurement Techniques

DESCRIPTION: Accurate and realistic assessment of the effectiveness of conventional munitions where weapon system aiming at munition release is crucial can be obtained with current computer and sensor capabilities. Today's assessment of weapon system effectiveness often relies on input data from a small set of data where live munitions are fired at surrogate or mock targets. Often the targets are benign and unrealistic. The approach which should be taken is to use actual realistic targets (possibly manned) and simulate the munition using an on-board computer simulation. This approach is being taken by the Army and Navy with respect to training. Weapon systems are being developed with an on-board "embedded training" capability. With the munition being simulated, all subsystems as well as the man-in-the-loop can be trained and/or evaluated. The data records from such training exercises are invaluable to the weapon system effectiveness analysts. Furthermore, with the use of programmable, digital computers, new munition concepts can be evaluated in the field by computer software changes. To achieve this capability for the Air Force, innovative research is needed to package a rugged and reliable instrumentation suite consisting of sensors, computers and software applicable to both guided and ballistic munitions.

The near-term objective o this program will be to investigate performance measurement techniques and computer simulation techniques required for an aircraft "embedded training" capability applicable to both training and munition concept evaluation. The long-range objective will be to develop a similar capability to evaluate Strategic Defense Initiative concepts using a simulated kill mechanism.

AF86-020 TITLE: Fuze Design for Long Term Storage

DESCRIPTION: Fuzes are subjected to a wide range of environmental conditions prior to their one time usage requirement. During this time certain physical and chemical changes occur which may negate their successful operation. It is essential that the shelf life and service life be correctly established and extended to minimize destructive sample testing of inventory fuzes. The current fuze surveillance program is adequate to assess reliability but does not address failure modes and causes of failures. It uses fuzes that are destroyed in weapons tests and determines reliability by statistical means. It is imperative to establish a firm service and shelf life that is based on physical and chemical analyses in lieu of destructive sampling techniques. This has an impact on the development, acquisition and operational cost of past, present and future fuze designs.

The objective of this program will be to develop a:

a. Methodology for the determination of the causes of fuze failure and suggest alternative materials, processes and designs to eliminate or reduce failures due to long term storage.

b. Plan for validating, methodology, alternative materials, processes, and designs.

Phase II of this program would require the accelerated lifetime testing of the end products of Phase I.

AF86-021 TITLE: Target Acceleration Term in Homing Missile Guidance

DESCRIPTION: Air-to-air homing missile guidance laws have been derived from modern, optimal control theory by a number of researchers over the last seven years. Though various coordinate systems and cost functions have been used, all of the resulting guidance laws contain a term which is proportional to the target's acceleration. While the overall performance of these advanced guidance laws has been shown superior to more conventional proportional navigation, the significance of the target acceleration term is not well understood. In-house work at the Air Force Armament Laboratory has shown that the inclusion of this term often does not improve miss distance against an evading target even when the guidance law is provided (unrealistically) with the perfect knowledge of the target's acceleration. The contribution of the target acceleration term varies from one engagement geometry to another with no obvious pattern. In effort indicates the target acceleration term degrades the guidance loop stability margins making the system more susceptible to noisy, inaccurate target acceleration estimates.

This program, then, will concentrate on understanding and improving the target acceleration term in modern, optimal guidance laws. The contractor should first address the simplifying assumptions made during the formulation of the optimal control problem and arrive at a theoretical understanding of their impact on the resulting guidance law performance. These assumptions include, for example, linear or constant radius curvilinear target motion, and instantaneous, unlimited control of missile acceleration in all directions. The contractor will then rederive the optimal control problem from first principles removing or relaxing those assumptions which most severely degrade the resulting performance. Recognizing that target acceleration can only be estimated (not directly measured), the contractor then should relate, in a statistical sense, the accuracy of those estimates to the performance of the guidance law in general and the target acceleration term in particular.

AF86-022 TITLE: Use of Artificial Intelligence for Target Vulnerability Assessment

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

The objective o this effort is to develop artificial intelligence techniques for target vulnerability assessment methodologies. Consideration should be given to development of algorithms for making expert decisions in damage assessments. Also of interest are techniques for alternative to expert opinions on assess vulnerability.

AF86-023 TITLE: 1.3 Micron Integrated Optic Frequency Shifter

DESCRIPTION: Increased Air Force emphasis on standoff, launch and leave tactical weapon delivery has created a need for small, very low cost inertial reference systems for weapon control, guidance, and seeker stabilization. Inertial sensors (gyros and accelerometers) which are critical to these inertial reference systems, meet cost, size and adverse environment requirements imposed by these weapons. The passive laser gyros have the potential to meet these requirements. Current passive laser gyros use bulk optic components and operate at 0.85 micron wave-length.

A passive laser gyro component of particular interest is the frequency shifter. Bulk optic frequency shifters do not show the low cost mass production potential promised by integrated optics. Incorporation of 1.3 micron technology in lieu of 0.85 micron will reduce losses on order of magnitude and enhance performance.

The objective of this program will be to investigate the potential of integrated optic frequency shifters for passive laser gyros that operate at 1.3 microns. This program will concentrate on the design of such a frequency shifter that could be coupled to a fiber optics gyro.

AF86-024 TITLE: Insulating Rails for Electromagnetic Guns

DESCRIPTION: An electromagnetic rail gun barrel consists of two current carrying rails separated by two insulating rails. During firing, the projectile is accelerated down these rails by an intense (0.5 – 2.0 megamp) current flowing in the rails and in an armature behind the projectile. The armature may be a plasma, in which case the rails are exposed to the plasma temperature and pressure.

Materials presently being used for insulating rails are glass fiber/epoxy composites or ceramics. The glass fiber/epoxy composites suffer erosion and ablation damage during firing. The ceramics frequently crack or flake off. Neither material is usable for more than a few shots, and a new material is required.

The new insulating material should be an electrical insulator. It should not be degraded by exposure to the arc plasma for a short time. The arc plasma is estimated to be at a temperature of a few tens of thousands of degrees Kelvin, and pressures are a few thousand atmospheres. Exposure times are less than a millisecond. The material may be installed in the barrel for long periods of time under preload, so it must not creep under loads equivalent to thousands of atmospheres. Candidate materials are toughened or fiber reinforced ceramics. Other material concepts are welcome.

AF86-025 TITLE: Scaled Down Physical Model of an Air Target for Performance Evaluation of Imaging IR Seekers (Short Title – IR Air Target Model)

DESCRIPTION: Infrared (IR) radiation from an air target serves as the source of energy from which an airborne IR seeker, in conjunction with a guidance system, tracks, and intercepts the target. At relatively long range, the target appears as a point source radiator. As the seeker-to-target range decreases, an IR imaging seeker images the IR target and by employment of proper algorithms, is able to discern targets from background. Furthermore, with sufficient seeker resolution, a track point on the target is established and maintained, and the missile is guided along a trajectory to intercept the target. During development of the seeker/guidance system, performance evaluations of the system may take place by way of simulations, which may take the form of digital, analog, hybrid, or hardware-in-the-loop (HIL). One aspect of HIL testing requires an IR target for presentation to the developmental seeker hardware. The IR target under consideration for this effort is a scaled down physical model of an actual air target incorporating a method to reproduce the IR signature of the actual target. As seeker-to-target range decreases, the angular extent of target increases. Since in simulation testing the seeker-to-target range is fixed, an optical system will be necessary to simulate this condition and at a rate corresponding to the closure rate. The IR signature characteristics, band pass (es) of interest and actual target size(s) will be provided as GFP.

The objectives of this program are:

a. To explore methods which will produce all aspect IR signature characteristics on the scaled down physical target which reproduces that of the actual air target.

b. To perform a preliminary design of the optical system which will compensate for seeker-to-target range closure (approximately 20,000 ft to 100 ft) at closure rates of up to 6,000 feet/second.

AF86-026 TITLE: Target Spall Data Collection System

DESCRIPTION: Target spall and fractured projectile particle debris are always present when a warhead fragment or a bullet impact a target at high velocities. The total amount of behind target debris is important to effects analyses of conventional weapons attack on target structures – aircraft, tanks, trucks, bunkers, etc. This type of detailed data is difficult and costly to acquire. Past methods have used wallboard materials to collect all the particles, with subsequent determinations made of the weight of each particle, its position in space behind the target, and the velocity at which it came off the target rear surface. This method has not been very successful because of the time involved in collection of data.

The objective of this program is to develop an automated method for collecting behind target debris data. A possible method is to obtain orthogonal flash radiographs of the debris at two different times behind the target, and analyze the resulting radiographs with automatic scanning mcirodensitometers. (Radiographs are needed to "see" through the highly luminescent flash accompanying, the impact phenomena). Other possible methods may use a collection medium that permits easier extraction of data than does wallboard materials. Also, holographic methods may prove useful, if the impact flash problem can be solved. The primary thrust of this topic is to move this type of work from the highly labor intensive category it presently requires to an automated task requiring little personal effort, since the labor pool available for this kind of work is nonexistent.

AF86-027 TITLE: General Research

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

AF86-028 TITLE: Smart – Mux for Digital Microwave Systems

DESCRIPTION: Digital microwave systems are being widely used on USAF Tactical Test and Training Ranges for transmitting data from remote locations to control complexes to provide real-time mission control, data analysis, etc. The digital microwave systems are commercial off the shelf systems design to carry 24, 56 Kbts channels on a T-1 (1.544 Mbts) lines. Additional high speed data (1.544may be transmitted on individual T-1 lines. Many ranges have data communications requirements which cannot currently be met using digital microwave equipment. Telemetry data from aircraft and missiles are typically transmitted at a data rate of up to 1.8 Mbts. Currently, equipment is not available to multiplex one or more telemetry data streams (over 1.544 Mbts) together for transmission via digital microwave systems.

The objective of this program will be to investigate the potential of developing equipment which will allow multiplexing of telemetry and other high speed data streams (over 1.544 Mbts) for transmission over digital microwave systems utilizing 2 or more T-1 lines and/or at the DS-2 level and de-multiplexing that signal at the receiving end.

AF86-029 TITLE: Robotics

DESCRIPTION: A typical loading process is the transportation of munitions to the flight line loading points for loading onto the aircraft. The munitions are taken of the trailer with the use of a hydraulically operated Bomb Lift Truck. The truck is then driven to the aircraft where the munition is then loaded onto the aircraft. Loading of numerous munitions becomes a labor intensive effort and to some degree is a strain on the operator. The application

of robotic systems to accomplish the loading process would provide a significant increase in loading times and saving manpower.

AF86-030 TITLE: Muscle Multiplier

DESCRIPTION: The handling and loading of missiles in the 400-600 lb class has become an equipment intensive and time consuming effort due to missile packaging and loading onto aircraft where space limits the use of equipment. Loading and handling of the 200 lb class missile many times is accomplished by hand, thus eliminating the problems due to packaging and space limitations in loading onto the aircraft. Application of technology in the area of exoskeletal devices is needed to solve the problem. Such a device would be worn by the loader and with use of hydraulics and sensor systems would multiply his strength 4 or 5 times his normal strength.

AF86-031 TITLE: Innovative Guerrilla Warfare Munitions

DESCRIPTION: Current and developmental weapons are designed to be effective against large concentrations of enemy forces. The majority of these weapons are expensive because they are designed to destroy hardened targets such as tanks, armored personnel carriers, bunkers, and bridges. Most of these weapons explode on impact and must thus be delivered on current enemy positions. Guerrilla warfare presents new requirements for weapons in that large areas need to be secured without destroying the local economy. Weapons are needed which work well against small groups (5-10 personnel) which are difficult to identify. We have a situation here which is akin to air-to-air combat identification wherein the weapons need to be selectively employed only against the combatants. Guerrilla warfare also presents the need to rapidly close borders to both ground and light aircraft transportation to prevent third party intervention. What is needed is a new family of weapons which are designed specifically to deter guerilla warfare.

The objective of the program is to define air delivered weapons concepts which will have a significant contribution to defeating guerilla warfare in such places as Central America. Extensive studies of the Afghanistan conflict, Central American conflicts, as well as the Middle East, guerrilla warfare should be conducted to formulate innovative weapons concepts. Concepts would include weapons which would not only kill insurgents but would also provide information on their movements. The weapons would need to be low cost, unsophisticated and tamperproof. Critical components would be built or simulated to ascertain feasibility after completion of a study.

AF86-032 TITLE: Graphical Optimization for Missile Layout and Weapon Physical Fit on Aircraft

DESCRIPTION: Background: The present method for determining the maximum number of sub munitions that can be contained in a missile dispenser is to fill the dispenser with the inert sub munitions and vibrate and refill until full (for example, BLU-63 bomblets in a TMD). The sub munitions are poured out and counted. Other sub munition shapes require scaled trail and error methods with three dimensional hand drawings to determine the maximum number of sub munitions as well as their location and orientation within the container. Internal missile components such as warheads, inertial measurement units, actuators, motors, electronics, and batteries are laid out graphically by hand to determine optimal packaging. A similar problem exists with the physical fit of weapons on a n aircraft. Three dimensional hand layouts are used to determine the interference points of weapons loaded on racks and rails fitted to various aircraft. Physical interferences between a missile exiting the launch rail, aircraft and/or other weapons is also to be determined in a similar manner. Future unconventional weapon designs will aggravate all of these problems.

Overview: A graphics computer program that can operate on a VAX/780 mainframe with a Tektronics 4125 type of terminal for a VAXstation 500 workstation is needed. It is desired that the graphics optimization be semi-automatic and reasonably fast with user interaction being desirable. Interference between objects or points of contact should be highlighted with color graphics and there should also be a capability during the optimization/weapon fit process to interactively increase the size of the container or reduce the size of the weapon being fitted. The program must be capable of easily building data bases of weapons/sub munitions from existing sub munitions or scaled three dimensional drawings. Adaptation of existing aircraft, racks, rails and weapon data bases is also required.

Phase I Objectives: A survey of existing optimization techniques is needed and a particular graphical optimization methodology should be proposed in detail. A survey of existing/developmental aircraft, weapon, racks, rails and submunition data bases should be undertaken to determine the feasibility/difficulty of building and/or reformatting these data bases. The feasibility of reformatting the output data for use in aerodynamic and radar prediction programs should also be addressed. The proposer must give a demonstration of his graphics capability at his facility that can perform some of the tasks mentioned in paragraphs 1 and 2. It is desirable that the proposer deliver and install at Eglin AFB, with appropriate documentation, a graphics program that is capable of performing some of the tasks mentioned in paragraphs 1 and 2 above.

AF86-033 TITLE: damaged or Destroyed Target Discrimination

DESCRIPTION: In any intense combat such as might be expected in Central Europe, the battlefields and lines of communication will be littered with destroyed or severely damaged targets after the first period of encounter. The precision guided weapons and airborne target detection devices may well select a target that is no longer a threat, thus lowering the overall force effectiveness by wasting weapons. It is highly desirable to develop means of discriminating between functioning targets and those that have already been destroyed.

Concepts for discrimination are required that are compatible with various sensor devices such as MMW, infrared, and microwave radar as well as imaging from each of these type of sensors. Target types such as vehicles, air defense sites, command centers, and lines of communication should be considered. While it is not probable that one concept would encompass all target and sensor types, it is desired to have concepts that cover as much of the spectrum as possible. Concepts should work as closely as possible to the same operational range and environment as the sensor they will augment.

AF86-034 TITLE: Propelled MK-82 and MK-84 Warhead Designs

DESCRIPTION: Low Level Laser Guided Bombs and other Air Force guided weapons utilize the MK-82 500 pound and MK-84 2,000 pound high explosive warheads. It would be desirable to increase the range from the target at which these weapons could be launched by incorporating an integral propulsion capability into the MK-82 and MK-84 warheads.

An integral propulsion concept is required for the MK-82 and MK-84 warheads to allow increased standoff range to be achieved by weapons employing these warheads. Concepts which would remove a portion of the current warhead explosive fill, and incorporate a separating bulkhead, rocket propellant, rocket engine blast tube, and rocket nozzle to provide an integral propulsion capability, while maintaining approximately the same center of gravity need to be defined.

AF86-035 TITLE: Low Drag Gun Projectile Concept Designs

DESCRIPTION: Electromagnetic guns and guns employing telescoping ammunition designs are capable of achieving projectile muzzle velocities of the order of 5,000 to 10,000 feet per second. The high projectile velocity is rapidly dissipated in the current projectile designs due to their high aerodynamic drag.

A gun projectile concept is required which has low aerodynamic drag allowing the high muzzle velocity to be maintained over a larger portion of the projectile trajectory. Concepts which employ tubular designs – a design in which an annular low drag projectile is employed due to its low frontal area – aerospike projectiles, and other low drag design concepts should be considered.

AF86-036 TITLE: Sub Caliber Gun Projectile Concept Designs

DESCRIPTION: Aircraft anti-armor gun systems use 30 millimeter caliber, gun launched, anti-armor projectiles incorporating a sub caliber kinetic energy penetrator – a rod having diameter of approximately 10 millimeters and a

length to diameter ration of ten – to achieve target defeat. The current concepts employ discarding sabots designs to accelerate the projectile in the gun barrel. These sabots are then separated from the sub caliber penetrator after the projectile leaves the gun barrel. The penetrator continues in its trajectory without the sabot. The discarded sabots, due to possible ingestion by the launch aircraft engines, present a hazard to the aircraft.

A sub caliber gun projectile concept is required which does not use conventional sabot techniques to launch the sub caliber kinetic energy penetrators. Concepts which employ consumable sabots, compound designs – the design would consist of a kinetic energy rod surrounded by a tubular projectile where the ballistic coefficient of the tubular projectile allowing the rod to separate from the acceleration structure after launch – and non-sabot concepts should be considered.

AF86-037 TITLE: Advanced Network Concepts

DESCRIPTION: Based on a concept of distributed information centers, an advanced distributed network concept will be developed. The important areas of interest are data entry, automated routing schemes, priority accesses, flexibility of the concept, and possible examples of different network designs. Critical areas are single point and multiple point entries into the network (nodal points). The network design concept computer language should be ADA or PASCAL.

AF86-038 TITLE: Distributed C3I Data Base

DESCRIPTION: In order to develop a survivable Command and Control structure for the 200 time frame, a distributed Command and Control systems concept will be investigated. For this system to work, the contractor will implement/design a distributed C3I data base to meet the needs of the user. This system must be user assessable, user friendly, provide near real-time or real-time data, provide real-time updates, and be reliable and maintainable.

The design of the data base must be flexible enough to allow growth and security. Several options must be explored in terms of design, feasibility of each design, and complexity of such a design. The options will be looked at, and the best survivable design will be specified. Priority accesses must be built into the data base design and recognized from several access points.

AF86-039 TITLE: Automated Airborne Vehicle Detection and Reporting

DESCRIPTION: Apply innovative techniques for the surveillance, detonation, detection and reporting of airborne vehicles operating below 1000 feet altitude. The system may be portable and capable of unattended operation with its own primary power. It should be capable of standard commercial network connectivity for passing an alert message or signal to an unattended central display. The phase one activity shall develop the technical approach and implementation of the demonstration at a Test Range.

AF86-040 TITLE: Integrate Fiber Optic Theory Into Integrated Circuit Technology

DESCRIPTION: The purpose of this research would be to merge the fields of fiber optics, microwave theory, and integrated circuit technology to develop an optical signal processor. This device would input and output digital laser light signals, rather than electrical signals. The recurring problems of heat dissipation, EMP, and radiation hardening would therefore be eliminated, as well as the need for optoelectrical converters and/or metal wiring. The goal of a Phase I effort would be to determine how microwave theory could be reduced to the size used by current fiber optic wave guides and IC circuits, and to propose how such devices could be made for optical switching.

AF86-041 TITLE: Two-Way Testing of Voice Communication Systems

DESCRIPTION: Methods currently used for specifying, evaluating, and comparing the performance of USAF voice communication systems measure intelligibility and, in some cases, quality. Typical test methods are Monosyllabic Word Intelligibility (American National Standard ANSI 3.2-1960), the Modified Rhyme Test (MRT), the Diagnostic Rhyme Test (DRT) and the Diagnostic Acceptability Measure (DAM). All of these measure performance in a one-way speech transmission situation.

These measurements are useful to equipment designers but do not tell the operational user how well the equipment will serve his needs. For example, one-way test data do not reveal the effects of time delays, interruptions and other processes that occur in operational voice communication.

A few test methods have been designed to provide measures of performance and acceptability in the two-way, talker-listener interactive mode that is representative of the actual use of voice communications in military operations. Examples are a picture-matching Free Conversation Test (FCT) developed by the British Post Office, a Communicability Test developed by the US Naval Research Laboratory, the Diagnostic Communicability Test (DCT), and an Operational Acceptability method currently in use by the JTIDS program office.

Although each of these methods has been found useful in limited applications, none has been widely accepted. Some guidelines are emerging and there is general agreement that additional refinement is needed. For the SBIR program, we require new methods that might lead to wider use and standardization.

AF86-042 TITLE: Communications Between Bistatic Radar Elements

DESCRIPTION: Multistatic radars use multiple, spatially separated receivers and transmitters to get several “looks” at a target simultaneously. To realize the full benefits of the multistatic approach, the target reports must be communicated to a site which sorts and processes all of the sensors returns. The radar transmitters are projected as being inexpensive and vulnerable to anti-radiation missile (ARM) attack while the passive receivers are projected as being expensive and concealed. The entire system is touted as being mobile and survivable.

The method of communicating the sensor information from each of the receivers to the processing site is an area of concern. Landline or fiber optic cables are jam-resistant and can provide reasonably high data rates. However, installation and maintenance costs are substantial and, once in place, mobility is limited. Radio frequency (RF) communications enable flexibility in locating the communications end points but are more vulnerable to jamming. Microwave links, as well as laser communications, are more resistant to jamming due to their directionality, but the line-of-sight requirement limits mobility and flexibility in locating the communications end points. An innovative solution is required to provide high data rate, jam-resistant, mobile, and maintainable communications for bistatic field radars.

AF86-043 TITLE: ADA Software Cost Estimating Models

DESCRIPTION: The Department of Defense (DOD) has mandated ADA as the software language for advanced development and engineering for weapon systems. All weapon system programs require extensive cost estimates before budget approval. Several cost estimating models exist (e.g. COCOMO, Price-S, etc.) for programs with large software projects, but the model parameters have not been designed to accurately reflect the costs associated with ADA. Since ADA requires a much higher degree of software engineering than other languages, and there is not much ADA project experience to draw on, current models produce cost estimates of questionable accuracy. This project would develop parameters and/or new cost estimating models specifically for ADA projects. The models must accurately estimate development and post deployment support costs of weapon system programs designed and coded in ADA.

AF86-044 TITLE: Millimeter Wave Monolithic Phased Array Technology

DESCRIPTION: There is a desire for airborne conformal arrays for satellite communications at the MILSTAR frequency bands (45 GHz/20GHz). We request an array design, which takes into account antenna RF, mechanical and thermal design, and both the transmit (45GHz) and receive (20GHz) frequency bands.

AF86-045 TITLE: Methods for Measuring Talker Identification in Voice Communication Systems

DESCRIPTION: Methods currently in use for evaluating and comparing USAF voice communication systems measure only the intelligibility. Typical test methods are Monosyllabic Word Intelligibility (American National Standard ANSI 3.2-1960), the Modified Rhyme Test (MRT) and the Diagnostic Rhyme Test (DRT). All of these use a carefully structure procedure for obtaining quantitative, repeatable measurements in a one way speech transmission situation.

These measurements are useful to equipment designers but do not tell the operational user how well the equipment will serve his needs. One very real requirement that has long been expressed (but never formalized) by operational users is the listener's need to be able to identify the talker.

Very little has been reported in literature on the auditory mechanisms by which listeners recognize and identify speakers. The need to understand these mechanisms and to develop test methods is becoming more urgent because of USAF's growing use of narrowband digital voice systems. Such systems produce speech that sound "artificial" but still provides some degree of identifiability.

We require innovative test methods to measure how well a given voice communication link can enable a listener to recognize and identify the speaker.

AF86-046 TITLE: Computer Software Security Development Process

DESCRIPTION: Modern computer systems have to be readily accessible to authorized users, adaptable, user friendly and capable of providing a wide range of services. This makes them vulnerable to break-in by unauthorized users and abuse by otherwise legitimate users. Of particular concern here is the vulnerability of large computer systems to the phenomena known as backdoors, trapdoors, and time bombs. A backdoor is an opening, usually inadvertent, left in software (including firmware), which permits unauthorized access to operational software, data base contents, or hardware. Trapdoors, usually deliberately made in software, cause information of interest to be duplicated elsewhere in the system while it is being processed legitimately. The duplicate information may be stored for later pickup. Time bombs are also usually deliberate and have been known to cause the total loss of an operating system, software and data base contents. They are usually set to act at a preset date or time. These problems can be extremely difficult to find, particularly the deliberate ones. For full security, all the possible backdoors, trapdoors, and time bombs must be found. Some techniques are already in use by computer manufacturers, NSA, etc. Others might be developed from commercial debugging software. Innovative solutions for a security configuration are sought. These solutions may affect software and/or hardware.

AF86-047 TITLE: Phase Shifters for Phased Arrays

DESCRIPTION: Ferrite phase shifters are a major factor in the development and acquisition of phased array radars. They are inferior and expensive; sources of supply are very limited. Other alternatives may either lack the power handling capability of ferrite phase shifters or suffer greater losses. Alternatives to current 4 bit or 6 bit ferrite phase shifters with respect to performance (insertion loss and peak power handling capacity) and cost (phase shifter and driver) are sought.

AF86-048 TITLE: Fiber Optic Based Millimeter Wave Electromagnetic Field Sensor

DESCRIPTION: Fiber optics are continuing to gain emphasis as a transmission medium. Single mode optical fibers have a bandwidth potential of greater than a Terahertz (10 to power 12 Hz). Single model fiber has also been studied for sensors, e.g. pressure, temperature, velocity, etc. There has been some experimentation with optical fibers as magnetic or electric field sensors with published results sensing fields at frequencies up to a few kHz. This medium (single mode optical fiber) offers the potential of a fully covert, non metallic (zero radar cross section) receiver. What is necessary is a method of implementing optical fiber electro magnetic field sensors capable of functioning at gigahertz (GHz) frequencies. Novel material coatings (e.g. magnetostrictive) sensitive to VHF/SHF/EHF frequencies or other known interactive effects such as Faraday rotation induced by an electromagnetic field on an optical beam need to be addressed and exploited. Improvements in the Verdet constant of the optical fiber by special dopants may provide the key to high field sensitivity at these frequencies.

AF86-049 TITLE: Ultra-Violet (UV) Surveillance Optics

DESCRIPTION: Future space surveillance systems may deviate from the traditional infrared (IR) wavelengths to include the visible and low UV wavelengths. Very little is known about the optical specifications for a UV space qualified surveillance telescope. These telescopes will most likely be required to stare at the earth's extended background, the earth's atmospheric limb and objects against the cold background of space. This topic will develop the specifications for a UV surveillance telescope. Tasks will include understanding system requirements and developing initial optical specifications, i.e. materials, surface and figure requirements, and coatings. It would also include a small brass board demonstration of the optic specified.

AF86-050 TITLE: Magneto-Optic/Dye Polymer Film Quantification

DESCRIPTION: Magneto-optic and/or Dye Polymer materials have proliferated to a point where they can be applied to many mass storage and retrieval applications. Predictions of 10E bits per square inch have been made which represent an order of magnitude advantage over today's magnetic capability with the versatility of read/write/erase. This topic will determine the best material with respect to throughput rates, packing density, signal-to-noise ratio, etc.

AF86-051 TITLE: High Temperature Heat Pipe Technology

DESCRIPTION: Heat pipes have been shown to provide superior growth conditions for the growth of bulk semiconductor crystals. Heat pipes allow for the establishment of isothermal conditions over large areas. This thermal property controls the distribution of impurities, and hence the electrical characteristics of the processed semiconductors. The isothermal conditions that they establish (for bulk growth and epitaxy) are essential to achieving optimum processing conditions for advanced electronic device applications. Currently, this technology suffers from two limitations; the inability to operate at high temperature and the inability to operate at high pressure. The development of technology to fabricate reliable high temperature heat pipes to operate at 1325 degrees C with inert overpressures of 60 atmospheres is required for the processing of III-V compound semiconductors. Innovative fabrication methods are sought.

AF86-052 TITLE: Fluoride Glass Optical Fibers

DESCRIPTION: Heavy metal fluoride glasses (HMFG) are a large family of vitreous materials potentially suited for use as low-loss, radiation hard optical wave guides operating in the 2-4 micron region of the spectrum. These non-oxide glasses may contain zirconium fluoride, barium fluoride, lanthanum fluoride, aluminum fluoride, and sodium fluoride. A research program concerned with techniques for reproducible fabricating HMFG into multikilometer lengths should be provided for testing, and consists of an HMFG cladding, and a protective overcoat. Such a program should be cognizant of the difficulties currently encountered in reliability preparing the HMFG, and suggest solutions. These problems include the short working range of the glasses (i.e., their low viscosity at

elevated temperatures), mid-infrared absorption due to oxide, hydroxyl, transition metal and rare earth impurities, light scattering from crystallites and inclusions, and optical losses due to defects in fiber geometry.

AF86-053 TITLE: Adaptive Nulling by Electrical Surface Control of a Reflector Antenna

DESCRIPTION: This topic request an innovative techniques for placing nulls in the side lobe pattern of a reflector antenna by changing the signal retransmitted from one or more small secondary antennas mounted on the surface of the reflector. This research should include both theory and a prototype for the proposed innovation.

AF86-054 TITLE: Inclusion Free Quartz

DESCRIPTION: Single crystal quartz is used in a number of military frequency and timing applications both in C3 and in surveillance systems. The availability of superior quartz material is essential for the proper operation of these systems under different environments, since the fabricated quarts resonator is essentially the heart of all frequency control devices. The Air Force and the Army have performed research on quartz material in the past few years with the result that high purity, low dislocation material is now available. One problem that has not been addressed, however, is the presence of inclusion in quartz. In fact, while inclusion counts are performed by commercial suppliers, there is no standard method for the test, so that the values reports are often meaningless. The presence of inclusions can be damaging in two ways. First, in some quartz, it creates dislocations, formed at the inclusion, which can result in the formation of etch channels during the fabrication of resonators, weakening the resonator. Second, there are now some applications where electronic circuits are directly deposited on the resonator surface. Inclusions near the surface can cause poorly deposited devices which will not function properly.

AF86-055 TITLE: III-V Compounds Trace Element Characterization

DESCRIPTION: Novel and sensitive techniques are being sought for the analysis of III-V compounds such as InP, In GaAs, and GaAs. InP and its lattice matched compounds are the materials of choice for long wavelength (1.1-1.6 micron) fiber optic systems; they also show promise for use in very high frequency radar systems. The characteristics of devices made from these compounds are determined by the presence of atomic impurities in both adverse and favorable ways. A quantitative analysis technique to map these impurities is vital to advancement of this technology. Existing techniques are limited by mass interferences; for example, measurements of iron (Fe) in a silicon (Si) matrix are obscured by the concurrence of 28 Si and 56 Fe. Both Fe and Si are important impurities in III-V compounds that must be accurately measured in parts per billion.

Sensitive analysis methods which can selectively discriminate against such interferences are being sought. It is desirable that these techniques allow for a depth profiling capability. A priority will be placed on methods of analysis which have the potential for high depth and lateral resolution in the ppb range.

AF86-056 TITLE: Super conducting Millimeter Wave Phase Shifter

DESCRIPTION: Develop a programmable 360 degree single bit phase shifter, employing super conducting electronics technology, suitable for incorporation into a millimeter wave phased array antenna. The phase shifter should employ planar construction techniques and should operate in the wavelength region around one millimeter. Device construction should emphasize simplicity, with a minimum number of nonlinear switching elements and programming should be by means of an external DC bias. Performance should emphasize broad bandwidth and low insertion loss for low power (receive only) application). Although only a single device is required to be constructed and demonstrated, the construction should anticipate the potential future need for large scale reproducibility with a minimum of variation in electrical characteristics between individual devices. In addition, the design should be compatible with a potential future extension to a larger number of phase shift increments.

AF86-057 TITLE: Hermetic Coating of Fluoride Glasses

DESCRIPTION: Recent advances in materials processing have provided the optics community with a wide array of low distortion, low loss optical materials. However, many materials, which are chemically stable in inert environments, may be subject to corrosion and/or erosion in operational environments. Moreover, many materials, which are otherwise attractive for multispectral applications, are compromised by some susceptibility to corrosion in even relatively benign environments. For such materials to be suitable in operational environments as optical components or optical wave guides, their surfaces must be protected in some fashion. The heavy metal fluoride glasses (HMFG) are a good example of such materials. These non-oxide glasses may contain fluorides of zirconium, barium, lanthanum, or aluminum. Innovative techniques are sought for hermetic coating of heavy metal fluoride glass in bulk form while maintaining the optical transparency of the glass, as well as in optical fiber form. The contractor will be asked to prepare or acquire the necessary glass and fibers.

AF86-058 TITLE: Remote Sensing of Meteorological Parameters

DESCRIPTION: The purpose of this effort is to develop space borne sensors to measure meteorological parameters to the accuracy required by the Air Force. The sensor in use by the Defense Meteorological Satellite Program (DMSP) meet the primary requirement for cloud cover imagery. The “mission” sensors provide much useful data, but improvement in their capability is desired. New measurement techniques or approaches, improvements in critical sensor components, subsystems, and proof of concept sensors for use on future DMSP spacecraft are desired. These improvements must be consistent with the limited power and size onboard the spacecraft. Examples of the parameters desired are clear air turbulence, surface temperature, snow and landlocked ice cover, soil moisture and sea state. Show and landlocked ice cover is qualitatively measured using the imagery from the OLS. It can determine snow cover under cloud free conditions only (resolution 0.3 nmi). The SSM/I passive microwave sensor to be flown in FY87 will have the ability to detect ice cover with resolution approaching 10 nmi.

AF86-059 TITLE: Launch Vehicle Cost Model

DESCRIPTION: A requirement exists to conduct research towards development of a parametric cost model to assist analysts in formulating independent assessments of program cots. The tasks involved are:

a. Develop a comprehensive data base:

- Collect historical launch vehicle data that represents actual development, and launch services costs.
- The data base must be representative of cost behavior; i.e. a realistic reflection of redirections, delays, reconfigurations, etc., and the resultant impacts. Data must be normalized to reflect technology advances and lessons learned.
- Categorize the historical data into typical systems, components, functions, etc.

b. Establish physical and performance characteristics of launch vehicles and the performance requirements of launch services.

c. Establish parametric cost estimating relationships (CERs).

Statistically correlate the cost data to the physical and performance characteristics. Establish mathematical relationships between the variables. Establish algorithms to be used as the basis for an automated parametric cost model.

Further activity in this project would be to produce an actually cost model that typifies cost behavior of the technical parameters. The model would be used for consistent and objective cost estimates in concept phase definitions, planning studies and other instances where a parametric cost estimating approach would be applicable. The model would be a micro-based system with a user friendly interface for the analyst. Simple procedures would also be developed for each maintenance and update of the data base and the cost estimating relationships.

AF86-060 TITLE: Doppler Lidar Wind Sensors and Differential Absorption Lidar (Dial) Sensors

DESCRIPTION: Space borne 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. Space borne DIAL sensors have the potential of measuring temperature and moisture profiles with great accuracy and vertical resolution using the absorption bands of 03 and H20, respectively. There is also potential for quantified measurement of visibility using Lidar sensors. The goal is to develop active Lidar sensors for DMSP spacecraft capable of satisfying validated requirements for wind, temperature, moisture and visibility.

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

AF86-061 TITLE: Solid State Laser Pumping Efficiency

DESCRIPTION: The use of solid state lasers in space is limited by the efficiency in the laser sources. This is primarily due to the inefficient coupling of pumping energy used to excite the lasing medium to energy level required for the spontaneous and stimulated emission of photons to take place. Most solid state lasers are currently pumped using flash lamps. This is inefficient because of the broadband nature of the flash lamp being used to pump a laser medium with a narrow absorption band. The efficient conversion of flash lamp emissions to a more narrow bandwidth could increase efficiency. Laser diodes are a potential narrow band pump source. They have been used in pumping low power level Nd:YAG lasers in laboratory conditions. The laser diode temperature tenability makes temperature stability a critical issue. The ability to fabricate large laser diode arrays has yet to be adequately demonstrated. The lifetime of the laser pumping mechanism is another critical issue. The goal is the development of efficient laser pumping techniques with the ability to provide laser output power of at least 2 joules/pulse at 10 Hz over a three-year untended lifetime. The laser mediums considered most likely to be used in the near term are Nd:YAG and the tunable sources Alexandrite and Titanium: Sapphire.

AF86-062 TITLE: High Quantum Efficiency Photo cathodes for 1.06 um

DESCRIPTION: Nd:YAG lasers are currently planned to be used in future DMSP Doppler Lidar wind sensors. The efficiency of the commercially available photo cathode materials leaves a lot to be desired in the 1.06 um region (less than 0.1%). Improvement in photo cathode quantum efficiency will reduce the required laser transmitted power and consequently, the power required by the laser from the spacecraft. In the past, more efficient photo cathodes in this region had been manufactured (e.g. Varian), but these are no longer available. The materials considered very promising at this time is GaA1As. The goal is the development of a photo cathode with a quantum efficiency at 1.06 um of more than 1%.

AF86-063 TITLE: Multiple-Band EHF/SHF Antenna Concepts

DESCRIPTION: As communication satellite payload throughput requirements increase, available resources become scarce. One solution to conserving resources is to utilize antennas designed for several different frequency bands (SHF-EHF, for example) to meet system needs. A first effort towards that solution is designing dual-band transmit/receive (T/r) antennas of high resolution and gain. These designs should then evolve to handle two T/R bands with one antenna, permitting full duplex operation across each frequency band.

Task output will be proposal for designs capable to being built and tested. Analytical support for conceptual designs should be supplied with task output.

AF86-064 TITLE: Test High Efficiency High Power Diodes

DESCRIPTION: Space Division needs to demonstrate the operation of high performance 20 GHz GaAs IMPATTs in a power combiner/amplifier at 19.5 to 21 GHz. Power combiner should be capable of operating in a 20 Watt, 40 Watt and 60 Watt mode with 30 dB and 50 dB of gain respectively All diodes will be GFE and capable of over 7 Watts power output and over 20% power added efficiency. Maximum allowable temperature rise at the junction is 175 degrees C for diode operation. Amplifier must be space qualifiable without the benefit of active cooling.

Required tests include Bit Error Rate testing, determination of gain and phase variation over frequency, and amplifier stability while the amplifier is in a frequency hopped mode. Contractor must determine the maximum rate of frequency hop for the amplifier as well as maximum bit rate.

AF86-065 TITLE: Thermal Cooling of a Low Noise Preamplifier

DESCRIPTION: Study the problems and technologies with cooling HEMT and FET devices in a preamplifier from 270 degrees K in a satellite receiver. Study emphasis should be on achieving a simple, lightweight, low cost space qualifiable design. Study must account for parasitic heat transfer associated with actual space operation. Responders must have experience with active cooling of space components.

AF86-066 TITLE: Design of a Continuous Real Time Empty Expert System

DESCRIPTION: The components of an expert-system-based control element of a complex system, which includes satellites and networks, need to be specified. Requirements dictate that the control element be able to control either a part of, or the entire system. This includes scheduling, telemetry tracking and commanding, as well as anomaly detection and diagnosis of space and ground based systems. This system will be hosted on a machine that is approximately six times the power of a VAX 780. The development environment will be Lisp based.

A major requirement of an expert system control element is that it run continuously in real time and be interactive. Continuous implies that the interference engine should not terminate when no rule is eligible to fire; the system should automatically restart when the host system boots; and working memory elements that have served their purpose must be removed. Real time operation implies requirements of speed and that a low priority diagnosis can be preempted for a more important one. Interactive implies that the system be able to deal with a command sequence, possibly with pauses between the command elements. Also, this environment will require that multiple expert systems be able to communicate. These considerations of requirements are examples of the type of concerns that must be dealt with. The project will require an in-depth consideration of the problem.

The specific tasks for this effort are:

1. Determine the requirements.

2. Analyze the requirements with a discussion of the rationale and tradeoffs involved for each requirement.

3. Predict and document the projected availability of such a system in 1990.

AF86-067 TITLE: Specification Methodology for an Expert System

DESCRIPTION: The components of an expert-system-based control element of a complex system, which includes satellites and networks, need to be specified. Requirements dictate that the control element be able to control either a part of, or the entire system. This includes scheduling, telemetry tracking and commanding, as well as anomaly detection and diagnosis of space and ground based systems. This system will be hosted on a machine that is approximately six times the power of a VAX 780. The development environment will be Lisp based.

The study of acceptance and assurance testing of software systems has produced many theories and practices. Some of these are specified as Military Standards. It is not clear if these standards can or should be adapted to expert systems. How does one determine if an expert system works? How should a military program decide that the builder of an expert system has met the requirements? How should the functional requirements be specified?

As with testing, costing theories and methodologies for software systems abound. Can these be adapted to expert systems? How should one charge for the development of an expert system? How does one compare two systems?

The specific tasks for this effort are:

1. Develop a method of specifying the requirements for an expert system. Provide the rationale for the method.

2. Develop a method of determining the cost for the development of an expert system and provide the rationale for the method.

3. Develop a method for acceptance and assurance testing of an expert system and provide the rataionale for the method.

4. Analyze the applicability of the existing Military Standards for software development to expert systems development.

AF86-068 TITLE: 44 GHz Low Loss Diode Phase Shifters

DESCRIPTION: Diode phase shifters are a key part of certain communications subsystems because of low weight and volume. However, typically the insertion loss if four dB or often greater over wide bandwidths. The subsystem using phase shifters has to be designed to minimize the deleterious impact of the high insertion loss. This is true especially in low-noise front-ends of millimeter-wave receivers.

Test data has shown that the insertion loss can be reduced by masking improvements in the diodes and the microwave circuit layout.

Designs are sought which will reduce phase shifter losses and non-linearities, and yet accommodate 5% or greater pass bands when operating as high as 44 GHz in space environments. Operation is required in radiation environments so hardness is a definite consideration when designing fundamental circuitry and implementing it in hardware.

AF86-069 TITLE: Low-Cost Autonomous Navigation for Spacecraft

DESCRIPTION: The objective is to develop an attitude determination and control system (ADACS) for Defense Meteorological Satellite Program (DMSP) 3-axis stabilized spacecraft that is lower in cost than the present ADACS. The performance requirements for normal operations are 0.01 degree per axis with jitter of less than 0.03 per second per axis. For autonomous operation, the requirement is for 60 days of operation at 0.12 degrees per axis. The reliability for the system should be 0.9 probability success over three years. The current system uses a celestial sensor, and an inertial measuring unit (IMU) containing four single-degree-of-freedom gyros for primary control. The system uses an earth sensor and a sun sensor to monitor performance. Any proposed development effort must lead to a lower cost system that can meet the requirements of the present ADACS.

AF86-070 TITLE: Detection of Cruise Missiles from Space Using Sparse Aperture Infrared Technology

DESCRIPTION: The Air Force Space Technology Center (AFSTC) has been assigned a program to develop the enabling technology to accomplish space borne surveillance of cruise missiles approaching CONUS. This effort shall provide an estimate of the effectiveness with which sparse aperture infrared technology is applicable to the cruise missile surveillance mission. This technology offers the capability of spectral, special and temporal filtering

of dim targets against a highly cluttered background. The contractor shall provide the necessary personnel, facilities, and equipment to perform the following tasks.

Task 1 – Review the recent government contracted activities of technology assessment of the sparse aperture concept.

Task 2 – Perform a critical design sensitivity study of the reticule spacing requirements, detector uniformity, aperture spacing and mechanical stability requirements, spacecraft jitter tolerance and signal processing requirements for multiple target detection.

AF86-071 TITLE: Estimation of the Atmospheric Propagation of UHF/VHF Waveforms

DESCRIPTION: The Air Force Space Technology Center (AFSTC) has been assigned a program to develop the enabling technology to accomplish space borne surveillance of cruise missiles approaching CONUS. This effort shall provide an estimate of key technology requirements and limitations imposed on a space borne platform providing cruise missile surveillance while operating in the UHF/VHF regime. This frequency regime offers enhanced target radar cross section which must be balanced against atmospheric attenuation, poorer range resolution and larger apertures. The contractor shall provide the necessary personnel, facilities and equipment to perform the following tasks.

Task 1 – Review the UHF/VHF technology concepts proposed in recent government procurement actions.

Task 2 – Prepare an energy/return signal amplitude in dB for the target RCS, antennae, transmitted power, atmospheric propagation in 100 MHz increments from 200 to 1000 MHz. The effects of rain, clouds, auroral activity and diurnal variation are to be quantified.

AF86-072 TITLE: High Resolution UV Filter

DESCRIPTION: AFGL is engaged in a program for obtaining high resolution ultraviolet (UV) images of missile plumes. To obtain the UV images, filters are used to eliminate the visible radiation. These filters do the job well, but they degrade the resolution of the image. It is desired to design and construct a filter that has the following characteristics:

a. It eliminates visible light by 6 to 8 orders of magnitude.
b. It does not degrade the resolution of the image by more than 5 lines per mm.
c. It does not diminish the transmission by more than 3 orders of magnitude
d. The center wavelength of the filter is to be between 2100 and 3000 Angstroms.
e. The FWHM bandwidth of the filter is to be between 100 and 200 Angstroms.

AF86-073 TITLE: Scribe Data Validation and Analysis

DESCRIPTION: SCRIBE (Stratospheric Cryogenic Interferometer Balloon Experiment) is a liquid nitrogen cooled high resolution interferometer system designed to measure the infrared emission spectra of the atmosphere from ground and altitudes up to about 30 km. The data will be used to establish the background radiation levels that Air Force electro-optical systems must contend with and to detect the presence and abundance of trace gasses in the stratosphere. Emission spectra from several flights of this system are available for several viewing angles (nadir, -4 deg. To 7 deg. Elevation). Research is needed to validate the measured spectra in terms of absolute radiometric calibration, spectral calibration and resolution. Also, research is needed in methods to retrieve profiles of trace gases and of temperature from the measurements; as well as in the sensitivity and limitations of such methods.

AF86-074 TITLE: Initial Processing of Space Shuttle Cloud Photographs

DESCRIPTION: Series of photographs of clouds taken during space shuttle missions in 1984 and 85 are to be digitized and rectified. The original film record is 35 mm black and white transparencies. The number of photographs to be processed is approximately 100. The film record and shuttle orbit information will be provided at no cost to the contractor.

Digitization will be in raster-scan mode with resolution at least as fine as the film itself, specifically at least 2000 pixels per scan line and at least 20 gray-shades per pixel. The recording medium is appropriately labeled 9-track tape or more versatile memory device. Physical tapes, discs or chips along with documentation of digitization equipment, process and recording parameters are the digitization end products.

Rectification means 1. determination of the angle relative to nadir at which each photograph was taken and 2. specification of the scale at all positions on each photograph. Complete documentation of software developed or tailored for this rectification and a report containing 1. and 2. for each photograph and referenced to each physical tape are the rectification end products.

This effort has a 6 month duration and a $50,000 budget ceiling. More favorable consideration will be given to proposals which provide computer-efficient yet universally readable digitized products.

AF86-075 TITLE: Electron Gun for Preionization of High Energy CO2 Tea Laser

DESCRIPTION: The electron beam injection high energy CO2 TEA laser is a strong candidate for the laser system to be incorporated into the global wind measuring satellite system (Windsat). A number of different electron gun designs for generating the electron beam used to preionize the laser plasma are possible. N addition a number of areas of further technology development have been identified. These include increasing the foil electron beam window lifetime, increasing cathode lifetime, as well as improvements in high voltage electronics design and control. AFGL currently has an electron beam injection CO2 TEA laser using the General Electric electron gun design as apart of a ground based laser wind measurement system. Further work however must be undertaken to improve the reliability and efficiency of such a system before it could be considered for space based operation.

To investigate and recommend suitable systems and technologies for an electron gun capable of supporting a high energy CO2 TEA laser with the following projected parameters:

Pulse repetition frequency = 0-50 Hz
Pulse length = 1-10 micro seconds
Pulse energy = 5-12 Joules
Chirp = less than 0.2 MHz
Number of shots during lifetime = 10 to the ninth

Consideration should also be given to the possible operation of the system in a vacuum environment as well as to the reliability necessary to fly on a satellite platform. Based on the results of this investigation, a following hardware development and testing program may be undertaken.

AF86-076 TITLE: Adaptive Feedback Controls for Acoustic Cavities

DESCRIPTION: A thorough review of current analytical and experimental methodology to design acoustic cavities in liquid rocket engines shall be conducted. This review will identify key elements in the design of the acoustic cavities. The design parameters will then be optimized for a typical liquid rocket engine. The parameters will also be examined to determine dynamic control systems which would keep the acoustic cavities tuned for maximum damping over the range of engine conditions from ignition to shutoff. The results of this project will provide valuable guidance and data for future advanced liquid propellant engine development work.

AF86-077 TITLE: Non Conventional Propulsion Concepts

DESCRIPTION: Bold, new non-conventional propulsion concepts are solicited for launching and maneuvering payloads in space. Non-conventional propulsion includes all propulsion concepts other than conventional chemical rocket propulsion which is presently used by the Air Force and NASA. The specific areas in which the AFRPL is interested include: 1. Chemically bound excited state propellants including free radicals, metastable helium and tetrahydrogen; 2. Electromagnetic and beamed energy propulsion with particular emphasis placed on solar propulsion concepts; 3. Electric propulsion concepts with the main devices; 4. Nuclear propulsion including fission, fusion and metastable nuclear states with current interest focused on particle bed reactor fission concepts; 5. Antimatter propulsion which emphasizes antiproton/proton or heavy nuclei annihilation concepts; and 6. Esoteric energy sources for propulsion including the zero point quantum dynamic energy of vacuum space and various multidimensional theoretical developments offering sources of new energies previously unknown. Each of these areas of interest has its special set of problems. Survey programs to find new ideas and study programs to investigate and evaluate highly promising concepts will also be considered when proposed b qualified organizations. Particular attention will be given to revolutionary concepts based on sound scientific principles offering quantum increases in performance and mission capability.

AF86-078 TITLE: Mechanical Properties of Rocket Nozzle Adhesives

DESCRIPTION: The structural/mechanical and thermal properties of rocket nozzle adhesives are used as an aid in manufacturing and in handling; in a hot motor environment the adhesive does not play any structural or stress bearing role, although its thermal characteristics are important. A general lack of structural property data exists for adhesives used in the major bond lines in rocket nozzles (for example: rubber/composite, metal/composite, and composite/composite interfaces). The objective of this study is to characterize the important properties of the most commonly used bonding agents and adhesives used in the amnufacture and handling of rocket nozzles. Properties/parameters that should be considered for study include the following: strength, modulus, microstructure, composition, property degradation during typical manufacturing/handling environments, adhesive application methods, etc. The bonding between the adhesives and materials typically found in rocket nozzles should also be considered; such material may include carbon-carbon, carbon-phenolic, silica-phenolic, fiberglass-epoxy, graphite-epoxy, graphite, rubber, aluminum, titanium, steel, etc.

AF86-079 TITLE: Development of New Thermoplastic Elastometers for Solid Propellant Applications

DESCRIPTION: Solid rocket propellants are currently produced by incorporating energetic ingredients into a chemical crosslinnked elastometer binder. These systems are castable and highly filled (84-90% solids by weight). Thermoplastic elastometers offer a unique, alternative approach for making propellants without chemical crosslinking, thus expanding the number of possible manufacturing approaches and dramatically reducing processing costs. The work envisioned here would involve the synthesis (or derivation) and characterization of new thermoplastic elastometers for use as solid rocket propellant binders. These elastometers could be either energetic or non energetic. Some of the basic requirements of a thermoplastic propellant binder would include: 1. low cost; 2. wide service temperature range (145 to –65 degrees Fahrenheit); 3. compatibility with energetic ingredients; and 4. capable of high volumetric loading.

AF86-080 TITLE: Continuous Low-Cost Processing Techniques for Manufacturing Solid Rocket Propellants

DESCRIPTION: Solid rocket propellants are generally manufactured in large vertical mixers, then dump casted into rocket motor casings. For large motors, this process involves pre-bathing of ingredients, numerous individual mixes, and a 10 day cure cycle. This program will investigate the use of continuous processing techniques as a means of simplifying and reducing the cost of this process. Specifically, the contractor shall develop, or modify existing, sub-scale equipment to demonstrate the feasibility of continuous processing for solid propellant rocket motor manufacture. Principal solid propellant ingredients include on elastic binder (10-16% by weight), dispersed solid fuel particles (10-20%) and various sizes of dispersed solid oxidizer particles. Inert ingredients with analogous behavior may be substituted for energetic ones in this feasibility program.

AF86-081 TITLE: Diagnostic for Vibrationally Excited Ground State Nitrogen

DESCRIPTION: Vibrationally excited ground state nitrogen, N2 is an important energy carrier in several proposed chemical laser schemes. An evaluation of the efficiency of these schemes will depend on the ability to measure number densities in various vibrational levels. A non-intrusive diagnostic is required which can detect densities as low as 1013/cm3 in a gas flow containing species such as HF, DF, NF(a), NF9b) and various electronically excited states of N2.

AF86-082 TITLE: High Power Microwave Amplifier

DESCRIPTION: Air Force requirements dictate higher power pulse microwave sources with improved efficiencies. One method to help meet these requirements is to phase-lock or couple tow or more sources together. Thus, research proposals are requested which will demonstrate the feasibility of amplifying input powers of megawatts to output powers of gigawat. Amplifiers with an operating frequency between 0.5 and 10 GHz, a 50 to 100 ns pulse width, and an efficiency greater than 10 percent are needed.

AF86-083 TITLE: Phased Array Imaging in Partially Coherent Light

DESCRIPTION: Resolvable space objects may reflect or emit radiation that when propagated over large distances may exhibit partial coherence. The imaging performance of a phased array optical receiver will therefore be affected. Proposer is to develop a mathematical and physical optics model for determining the imaging characteristics of a phased array telescope in partially coherent light.

AF86-084 TITLE: Pattern Recognition Methods in Civil Engineering

DESCRIPTION: An exploratory study is needed on the utility of pattern recognition techniques in the study of problems with evolving experimental data bases in simulated nuclear weapon effects environments. Such topical areas as ground motion, structural response and damage evaluation are associated with empirical evidence which might be between synthesized and analyzed using modern signal analysis and pattern recognition techniques. These techniques are capable of handling and classifying far more data features than current procedures for purposes of detecting similarities or differences in the response of a physical system to a given input, such as a simulated nuclear air blast or ground shock.

AF86-085 TITLE: Development of the PDA/PATRAN-G Post-Processing Capabilities of the ARCCS VAX for MSC/NASTRAN Results Generated on the CRAY-1S.

DESCRIPTION: With MSC/NASTRAN now being run on the CRAY-1, the capability for post-processing the results using PDA/PATRAN-G has been lost. Theoretically, MSC/NASTRAN results can be brought to the ARCCS VAX and displayed using the post-processing capabilities of PDA/PATRAN-G. Currently, MSC/NASTRAN output files are translated by NASPAT into ASCII files and thin into neutral file format, brought across to the ARCCS VAX, and translated into VAX readable binary for PDA/PATRAN-G. However, PDA/PATRAN-G will not accept the files for post-processing. It is desired to reinstate this post=processing capability of PDA/PATRAN-G by modification of existing software.

AF86-086 TITLE: Adaptive Grid Techniques or Use in Computational Fluid Dynamics

DESCRIPTION: High energy laser systems are typically build using a flowing media control large amounts of head release due to chemical reaction or energy deposition in making the lasing specie. The ability to computationally model these flow fields using the shortest amount of computer time is imperative. One of the methodologies employed to study the effects in laser whether shock and a cousins connectivity and adapts to the data, optimizing to several measurable properties of the computational mesh.

AF86-087 TITLE: MATE Interface Connector Assembly 9ICA) Standard

DESCRIPTION: The purpose of this standard is to ensure interchangeability of the input/output interface used with modular automatic test equipment (MATE), and provide computability between the input/output interface with MATE unit under test (UUT) test adapters. This standard establishes the mechanical and electrical requirements of the I/O interface. These requirements include physical size, fastening/locking method, mechanical and electrical interlocks, operator safety, method, mechanical and electrical interlocks, operator safety, method of connection, pin type, pin field, and total number of interface pins.

Research is required to update the MATE ICA to keep pace with emerging test requirements and interface connector capabilities. The following ICA areas require research:

a. Does the existing standard need an increased digital capability? How do we make the digital area transportable when there are so many different logic levels used on weapon systems? Should the MATE ICA standard permit differential line drivers and receivers at the interface to preserve high signal quality and maintain system throughput?

b. The existing MATE ICA standard provides a rigid partition between stimulus and measurement capabilities of the automatic test equipment (ATE). Can we provide a universal pin capability in the ICA in which many of the pins at the ATE interface can be switched between stimulus and measurement functions under test program control.

c. Research is needed in the area of pin electronics to determine if this technology can be inverted into the MATE ICA standard without impacting the MATE objective to achieve test program set interoperability between MATE ICAs.

d. Identify the quantity and types of test signals required to satisfy current and future AF test requirements.

e. Survey new technologies in this area and identify possible improvements to the MATE ICA that would increase its performance, decrease its size, decrease life cycle cost, and improve test program set transportability.

AF86-088 TITLE: Electro-Optic Unit Testing

DESCRIPTION: Research is required to assess the automatic test requirements for electro-optic units under test (UUTs) and identify automatic test equipment (ATE) interface standards for testing these devices. Electro-optics is being used ina wide variety of applications and there does not exist a set of accepted standards for testing electro-optic UUTs. Substantial savings can be achieved if we can identify suitable modular automatic test equipment (MATE) testing methodologies and standards for interfacing the electro-optic UUTs to the ATE.

AF86-089 TITLE: Chemical Agent Dosimeters

DESCRIPTION: The purpose of the dosimeter is to detect and visibly warn of accumulated doses of chemical agents. The device must be sufficiently sensitive to provide warning prior to meiosis (pupil dilation, tunnel vision, etc.) effects being encountered by personnel. The dosimeter must withstand use in the field in a combat environment. It should be small, lightweight, inexpensive, easily renewed/reset, and rugged. It is desirable for the dosimeter to indicate what class of chemical agent is being detected since the treatment varies. Differentiation between nerve agents and blister agents is sufficient. This device would provide individuals with a means to monitor their own exposure to chemical agents. It is an adjunct to the primary detection devices which provide indication of area contamination. Use of the device can provide improved morale by removing uncertainty as well as avoiding unnecessary treatment which is incapacitating by itself.

AF86-090 TITLE: Filter Life Indicator

DESCRIPTION: The purpose of the filter life indicator is to show when an air filter has nearly reached the end of its useful life. The filters are used to remove chemical and/or biological agents from the air. There are two types of filters that need indicators: personal chemical mask filters and large filters in the hardened shelters. It is desirable for the device to activate both audible and visual alarms, especially for the large filters, when approximately 75 percent of the useful life of the filter is reached. The indicator must provide advance warning so that filter does not pass chemical or biological agents, even if the filter has been exposed to some non-hazardous, but still contaminating, vapor. The device must be cheaper than simply changing the filer to a regular basis. It is desirable that the device provide alarm within 15 seconds and that graceful degradation to be observable.

AF86-091 TITLE: Aluminum-Graphite Fiber and Titanium-Graphite Fiber Composite Structural Materials

DESCRIPTION: The purpose of the composite materials will be to provide aircraft structural components with high strength, high temperature, electrically conductive, and long service life properties that can be produced using cost effective, state of the art manufacturing technology. The weight of the composite panels shall be less than equivalent strength metal panels. The metals and fibers must be atomically bonded to provide the required properties. The utilization of powder metal technology may be considered. The proposal tasks shall include tests of specimens to verify the required properties and submittal of specimens.

AF86-092 TITLE: Networking Engineering Workstation Network With Other Computer Systems

DESCRIPTION: The Deputy for Engineering, Aeronautical Systems Division (ASD/EN) is currently in the process of procuring 32 Bit engineering work stations. The contract for these engineering work stations is project to be signed not later than 1 July 1985. These work stations are to be placed throughout the organization and used by the approximately 1600 assigned engineers. This contract includes a network protocol for the engineering work stations in a UNIX operating system environment.

The task at hand is to develop a network linking these workstations with the Digital Equipment Corporation VAX 11/782's, 11/780's and 11/750's currently in place. Research should be done to find the most cost effective way of establishing this network. The concept developed should allow for easy addition of computer systems from numerous vendors. The research should consider not only the current environment, where ASD/EN is located in at least eight (8) buildings throughout Area B, but also the proposed environment where EN is located in a single complex. The concept should provide sufficient redundancy or alternative paths to prevent a single point of failure from disrupting a significant portion of the network.

The concept developed should span the planning and implementation stages of this network. Established check points should be included in the plan to ensure correct installation.

AF86-093 TITLE: Automated Technical Presentation Package

DESCRIPTION: The Deputy for Engineering, Aeronautical Systems Division (ASD/EN) has procured over ninety Air Force Standard Zenith Z-100 micro-computers. The Z-100's considered will run under MS-DOS 2.1. Utility packages such as dBase 11, Lotus 123, and WordStar are used as tools in the accomplishment of mission objectives. Results are transformed to overhead slides for use in support of engineering/technical briefings.

The task at hand is to develop a system by which the briefer could assemble an automated presentation on the Z-100 that could integrate test and graphics generated by the utility programs. The briefer would then be able to take this presentation, via a floppy disk, to a Z-100 connected to a Large Screen Projection System (LSPS).

The system developed should emphasize ease of use and employ a direct method of developing a comprehensive, professional automated presentation. The Z-100 operating the LSPS should be developed as a complete presentation. The Z-100 operating the LSPS should be developed as a complete presentation system in itself.

Software for designing presentations on selected Deputy Z-100's is a requirement. The concept developed should span the planning and implementation stages of this system.

AF86-094 TITLE: New Concepts and Innovations for Aeronautical Systems/Subsystems

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

AF86-095 TITLE: Three Dimensional Sound for Cockpit Information Transfer

DESCRIPTION: Pilot workload has increased tremendously with new generation vehicles, and display technologies have proliferated. These display technologies have all been directed to the visual sense, and with the exception of a few aural warning devices, the sense of hearing has been neglected.

A recent innovation has been the development of three dimensional sound. Three dimensional sound not only provides "presence" but also a sense of direction of the origin of the sound. With proper development and application, this technology could provide rapid information transfer to the pilot. For example, in conjunction with a radar warning receiver, information could be conveyed as to threat identification, relative distance, relative closing rate, and direction. Other potential areas of application are flight simulation and training. Maturation of this technology could provide a significant increase in aircrew capability.

AF86-096 TITLE: Sensor Penetration of Dust Clouds

DESCRIPTION: The objective of this topic is to develop an airborne sensor capability to allow detection and identification of small objects under degraded conditions caused by a high count of particles (e.g. ash, soot, dust, moisture) suspended in the atmosphere, such as could be expected during a severe dust storm and following natural or man-made explosions (e.g. volcanic, conventional, nuclear).

The sensor must be able to locate airborne objects against either sky or ground clutter, as well as objects actually on the ground. The sensor resolution should be capable of detecting and classifying the object. A resolution capability to identify objects is highly desirable.

AF86-097 TITLE: Weight Prediction Techniques for Single Stage Transport Systems

DESCRIPTION: Innovative structural and thermal protection system weight prediction techniques are sought for application to conceptual design studies of single-stage, transatmospheric, transport system which have self-contained landing gear and are capable of horizontal takeoff and landing from conventional runways. Methods are needed for vehicles having takeoff gross weight in excess of one million pounds. Propulsion systems range from all-rocket to hybrid rocket-air breathing configurations, having storage and cryogenic propellants. Structural concepts include both hot and thermally protected primary structure. Conventional empirical weight equations for transport aircraft structural components are not suitable for this kind of vehicle because of the unique environmental requirements and the structural arrangements that must be used to minimize structural fraction and provide tankage for propellant quantities that are large in ratio to takeoff gross weight. Weight prediction methods must be sensitive to variations in loading and environmental conditions, to durability and damage tolerance considerations, to the application of conventional and advanced materials and structural arrangements, and to variations in material derived from simplified load/allowable relationships plus the weight increments that characteristically must be

added to these basic weights in order to achieve practical realistic weight estimates. Empirical methods, when appropriate, may be considered for use in part of the methodology.

AF86-098 TITLE: Sub micron VHSIC for Enhancing Aircraft Self-Sufficiency

DESCRIPTION: There is a need to show how the self-sufficiency of deployed aeronautical weapon systems would be enhanced through the use of sub micron very high-speed integrated circuits (VHSIC) for embedded diagnostics and embedded training. The operational benefits and penalties need to be quantified in relative terms; i.e., relative to a fleet without these embedded features and relative to a fleet with these features but using non-sub micron VHSIC technology.

AF86-099 TITLE: Means of Modifying Local Hypervelocity Flow Fields

DESCRIPTION: This project shall define and investigate innovative methods of modifying the flow field around vehicles traveling at hypersonic speeds at altitudes above 100,000 ft. The intent of this project is to define non-mechanical methods of selectivity modifying the flow field to, for example, control local aero heating, decrease the interference on sensors, and improve control surface effectiveness. The methods of achieving the flow field modification, estimates of the systems necessary to achieve the flow field modification, and the effectiveness of each approach shall be determined.

AF86-100 TITLE: New and Novel Ramjet Cycles

DESCRIPTION: This project shall define and investigate innovative aero propulsion engine cycles that utilize the energy released from the recombination of disassociated O2 and N2 which is produced by hypervelocity flight. The potential application of this technology is for vehicles operating about 100,000 ft. altitude. This program should include a literature search of previous or existing work in the are of scramjet engine and hypersonic nozzle design.

AF86-101 TITLE: Innovative Advanced Packaging Techniques for Future Avionics Systems

DESCRIPTION: A number of technological advances in the area of microcircuits and materials are creating a design environment which will require a major rethinking on how we package avionic systems in the next century. With the advent of very high-speed integrated circuits (VHSIC), microwave integrated circuits, GaAs phased arrays, composite materials, etc., the opportunity to design innovative packaging techniques is essential to take advantage of these technology advances. Since very high mean time between failure (VHMTBF) will result from the ability to have redundance, self heal systems and SW reconfiguration capability; the avionic systems may exceed the life of the vehicle. Packaging techniques which look at avionic systems as an integrated part of the aircraft structures or part of the pilot equipment should be considered. AN example of potential areas of investigation would be the helmets to house a major portion of avionic sensors. Helmet avionics may also become mission related. This could result in standardized platforms with many carry on missionized interface avionics. This topic is targeted to innovative approaches beyond rack mounted or line replacement unit packaging techniques.

AF86-102 TITLE: Survivable Tactical Aircraft Basing Concepts

DESCRIPTION: This project shall define and investigate innovative concepts for basing tactical aircraft that are less vulnerable to damage from attack by non-nuclear weapons. The objective of this project is to develop fixed basing concepts for tactical fighter, interceptor, and attack aircraft that are significantly less vulnerable to attack and can sustain normal operations while under attack or can quickly (less than 10 minutes) return to normal operations following attack. This project shall also investigate innovative methods of supporting aircraft during taxi, takeoff, and landing. The systems so defined are intended to replace conventional mechanical landing gear systems. Emphasis should be placed on new approaches – not previously investigated – and significant improvements in

previously defined alternative systems such as air cushion landing systems. The investigation shall consider both conventional and short/vertical takeoff and landing aircraft.

AF86-103 TITLE: Infrared (IR) Sensor Simulation

DESCRIPTION: The objective is to evaluate known IR phenomena and to identify those effects most significant from the standpoint of effectiveness in training simulation; that is, effect which contribute to the quality and effectiveness of the training. The immediate task is to collect existing IR research data and analyze it, using the contractor's expertise in IR sensors and IR operational use. The desired results would be candidate IR sensor effects and either display or data base parameters, that can become appropriate subjects for experimental studies on the part of the Air Force.

AF86-104 TITLE: Tech Mod for Small Businesses Supplying Products to the Propulsion Sector

DESCRIPTION: The Tech Mod Program addresses the development, integration, and implementation of new manufacturing technology that can be applied to the propulsion sector. Small businesses that are currently either supplying machine tools or processing equipment to the propulsion sector, or companies that are supplying parts and hardware to the propulsion sector are encouraged to submit proposals. The proposals may either relate to improvements that are or will be offered to the propulsion sector or improvements that are or will be implemented within the company offering the proposal and that will significantly reduce the cost or propulsion systems to the United States government. The types of work included in Tech Mod are study, development, and implementation efforts relating to:

a. Enabling technology;
b. Design of material handling, storage, and movement systems;
c. Design of special tools, test equipment, and inspection equipment;
d. Design and integration of factory layout and work cells;;
e. Qualification of new processes, cells, and work centers;
f. Qualification of hardware produced by new processes;
g. Integration of new technology into the production systems;
h. Management information systems (internal to the company only).

AF86-105 TITLE: Operational/Maintenance Histories in Measuring and Predicting Reliability, Maintainability, and Operational Cost for Aircraft Engines

DESCRIPTION: The objective is to develop a set of maintenance histories of current fighter aircraft engines to use as a baseline for new engines. The analysis will demonstrate the methodology and the technique used in the development of the specific operational histories and consolidate the data to allow direct one-to-one comparison. The technique will utilize available data allowing the integration and trace ability between the different levels of maintenance to identify the major hardware maintenance cost drivers.

AF86-106 TITLE: Display Techniques for Pilot Interactions with Intelligent Avionics

DESCRIPTION: Over the next few years, intelligent systems will be developed to analyze air threat information and identify, characterize, and prioritize threat aircraft. Combined with advances in high-speed, three-dimensional graphics, such systems have the potential to greatly increase the pilot's situational awareness and combat effectiveness. However, this potential can only be reached if presentation methods and formats are developed to provide the pilot with this information in an easily and quickly digestible form. In view of the above, research is needed in the following areas:

a. Development of methods of displaying relative three-dimensional positions of threat aircraft along with their identification and relative threat value. Exploration of the uses of alternate viewpoints in concert to provide a more complete situation description.

b. Development of formats for displaying hostile formations, their intentions, flight path predictions, sensor and weapon coverage envelopes, and times to intercept.

c. Development of methods of displaying sensor information certainties-uncertainties and possible alternatives of identification and intent of threat aircraft.

d. Development of techniques for interactively modifying an individual display or display suite to enhance the pilot's understanding of the environment (e.g. zoom, alternate views, voice data).

AF86-107 TITLE: Growth of Laser Quality AgGaSe2

DESCRIPTION: Nonlinear laser materials are useful for extending the wavelength range of a given laser source through doubling, mixing, and parametric oscillation. Silver-gallium selenide (AgGaSe2) is one nonlinear material which shows promise as an optical parametric oscillator. With a pump laser operating at 2.0 microns, continuously tunable output in the 2.5 – 5.0 micron region should be possible. However, use of AgGaSe2 in high average power applications (greater than 1W) requires that crystals be grown with extremely low absorption coefficients in the mid IR to prevent thermal degradation of performance and to reduce insertion losses. Also, bulk and surface damage thresholds of AgGaSe2 crystals must be high enough to prevent crystal damage by the laser pump and output beams.

The goal of this program is to grow large (1 cm X 1 cm X 3 cm) single crystals of AgGaSe2 with absorption coefficients less than .05 cm – 1 in the 2 – 5 micron region and surface flux damage thresholds greater than 50 MW/cm2 when irradiated with Q-switched laser pulses. Commercial availability of improved AgGaSe2 would make possible a high average power, tunable IR laser useful in a number of commercial, scientific, and military applications.

AF86-108 TITLE: Long Life Harmonic Generation Cells

DESCRIPTION: The Air Force has a number of programs which rely on the use of either angle tuned or temperature-tuned optical harmonic generators. A significant problem in the utilization of deuterated crystal doublers such as cesium dideuterium arsenate is deuterium loss from the crystal itself. This probably is due to an exchange process involving transports of hydrogen and deuterium, probably as H2O and D2O from and to surroundings, respectively. Potential culprits are ordinary hydrogen-silicones for mountings, films on windows, and inadequate degassing of cells. Transport apparently occurs because of temperature cycling of the crystal holder, or of the environment. Cells are required that are sufficiently rugged for an airborne environment, prevent deuterium loss from the doubling crystal, have free apertures of approximately 2 cm squared, can heat as well as cool the doubling crystal to maintain a constant and near uniform temperature, and can double neodymium lasers with average powers in excess of 100 watts. If such cells were available, the lifetime issue associated with deuterated doubling materials would be eliminated.

AF86-109 TITLE: Fiber Distribution Network

DESCRIPTION: Optical techniques for signal distribution in phased-array antennas are of increasing importance as the trend toward higher system operating frequencies reduces the back-place area available for each element. The use of optical fibers to distribute the various signals required by phased-array antennas is dependent on a distribution network consisting of up to 10,000 fibers. Techniques are required that minimize splitting and input/output coupling losses. The objective of this program is to demonstrate single mode coupling techniques for a 100 to 1 fiber splitter with less than 5% variation in amplitude between any of the output fibers. The coupling techniques should not introduce significant phase errors for microwave modulated light. These coupling techniques will provide a significant step toward applying fibers to radar operating at x-band and above.

AF86-110 TITLE: Organic Optical Parametric Oscillators

DESCRIPTION: The Air Force has need of lasers that are tunable over the visible and near infrared wavelength region. A demonstrated technique to accomplish continuous tunablity involves the use of nonlinear materials in cavities, that function as optical parametric oscillators (OPO) or optical parametric amplifiers (OPA). Present OPOs are low power devices (lmw average power). While these devices are useful for laboratory spectrographic work, their low power is of little use for military applications. New organic nonlinear materials are being developed that have very high nonlinear coefficients and high damage thresholds. The objective of this program is to demonstrate the use of these materials in an OPO configuration to efficiently produce 100 milliwatts at 10 hertz with continuous tuning over at least 50% of the 500 to 1000 nm band. Approaches should take advantage of the nonlinear qualities of the organic materials to achieve a simple design for the OPO and its tuning mechanism. If this use of nonlinear organic materials is shown to be feasible, tunable lasers could be produced that are as simple in design as present nontunable lasers.

AF86-111 TITLE: Electronic Multiplier Stability

DESCRIPTION: Because of ever increasing needs for high spatial resolution, high sensitivity sensors, it is becoming more attractive to use micro channel plates as an electron multiplier gain stage between photocathodes and detectors. This, to a large extent, circumvents detector and amplifier noise. Unfortunately, these plates have had limited lifetime while in use. Aging results in reduced gain and spatial non-uniformity. There is no known fundamental reason prohibiting long life. Possible causes for performance loss are residual gas and impact ionization interacting with open chemical bonds resulting from improper surface chemistry. Research and analysis are needed to determine the actual degradation mechanisms for micro channel plates. This is expected to result in identification of processes or methods of manufacture or curing which will substantially improve device lifetime.

AF86-112 TITLE: Infrared Target Modeling for Image Understanding Applications

DESCRIPTION: The interpretation of infrared (IR) imagery by humans or artificial intelligence (AI) methods requires a detailed understanding of the phenomenology associated with the infrared spectrum. The IR Modeling of man-made targets (e.g., tanks, trucks) provides an analytical mechanism for embedding the phenomenological knowledge into an interpretation system. Research is required to define the proper level of model fidelity (thermal and spatial resolution, etc.) to support each stage in the interpretation process, to define the appropriate geometric representation required for the model theory used at each level, and to define the analytic relations between the representation levels that are necessary to support the use of AI reasoning techniques on the sensed target.

AF86-113 TITLE: Symbolic RF Signature Prediction

DESCRIPTION: Model-based vision systems have primarily been developed for photo-type inputs; however, they have not been actively researched for RF imaging sensors. Research is necessary to develop/adapt electromagnetic (EM) models (e.g. physical optics, geometric theory of diffraction) for use in these systems for applications concerning man-made object recognition. Possible research topics include:

a. Geometric Object Representation: The method of input to EM models, which entails representing the physical object in terms compatible with the model program, is quite tedious and complex requiring significant expertise. Capturing this expertise as part of the model-based vision system is important.

b. EM Model Compatibility: EM models normally output numerical information representing the combined effects of the total object scattering characteristics. Models and geometric representations that are decomposable, that are efficient yet rigorous, and that provide symbolic information are necessary for vision system compatibility.

AF86-114 TITLE: Design Automation Entity-Relationship Modeling

DESCRIPTION: A major issue in developing design automation technology for digital systems is the definition of formal entity-relationship (ER) models for multiple levels of design abstraction. Formal ER models must be created for the specification of each design level's requirements and for the hardware, software and functional design components used within each level. For example, precise and internally consistent ER models are required for such system requirements as risk, availability, survivability, and maintainability.

Intuitively, multilevel digital system design can be visualized with a bulls eye diagram comprising Physical Design at the center, Processor Functional Design as the first shall surrounding Physical Design, Multi-processor Functional Design as the next shell, and System Level Requirements as the outermost shell. System Level Requirements propagate downwards towards Physical Design. Each design level physically implements part of the system requirements, transforms these requirements in some way, or propagates appropriate requirements to lower design levels. Physical Design spans all levels of functional design at the chip, board, motherboard, and box levels. It includes electronic design (layout, routing, packaging, wiring/cabling), electrical design (power distribution, power supplies), thermal design, mechanical design, and structural design. Processor Functional Design issues include micro programmed horizontal machines, hardwired synchronous machines, systolic arrays, automatic micro code compilation, and automated micro code compiler targeting. Multiprocessor Functional Design includes distributed system design issues involved in networking distributed operating systems and distributed executives. Requirements, both at the system level and lower design levels, are specification models that logically imply system physical implementation. Requirements models are independent of system application domains.

The objective of this research is to define and verify high-level ER models for multilevel digital system design – specifically, models for System Level Requirements, for requirements at lower design levels, and for functional, software, and hardware design components likely to be used in each design level. Potential follow-on work will expand the high-level ER models into more detailed ones and will demonstrate the utility of these models in automated design synthesis.

AF86-115 TITLE: Multiprocessor Design Aids

DESCRIPTION: Several building-block multiprocessor architectures are becoming available to designers of embedded military electronic systems. These architectures allow a mix/match selection of processor modules to be flexibly configured to meet a range of system requirements. For example, one set of requirements may require several identifiable processors on the same linear bus; another set of requirements may demand several different processors connected by a hypercube bus configuration. Modularity and reconfigurability in the System Executive and Operating System support this reconfigurability, in ways similar to commercial computing systems. The amount of reconfiguration flexibility varies from architecture to architecture. Current architectures include the Westinghouse VHSIC Brass board, the Ratheon Advanced Onboard Signal Processor the IBM Common Signal Processor, the Bell Labs Enhanced Modular Signal Processor, and the Bell Labs Generic Signal Processor Architecture.

To assess the suitability of candidate architectures to meet a specific set of system requirements, formal design tradeoff studies must be performed. Currently these studies are expensive and costly, because they are done with human experts by hand. However, the development of appropriate Expert System design aids for multiprocessor architectures is feasible with today's artificial intelligence technology. Such multiprocessor design aids would both greatly shorten the time and cost of contracted design trade of studies, as well as provide the government with expert design aids to perform many such studies in-house, at further time/cost reductions.

The objective of this research is therefore to 1. study the structure and function of existing multiprocessor building-block architectures; 2. define structure and behavior (both internally and from the user's perspective) of an expert design system targeted to one or more multiprocessor architectures, and capable of addressing a broad range of system design requirements.

AF86-116 TITLE: Expert System for Pilot Decision Aiding

DESCRIPTION: In recent times, avionics systems have evolved to dramatically enhance the effectiveness and survivability of military aircraft. However, the point will quickly be reached when further advances are offset by the inability of the human pilot to rapidly assimilate all the information presented to him. Something must be done to aid the pilot in making sound decisions under combat conditions, while taking full advantage of all available data. To address this need, a comprehensive program in the field of artificial intelligence (AI) is planned that will yield systems that are smart enough to integrate, in real time, vast amounts of data for the pilot. While many approaches will eventually be investigated, present areas of interest are focused on real time decision aiding. An expert system utilizing AI concepts could make recommendations to the pilot based upon its own rule table and knowledge database. The rule table would be specific to the area the system is "expert" in, and the knowledge database would be dynamically updated to reflect information derived from other avionics systems. The pilot would then make the final decision. In view of the above, research is needed in the development of AI techniques for application to expert systems in areas that include the following:

a. Expert system for aircraft route planning. The system would utilize stored terrain data, cultural features, and threat information to plan the most survivable route. Maximum advantage would be taken off terrain masking and threat characteristics, with real time dynamic route re-planning in response to changing threats or mission requirements.

b. Expert system for threat reaction aiding. The system would recommend various lethal or non-lethal countermeasures according to the mission requirements, threat characteristics, and the overall situation at that moment.

c. Expert system for overseeing the operation of other expert systems in the avionic suite of an aircraft. This "meta" expert system would coordinate data and decision information among all the other expert systems and ensure that their combined responses make sense.

AF86-117 TITLE: Distributed Kalman Filter Architectures

DESCRIPTION: Recently developed navigation equipment, such as the GPS Phase II User Equipment, have been implemented as self-contained navigation systems. These systems often contain their own Kalman filter, which either acts to smooth data when the unit is unaided, or as an estimating filter when inertial data are accepted. This type of implementation is suitable for austere systems, but causes difficulty when attempts are made to integrate several sensors of this level to form a hybrid navigation system. Often the hybrid system will take the form of a "cascaded" filter with one or more filtered sensors sending data to a central filter, with a potential loss of optimality and filter stability in certain circumstances. Integration is also hampered by difficulty in correlating the time of the measurements in different sensors, the different filter cycle times required by the sensors, and the different measurement rates of the sensors.

The objective of this work is to develop architectures and design techniques which will allow hybrid systems consisting of various independent sensors communicating via a mux-bus to achieve the performance and stability that the sensor set should provide. These techniques should minimize measurement timing sensitivity, and require reasonably low data transfer rates over the bus. The techniques developed should apply partitioned square root or upper diagonal filter algorithms to produce multi-rate filtering that permits significant decoupling of processing requirement for higher and lower rate sensor outputs while maintaining near-optimal estimation. These techniques can then be extended to the more general case of distributed filtering across the distributed navigation suite.

AF86-118 TITLE: Fiber Optics Infrared Sensor Device

DESCRIPTION: The exact placement and packaging of infrared imaging sensors aboard high performance aircraft is dictated by concerns for aircraft radar cross section and aircraft aerodynamics. Conformal packaging of sensors can meet these concerns. In order to control cost and meet packaging considerations, it is desirable to time-share multiple independently positioned optics with a single detector/dewar assembly. The Air Force desires a device that

would demonstrate the ability of an imaging system's optics to be remotely located away from the systems detector/dewar assembly.

One example of such a demonstration device would be a fiber optics bundle. This would involve forming optical fibers and integrating these fibers into an optical bundle. The relative position of each individual fiber would be maintained at each end of the bundle. The optical bundle would link the sensor's optics with the sensor's detector/dewar assembly. The sensor could be a scanning or staring system. Optical transmission of the fibers would have to be in the 3-5 micron or 8-12 micron region to be consistent with present day imaging systems.

AF86-119 TITLE: Gallium Arsenide (GaAs) Device

DESCRIPTION: Research is needed to understand better the physics of GaAs devices and circuit operation. These devices and circuits are needed for avionics, missile, and space applications. Such devices provide ultra high speed digital data rates; recently, clock rates of 10.0 gigahertz at 77 K have been observed. Higher speed circuits allow fabrication of radar systems with improved performance characteristics. The purpose of this research is to supplement and enhance the development of GaAs technology. Of prime interest is work on modulation doped field effect transistor (FET), since this represents a new and extremely promising technology. Other areas of interest are insulated-gate GaAs field effect transistor technology, bipolar heterojunction transistor technology, and metal silicon FET technology. Theoretical, analytical, or device and circuit fabrication efforts are of interest to further develop the above indicated technologies. Theoretical research may include two-dimensional device modeling, evaluation of ballistic effect, velocity overshoot effects, Gunn domain formation, and circuit simulation. Analytical work may include materials evaluation by Auger spectroscopy, Rutherford backscattering, etc. Finally, transistors and circuits could be designed, fabricated, and tested. The above description maps out a wide area of interest and the anticipated program would attack a small segment of this above described area. Proposals addressing individual areas are encouraged.

AF86-120 TITLE: Impact of Material Characteristics on Compound Semiconductor Performance

DESCRIPTION: Thin layers of semi conducting material with very sharp interfaces have been shown to have a number of properties that are very interesting to the Air Force. Specific device concepts employing these structures are under development, and basic research to support those developments is underway. Primary interest at this time is in the GaAs/AlGaAs system, but other materials will become of interest as they show significant advantages. At the present time, molecular beam epitaxy and metal organic chemical vapor deposition are the primary methods used to grow thin structures, and there is interest in program to improve these two techniques or in other techniques that might be better. New physical principles govern the performance of the new class of devices that are evolving and new measurement techniques or variations of established techniques are needed to understand the materials properties that control that performance. Research to show the connection between the material characteristics nad device performance is also of interest. Examples of research that would be of interest are: 1. development of experimental techniques to measure interface sharpness between layers of GaAs and AlGaAs to within a half of a lattice constant; 2. development of ways of determining carrier concentration profiles within 100A of an impurity and defect profiles close to interfaces for both residual and doping concentrations; and 4. research of unique characteristics that would have a significant impact on present or new device concepts. Theoretical research to develop models of the materials properties of thin structures and devices fabricated from those structures is also of interest.

AF86-121 TITLE: A Natural Language for System Avionics Software

DESCRIPTION: The objective is to analyze the feasibility of designing a natural language as input to a software development environment typical of system avionics. A survey of existing and/or proposed environment facilitiates the structuring of typical programmer's jargons and styles onto a requirement hypergraph. The long range objective is an expert system for automated software development. Provisions are to be made for:

a. A generalized vocabulary minimally dependent on HOL constructs (such as Ada, Pascal, FORTRAN, LISP, etc.)

b. Navigation throughout the discourse of the avionics tree (functional and integral avionics) without disrupting language integrity.

c. Expert system's introspection for:

1. Adapatation and learning from user supplied knowledge, and

2. Feedback to users on the system's decisions and reasoning strategies.

The intended goal of this research is an intelligent interface bounded by the discourse of system avionics. Driven by an interactive parser, this interface will lprocess the given description (design requiremntsts) and generate partially predefined data structures. These may be organized as sub-graphs, within the discourse hypergraph, upon which and interpreter is activated, triggering a two-way exchange of both user-supplied and knowledge based facts. Initial results should suggest a very high order, user friendly dictionary with language constructs for the purpose of supporting a dialogue between the user and the expert system.

AF86-122 TITLE: Design Automation Alternative to AND/OR Trees

DESCRIPTION: In current second-generation silicon compilers, design optimizations are performed on a small scale using the artifical intelligence approach of AND/OR search trees, a quasi-random process for "discovering" designs satisfying requirements specifications. AND/OR tree searches are used because no current analytical design models are available to support formal mathematical derivation of designs for requirements specifications. In the future, design optimization problems (which are currently small in scale and soluble with the tree search approach) will become larger and more complex. Their successful solution will then depend partly on having design optimization approaches available which complement AND/OR tree searching by formally deriving, rather than discovering, optimal designs. For example, having only one tree-search-complementary approach available would more than triple the number of available design optimization methods, because the new approach could be used in clever combination with AND/OR tree searching, as well as separately.

The required research, therefore, entails identification and feasibility study of a new approach to design optimization that supports formal derivation (in the mathematical sense) of optimal designs, and is complimentary to AND/OR tree searching. The first part of the effort involves identification of second-generation silicon compilers AND/OR search trees that are available for performing experiments, and location of whatever raw data (such as integrated circuit process parameters) are required for the new design optimization approach. The second part of the effort is a feasibility study of the new approach adequate to justify (if successful) a potential follow-on detailed performance evaluation and prototyping effort involving the new optimization approach.

AF86-123 TITLE: Storage Techniques for Digital Terrain Data

DESCRIPTION: Changing threat situations and mission requirements have resulted in greater emphasis on high-speed low-level flight for enhanced aircraft survivability in the modern battlefield. This mode of flight places great demands on the map reading ability of the pilot in a single seat aircraft. Currently, the Air Force is using paper and film map systems which are proving inadequate in this new situation. Research and development programs seeking to overcome the limitations of paper and film maps have resulted in rapid advances in digital terrain map systems (DTMS). These systems can present terrain, cultural features, and threat accuracy of these systems is approaching that necessary for passive terrain following/terrain avoidance/threat avoidance. A major problem area right now is how to effectively store all the appropriate data so that a DTMS can access them for retrieval and updating in real time, while providing different components of the data to multiple simultaneous users. Current approaches to storage place undue limits on map area and system access time, as well as requiring excessive volume and power.

AF86-124 TITLE: Fastener/Joining Methods for Carbon/Carbon Structures

DESCRIPTION: The Air Force has a documented need for advanced high performance missiles that fly at hypersonic speeds. These missiles will require high temperature airframes that are capable of operating at temperatures in excess of 2500 degrees F. At the present time, a carbon/carbon primary structure appears to be the lightest weight, most attractive structural concept. In addition to the development of the material, one of the more challenging technical problems will be the development of fasteners and/or joining methods for these carbon-carbon structures. The initial effort should be directed toward assessment of feasible structural joining methods with a follow-on potential for the design, fabrication, and testing of representative structural joints.

AF86-125 TITLE: Vapor Content in Fuel Tank Ullage Spaces

DESCRIPTION: Fuel fires and explosions from hits into the ullage space in aircraft fuel tanks are a major cause of aircraft losses. Many approaches are available to prevent fires and explosion in the ullage and many more are either in development or will be in the future. Each new concept or technique requires extensive ballistic testing with elaborate fuel tank specimens to insure that the new concept is functional and reliable. These tests are expensive and a rapid means of determining if the desired ullage conditions are present is needed.

Innovative concepts or techniques are sought which would provide test engineers with a rapid and accurate means of determining the ullage composition of fuel aircraft tank specimens such that the desired condition can be obtained prior to testing. AN effective system would prevent misfires, lost test time, needless specimen repairs and would improve test efficiency. The ullage environment of jet fuel temperature, pressure, and device location must be design considerations.

AF86-126 TITLE: Use of Transmission Holograms to Reduce the Size, Weight, and Cost of Aircraft Head Up Displays

DESCRIPTION: One major obstacle to reducing the size, weight, and cost of aircraft head up displays has been the need for large, heavy, and expensive glass relay lens optic systems. With the increased use of narrower bandwidth cathode ray tubes in combination with holographic beamsplitters to improve field of view, it is time to consider raplcing the relay lens systems with transmission holograms. The purpose of this effort will be 1. to use computer techniques to design transmission holograms to replace the relay lens systems in head up displays, 2. to build a transmission hologram lens system to replace the relay lens system on the F-16 C/D Wide Angle Conventional Head Up Display for Air Force flight test evaluation, and 3. to document the results of the design and construction of the transmission hologram lens system in a technical paper.

AF86-127 TITLE: Low Density Flow Effects for Hypervelocity Vehicles

DESCRIPTION: Concepts and ideas are solicited for the development of accurate aerodynamic prediction/design methods to account for viscous interactions within the limits of continuum aerodynamics. The approach must account for transverse and stream wise variations in edge conditions and be verified by a representative sample of the experimental data base. Skin friction and heat transfer coefficient are the major characteristics to be determined, although displacement thickness and momentum thickness are also desired. Generation of a complete bibliography of theoretical and experimental work will be a required preliminary step in any raw development.

AF86-128 TITLE: Structural Joining Methods for Dissimilar Metal Airframes/Tankage

DESCRIPTION: The Air Force is actively pursuing the development of manned, reusable hypervelocity vehicles for orbital and sub orbital missions. The airframes for these vehicles will, at least partially, be built out of materials that have, heretofore, never been used as primary flight vehicle structure. These vehicles will also contain cryogenic fuels and be required to achieve structural mass fractions that are a lower than any that have been achieved before in aircraft structure. This effort would look at potential joining methods for dissimilar metallic materials such as

titanium-to-super alloy materials. It should consider at least various types of welding and brazing that would provide both structurally efficient as well as leak free joints for the containment of cryogenic propellants (LOX & LH2). The follow-on potential is the design fabrication and test of small but representative structural test specimens that would be thermally tested through repeated cycles from liquid hydrogen temperatures to reentry temperatures.

AF86-129 TITLE: The Effect of Pyrolysis/Electrolysis Techniques Upon Chemical/Biological Agents

DESCRIPTION: The purpose of this effort is to define and evaluate the potential feasibility and practicability of using pyrolysis and electrolysis techniques to avoid and/or protect internal portions of an aircraft (crew compartment, avionics bas, etc.) from any contamination in a chemical and biological threat environment. The concept of pyrolysis reflects the technique where the chemical/biological agent is destroyed via the application of heat or a burning process. The application of a microwave energy device integrated with the environmental control system is one possible choice for this study. The use of ultraviolet and/or alpha rays and/or radio frequency bombardment are electrolysis concepts which should be considered. The program should cover the ability of electrolysis devices to neutralize or destroy chemical/biological agents while keeping radiation levels for the crew and equipment within safe limits.

AF86-130 TITLE: Flying Qualities Requirements for Nonlinear Flight Maneuvers

DESCRIPTION: Innovative analysis methods and criteria are needed to define general flying qualities requirements that consider the non linearities which may dominate characteristics of aircraft during large amplitude motions and maneuvers near the boundaries of the flight envelope – possibly a greatly extended envelope. Aircraft with high authority stability and control augmentation systems can be particularly unforgiving in these extreme operating conditions if their design margins do not adequately consider both aerodynamic/inertial and flight control system non linearities. One must also consider the pilot's capabilities and limitations to insure the combined system will have flying qualities appropriate for its mission or tasks. The pilot's information requirements and essential cue are key elements of this flying qualities issue. Efforts are solicited to develop analysis methods useable to define the pilots information needs during flight at unusual attitudes in order to assure his awareness not only of "where he is" but "margins remaining" as well. A second research goal is to develop design methods and criteria that insure consistency among displayed information, motion cues, and other sensory inputs to the pilot.

AF86-131 TITLE: An Investigation of Non-Catalytic Materials and Coatings Applicable to Hypersonic Lifting Entry Systems

DESCRIPTION: Hypersonic lifting entry systems create a disassociated an slightly ionized plasma sheath caused by their induced shock envelope. The energy tied up in this process is, potentially, unavailable to heat the configuration. The amount of that energy which heat the configuration is a direct result of the ease with which the disassociated plasma recombines at the surface. The recombination process is controlled by the catalytic behavior of the vehicle surface. The purpose of this study is to screen practical materials and coating systems according to their ability to resist recombination of low density, high temperature plasmas and to produce a report which will focus research into the development of promising material systems with the desired characteristics.

AF86-132 TITLE: Modeling Techniques for Composites Subjected to Rapid Thermal Loading

DESCRIPTION: The effect of cyclic mechanical loading on delaminations in composites has been investigated for some time. However, the effects of rapid thermal pulse loading on delaminated composites have not been studied. Modeling techniques need to be developed in order to understand the overall effect of thermal pulses on delaminated composites.

AF86-133 TITLE: Electrical/Electronic Signal Tester

DESCRIPTION: Aircraft Battle Damage Repair (ABDR) techniques for repairing damaged wiring in combat damaged aircraft vary depending upon the characteristics of the particular wire being repaired. With the growing application systems that employ fiber optics and ribbon wiring with extremely low signal power or voltages, it becomes imperative that a test procedure be developed. The purpose of this proposal is to develop an electrical/electronic signal tester that will possess the following capabilities; be able to measure voltage, frequency, and current across the repair and be able to generate any type of signal to be sent across the repair to allow measurements of signal degradation. The tester must be able to reproduce the signal generated by any onboard aircraft system. The F-16 aircraft will be used as a test case aircraft. The tester must be compatible with the Air Force's concept of operations of ABDR.

AF86-134 TITLE: Air Data Sensors for Extended Flight Envelope

DESCRIPTION: Extension of fighter aircraft flight envelopes is the subject of a current Air Force program. The primary purpose of this program is to allow improved mission effectiveness by use of controlled flight at high angle of attack or other penetrations of other existing "boundaries". Flight into these areas involves potential control departures in high pilot workload environments and will almost certainly require a significant flight control system (CFS) use. In order for the FCS to operate, proper air data are necessary either for direct feedback or gain scheduling. Efforts are solicited to develop means of sideslip, their rates, and total velocity while outside the conventional flight envelope. Excursions into this regime are expected to be short term (less than 10 seconds) but of a highly dynamic nature.

AF86-135 TITLE: Wake Turbulence Model

DESCRIPTION: In many of today's state of the art computer simulations of complex viscous fluid flows, a great deal of attention is given to regions of turbulence in these areas. The long-term solution for turbulent flow will be accomplished from first principles, but at present, this method is impractical because of the storage and computational requirements. High order closure turbulence models have been successful to a certain degree, but in general are used for an overly broad range of problems.

A focused approach is therefore proposed to study available turbulence data, primarily in terms of the mixing and decay properties of turbulent flow for engineering applications. It is desirable to differentiate between the large oscillatory structure in the wake as opposed to the broad band high frequency, small scale motion. In addition, a quantitative definition of the interaction between large scale, low frequency and small scale, high frequency components of turbulent flow should be developed. The energy cascade and interaction between overlapping areas where the Strohal number varies about a value of 1.0 should be resolved. In summary, a quantitative wake turbulence formulation is desired for general use in numerical simulations of turbulent flow problems.

AF86-136 TITLE: Stress Intensity Factors for Cracking Metal Structures Under Rapid Thermal Loading

DESCRIPTION: Studies have been conducted to determine the behavior of structures subjected to rapid thermal pulses. However, the effects of rapid thermal pulses on cracked structures have not been evaluated.

The purpose of this program is to develop analytical techniques for predicted stress intensity factors of cracked metallic structures subjected to rapid thermal pulses The end product would be a computer program capable of predicting stress intensity factors for cracks with general geometries and time-temperature profiles as input.

AF86-137 TITLE: Crew Escape capsule to Airframe Latch/Disconnect Mechanisms

DESCRIPTION: Future combat fighter aircraft may have a separable crew escape capsule incorporating seating structure, partial instrument panels, and the windscreen canopy. The F-111 fighter/bomber aircraft is the only

current operational aircraft with a separable crew compartment escape system. This system depends upon detonating cord and pyrotechnic powered guillotine cutters to sever necessary structure and control system connections during emergency escape. The F-111 capsule cannot be removed for inspection or maintenance. The need exists for unique latching mechanisms and associated system disconnects that will allow for future escape modules to be mated to the airframe as an independent structure. This requirement will allow for simpler assembly of aircraft, improved maintenance, and significantly reduced life cycle cost of future capsule escape systems and airframes. The successful implementation of the requirement depends upon the development o fa highly efficient structural latching mechanism and control system disconnects that can be operated manually or by automatic command to release the escape system during all possible combinations of aerodynamic loads and maneuvering load factor accelerations. This program should result in one or more preferred concepts along with supporting analysis and rationale. Simplicity, reliability and ease of operation should be heavily weigh in determining the preferred conceptual design. The successful development of latching and disconnect mechanisms would have additional benefit toward solving pilot ingress and egress sunder chemical defense conditions on the flight line should the sealed cockpit, containing the crew, be mated to aircraft via robot systems immediately prior to sortie launch. Additionally, the Air Force interest in modular fighters with detachable components, i.e. fuel cells, avionics, weapons, engines, etc., as contained in conformal fuselage units, would require efficient high strength latches and disconnect mechanisms not unlike those required for the crew escape system.

AF86-138 TITLE: Stability and Control of Hypervelocity Vehicles

DESCRIPTION: Research on lifting hypervelocity vehicles began about 30 years ago and has included analytical studies, wind tunnel testing, and flight-testing. This class of vehicle includes X-15, Dyna-soar, ASSET, and Space Shuttle to name a few. Although many lessons have been learned about the stability and control of this class of vehicle, much must be done to develop advanced configuration for military applications.

The purpose of this research is to develop analysis methods and design criteria for lifting hypervelocity vehicle stability and control. Reviewing past results, collecting lessons learned, and identifying gaps and deficiencies would lead to recommendations of design approaches. These approaches could be contrasted with current and proposed military design techniques. Methods and criteria could include disturbance phenomena and models (anticipated and encountered), interference flow-field control limitations, control power requirements, critical in puts and input limitations, stability limits, control of configurations with reduced static stability, transient propulsion effects, etc. Such an effort would lead to development of rational stability and control design approaches for future hypervelocity vehicles.

AF86-139 TITLE: Vortex Flow Control

DESCRIPTION: Vortex flow control technology research and development has recently been devoted to investigating the control of forebody and wing leading edge vortices. Present invasion analytical tools and an empirical wind tunnel database allow for the initial design of wing leading edge vortex flow control flaps. However, viscous effects tend to degrade the predicted performance benefits substantially.

Research is solicited to investigate the viscous flow impact, including the secondary vortex effect, on the leading edge vortex of advanced moderately swept fighter wings incorporating vortex flap leading edge devices. The interaction of forebody vortices with the wing leading edge vortex system should also be addressed. Developing an accurate vortex flap design tool, which includes the effect of viscosity, is the ultimate goal of this research effort.

AF86-140 TITLE: Inspection Methods for Subtle Thermal Damage in Composite Airframe Structures

DESCRIPTION: Organic matrix composites are in major USAF use and are projected for even more extensive application on airframes and space structures. Thermal damage to these materials can range from gross charring and blistering to nonvisible or subtle damage which may affect durability and damage tolerance. In addition, the extent of subtle damage beyond visible damage zones is of importance to structural repair. This program will initially assess test methods, including nondestructive evaluation, that can detect subtle forms of damage. The second phase

would apply the methods to assess threshold thermal levels (temperature and heating rates) on epoxy, bismaleimids, and thermoplastic structural elements

AF86-141 TITLE: Fluid Filled Transparencies

DESCRIPTION: Aircraft transparency systems must survive in an increasingly hostile flight environment. Threats to the transparency system include:

a. Aerodynamic heating at high mach number.

b. High cockpit temperatures when the canopy is closed in a hot, sunny ground environment.

c. Condensation on the inside of the transparency when warm cabin air contacts cold-soacked transparencies.

d. Flash blindness resulting from a nuclear flash during night operations.

e. High temperature burn through or frosting due to an engagement with a high or medium energy laser.

New transparent materials to counter the above threats will not be available in the foreseeable future, consequently innovative concepts are needed to develop survivable transparencies using today's materials. The purpose of this effort is to explore the feasibility of introducing a temperature, photochromic, and color conditioned fluid between channeled layers of a laminated transparency system to evaluated the degree to which the threats identified above can be nullified. It is envisioned that light and dark fluids would be mixed in a proportion to yield the desired light and heat rejection for the transparency. Photochromic elements would then be introduced into the fluid to provide the desired response to light stimuli. Next the fluid would pass through a temperature conditioner to cool or heat the fluid depending upon sensor inputs reporting on the environmental conditions in the transparency. The final step would be the introduction of the fully conditioned fluid into the appropriate channeled gap between the laminates. The fluid flow rates and delta temperatures would be determined by the heat transfer balance of the system. An analysis of the heating and cooling requirements for the fluids would be performed for an assumed windshield design and several critical points in the flight envelope. A simple mockup of the system consisting of two sheets of plastic separated by a gap would be fabricated to explore the optical qualities and the response of the photochromic elements to light, and to validate predicted heating/cooling requirements. Several different fluids would be demonstrated to determine the impact of this variable on the system performance. The successful demonstration of the fluid-filled transparency concept could have a significant impact on the design of survivable transparencies for future tactical aircraft.

AF86-142 TITLE: Super Maneuver Definition and Measure of Merit Development

DESCRIPTION: Maneuvers, that include at least transient excursions into the regions beyond the conventional and combat flight envelope, are being defined as super maneuvers. The intent is to allow a more rapid firing solution, whether as a result of pointing the weapon system or maneuvering the velocity vector. The direct enabling technology comes from increases in force and moment generation plus eliminating or overcoming the causes of departure from controlled flight. Current means for comparing performance, such as specific excess power, do not account for the benefits available from this type of maneuvering. Efforts are solicited which address the definition of specific maneuvers to be considered and metrics that are capable of showing their worth.

AF86-143 TITLE: Noncontacting Linear Displacement Sensor

DESCRIPTION: The purpose of this research is to develop a noncontacting sensor capable of sensing the distance between two objects within a range of 0 to 1 inch with a measuring accuracy of .001 inch. The sensor must be able to operate in a Mach 6 flow at a temperature of 1100 R. The purpose of such a sensor is to accurately determine the location of a boundary layer probe relative to the model surface during wind tunnel experimentation investigations.

AF86-144 TITLE: Parachute Landing Impact Attenuation

DESCRIPTION: Analysis of noncombat USAF aircraft ejection statistics shows that parachute landing impact is a frequency source of major injury during an ejection. Approximately 20% of the ejected sustain some sort of major injury, with ground impact injuries accounting for approximately one third of these. Crew members ejecting under emergency conditions from a disabled aircraft are at a much higher risk of parachute landing impact injuries than sport parachutists or paratroopers. The sport parachutist or paratrooper can plan the landing conditions in terms of terrain, wind conditions, and visibility. The ejected must accept the conditions that exist at the time of abandoning the aircraft. In addition, the ejected may have received relatively little training in parachute landings and could conceivably be injured during the ejection from the aircraft. These facts lead to the need for some form of ground impact attenuation for the ejected other than his or her legs. Innovative concepts for reducing the ground impact loads on the ejected are solicited. The concepts could include inflatable impact attenuation systems tailored to human acceleration tolerances. This could include repositioning the crew member before impact to reduce the accelerations along the more critical axes. AN inflatable exo-skeleton system for redistributing impact loads to the body coupled with an impact attenuation system is another example of a possible system. The descent rate of the parachute should be assumed to be 20 feet per second. Uneven terrain and the resultant translation velocity resulting from wind drift and parachute oscillation should be considered in the analysis. New concepts in parachute design or employment are beyond the scope of this effort. Successful development of an impact system could significantly reduce the number of major injuries during ejection. It could also provide the opportunity for reducing the parachute size and the acceptance of higher descent rates. This program should result in one or more preferred concepts along with supporting analyses and rationale. Simplicity, reliability, and ease of operation should be heavily weighed in arriving at the preferred concepts.

AF86-145 TITLE: Fasteners for Above 500 F Aluminum Airframe Structures

DESCRIPTION: Elevated temperature aluminum alloys (e.g. the Al-Fe-X family) are becoming viable structural materials for critical minimum weight USAF structural applications at temperatures above 500 F. However, mechanical fastening of aluminum structural elements operating over large temperature ranges is not state of the art. Conventional steel or titanium elevated temperature fasteners (e.g. A-286 and Ti-6Al-4V) have much smaller coefficients of thermal expansion than exhibited by aluminum, thus contributing to reduced fatigue performance of the airframe. This program will initially assess mechanical fastening methods using high installation. A subsequent program phase will optimize the concepts and provide a broad fatigue database. In addition, concepts for blind installation will be developed.

AF86-146 TITLE: Landing Gear Pin Bushing with Soft Wear Surface

DESCRIPTION: Landing gear designs have always relied upon the traditional hard pin/soft bushing joints in linkage attachment. In these designs, the brushing provide the wear surface and, thus, need to be replaced on a regular basis. Such bushing replacements normally require that the landing gear be removed and disassembled, the bushings forced out, the holes cleaned and reprotected, and a new bushing pressed in. Often the inner surfaces of the holes have to be burnished or re-boarded because of galling, corrosion, etc. In some cases, there is insufficient wall thickness remaining in the lug for such refinishing and the part has to be discarded and replaced.

Ideas/approaches are being sought to determine the feasibility of reversing this design tradition: e.g. investigate the possibility of designing the points wherein the pins/bolts can be made with a “soft” wear surface and the bushing provide the hard, non-sacrificial surface. If this could be accomplished, then the worn pins could easily be replaced as needed leaving the bushing permanently installed. Cost savings in maintenance would be impressive.

AF86-147 TITLE: 4,000 F Composite Constituent Materials and Processing for Turbine Engines

DESCRIPTION: Because of their tailor ability, low density, and potential for high temperature properties, there is a need for the development of structural composites for long term use in an oxidizing media. Ceramic and carbon-carbon composites development for use at 4,000 F in an oxidizing environment require constituent materials and

processing techniques to maintain composite structural properties for long periods of time. The specific needs shall be the development of: 1. ceramic fibers and oxidation protected carbon fiber and fabrics that maintain high strength and are stable at high temperatures 2. matrix development and 3. integrated composite systems that include fiber, matrix, coating, and processes that result in high temperature, oxidation resistant, structural composites.

AF86-148 TITLE: Two-Phase Elastomer Toughening of Bismaleimide Resins

DESCRIPTION: The use of carboxy terminated butadiene nitrile (CTBN) elastomers with epoxy resins to create a precipitated phase of CTBN particles in an epoxy continuum has been demonstrated to provide effective toughening with only minor reduction in elevated temperature mechanical properties. In this program, the concept of toughening bismaleimide resins with second phase elastomers will be investigated. The goal is good room temperature toughness with good structural performance in the 350-450 F range. Toughening approaches will be evaluated using neat resin specimens and laboratory scale graphite fiber plastic composites.

AF86-149 TITLE: Tough, Heat Resistant Coatings for Graphite Fiber Reinforcements for Composites

DESCRIPTION: Plastic composites made with graphite fibers that have been coated with tough, high elongation resins such as adhesives or elastomers, have higher toughness (.e.g impact resistance) than conventional composites. However, the coatings evaluated to date have limited elevated temperature capability. In this program, coatings having temperature shall be fabricated with coated graphite fibers and bismaleimide laminating resins and evaluated for toughness and in-plane mechanical properties.

AF86-150 TITLE: Fabrication of Microelectronic Packaging Materials

DESCRIPTION: Approaches are needed to solve microelectronic problem areas and to model and develop new packaging approaches, reliable solder materials, optimized printed wiring boards and materials with required properties, such as specified thermal expansion coefficient and low dielectric constant. Approaches are also required in the areas of materials and process development for microwave circuits packaging. Another general area of interest associated with the manufacturing of packaging materials is the area of process control (i.e. electrochemical plating and etching).

AF86-151 TITLE: Impact of Material Characteristics on Infrared Detector Performance

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance requirements with the emphasis being on long wavelength detection. New concepts such as heterostructures and super lattices detectors are desired for long term applications. Detector arrays are being driven to needs for material uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

AF86-152 TITLE: Fabrication of Microwave Device Materials

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide material that is used for device substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers. The latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance.

Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

AF8-153 TITLE: Paint Removal from Carbon Fiber Reinforced Epoxy Resin Composites

DESCRIPTION: New and novel non-chemical paint removal techniques are required for use in the removal of polyurethane base paints from epoxy resin base fiber reinforced composites. Techniques must be environmentally compatible, non hazardous to workers, and cause no degradation to the mechanical, chemical, or physical properties of the composite material.

AF86-154 TITLE: Photoelectron Emission Techniques for Pre Bond Field Inspection

DESCRIPTION: Nondestructive techniques are required for use in the field as well as in the depot for the pre-bonding inspection of prepared surfaces to insure that durable adhesive bonds will be formed. The use of photoelectron emission techniques as well as various other nondestructive approaches shall be evaluated in order to demonstrate the feasibility of developing a portable, field usable surface examination technique.

AF86-155 TITLE: Nondestructive Determination of Resin & Moisture Content

DESCRIPTION: Techniques are required to nondestructively determine the carbon fiber/resing ratio in uncured prepreg as well as in cured composite components. In addition, a nondestructive method for the determination of the amount of water absorbed by a composite, that has seen environmental exposure, is needed.

AF86-156 TITLE: Reliable High Temperature Materials for Advanced Gas Turbines

DESCRIPTION: In Air Force turbine engines, materials are operating at or near their capacity with regard to stress, temperature, and environment. Yet, it is necessary to extend the life of current systems. New systems are envisioned that will demand lighter-weight structures of extreme reliability and resistance to environmental attack of catastrophic failures. A rational basis for developing improved material systems (high temperature and refractory alloys, ceramics, or refractory composites) is required through understanding of the principles that govern properties and behavior as functions of microstructural features, composition, and processing. New approaches leading to increased performance of high temperature alloys, ceramics, or refractory composites are required as follows:

a. High Temperature Alloys Approaches to thermodynamically stable oxidation-resistant turbine engine blade, vane, and disk alloys which offer significantly improved creep, fatigue, and oxidation properties.

b. Ceramics – Research to identify new families of high performance ceramics or composite materials capable of economical consolidation, reproducible processing, and improved thermal stress and fracture reliability is needed to extend the limits of future generation high temperature turbine engine components.

c. Composites – Approaches to improved oxidation resistant carbon-carbon and ceramic composites for use above 3000 degrees F are required.

AF86-157 TITLE: Practical Manufacturing Techniques for Metal Matrix Composites

DESCRIPTION: Graphite-magnesium and graphite-aluminum metal matrix composites offer significant potential for high performance lightweight spacecraft structures because of their stiffness and dimensional stability. However, practical manufacturing techniques for forming materials and structures are lacking. Innovative ideas are needed in the areas of processing concepts for making tape or sheet and of fabrication of large components.

AF86-158 TITLE: High Performance Aluminum, Titanium, and Magnesium Alloys

DESCRIPTION: New approaches leading to improved rapid solidification technology (RST) for aluminum, titanium, and magnesium alloys are needed. Current Air Force interest in aluminum alloys centers around three families of alloys: namely, high strength/corrosion resistant alloys, high modulus/low density alloys, and elevated temperature aluminum alloys. Included is the response of these alloys to various types of processing: e.g., consolidation, forging, extrusion, and rolling. A new initiative in this area is directed for development of ultra-high temperature aluminum alloys to replace titanium in engine and aircraft applications to temperatures of 900 degree F. Titanium alloy requirements through RST are directed to the development of alloys with improvements in three areas: temperature stability to 1400 F, strength to 210 ksi, and higher modulus/density ratio to use in advanced engine and airframe applications. Approaches are needed in the following areas: development of a rapid solidification process suitable for Mg alloys, Mg alloy development, low cost consolidation techniques, and evaluation of mechanical properties.

AF86-159 TITLE: Improved Nondestructive Evaluation

DESCRIPTION: Nondestructive evaluation plays a major role in the production, operational safety, and maintenance of Air Force systems. Current emphasis has largely been on the inspection of airframe and engine components, sub-assemblies, and entire systems during manufacture, and through out their service lives as a major element of maintenance and repair procedures. The tremendous variations encountered in the articles to be inspected, in matters such as geometry, material composition, service conditions, and defect detection and characterization requirements, has led to the study of many physical, chemical, and mechanical phenomena that can be used as nondestructive inspection and evaluation (NDI/E) techniques. Advanced, innovative approaches are needed to improved NDI/E techniques for the detection and characterization of flaws in airframe and engine materials and components, and also for the real time monitoring and control of manufacturing processes. In particular, research is needed on electro-magnetic, ultrasonic, radiographic, and new and improved methods for the detection of bulk and surface defects in metals and composites, examination of surfaces prior to adhesive bonding, as well as determination of resin and moisture content in advanced composites, imperfections in material coating, and corrosion. Furthermore, advanced NDE signal processing concepts and methods, including that necessary for decision-making, are sought. Of particular interest are those efforts that give an improvement in the reliability of the NDI/E process that allow the quantitative characterization of the flaws. Furthermore, proposed methods should have the potential to be useful in a manufacturing or in-service environment as appropriate.

AF86-160 TITLE: Polymer Precursors for Ceramic Matrices in Composites

DESCRIPTION: Dramatic progress is being made in synthesizing novel polymeric materials, that yield oxidation resistant ceramic substrates upon pyrolysis. These materials exhibit great potential for extending the oxidation resistance of carboneous substrates and composites. Liquid infiltration of inhibitors into composites using organometallic polymers is an attractive approach for developing high temperature oxidation resistant matrices. Silicon carbine, boron carbine, silicon nitride, and other materials including mixtures can be deposited in a controlled manner at relatively low processing temperatures within the composite and, thereby, avoid deleterious effects such as attack of the reinforcement which occurs with high temperature pyrolysis. Controlled levels of inhibitors can be introduced through the fabrication process of carbon-carbon composites from prepregging to late stages of composite densification because of the attractive theological properties of these precursor resins. Viscosities of polymer mixtures can be tailored to infiltrate even the fine pores of a highly densified composite. The work envisioned for this program is to experimentally infiltrate polymeric precursors into a carbon on ceramic matrix composite substrates at various points in the processing cycle. Important considerations are the selection of polymer inhibitors for achieving oxidation resistance in composites exposed to cyclic temperature environments with peak temperatures ranging from 2,500°F up to 4,000°F, the anticipated weight pick-up of the composite, the degree of oxidation resistance achieved, and the retention of mechanical property integrity following processing and oxidation testing.

AF86-161 TITLE: Processing of Organic Resin Matrix Composites

DESCRIPTION: The Air Force is interested in approaches towards controlling the processing of organic resin matrix composites. This research and development can include the following areas:

a. Characterization of the processing behavior of resins as a function of critical materials and process parameters.

b. Modelling of the critical materials – processing interactions.

c. Development of novel sensing technology to provide in-situ feedbacks during processing to facilitate real-time control of critical parameters (e.g. resin flow, void formation).

d. Validation of results through preparation of materials and processing into material forms and composites.

AF86-162 TITLE: Processing Techniques for High Performance Thermoplastic Composites

DESCRIPTION: The Air Force is interested in new approaches for processing thermoplastic matrix composites. This research is to focus on the new generation of high performance thermoplastic resins such as polyetheretherketone from Imperial Chemical Industries and KII polyimide from Dupont. The research can include the use of novel product forms such as spun thermoplastic matrix fibers and the development of processing technology for utilizing these product forms. The processing research and development can also include techniques for modeling the processing response of these novel product forms during processing, as well as unique approaches to in-process monitoring and control of the consolidation and crystallization or cure (whichever is appropriate to the matrix material being utilized) of the composite. The research should include validation of the results via preparation of materials followed by processing into coupon-type specimens and subsequent mechanical testing.

AF86-163 TITLE: In-Situ Sensing of Thermoplastic Matrix Composites Response

DESCRIPTION: The Air Force is interested in research to develop "sensors" or other approaches to monitoring in-situ the response of thermoplastic matrix composites to both in-processing and in-service stimuli. This is to include both the dynamic response of the matrix materials during processing, as well as the response of the resulting composite during in-service exposure to environmental conditions and mechanical stresses. Key material parameters such as viscosity, percent crystallinity or percent cure, residual strain, and instantaneous in-situ strain response are examples of the type of data desired from the sensors. The research is to include methods that will allow the sensors to be left in place without degrading the properties of the laminate globally. The goal to the program would be the development of sensing approaches that would not affect the local behavior response of the laminates. The sensors would have to be capable of operating at temperatures up to 800 degrees F and in a humid environment.

AF86-164 TITLE: Advanced Antenna Window Concepts

DESCRIPTION: Current antenna window materials and designs fail to provide an adequate balance of performance features for meeting potential future requirements. Critical materials limitations are well-known, and occur in such areas as ablative recession, hot electrical transmission, structural capability, and processing restrictions on window size. The primary objective of this innovative research is to identify new and advanced materials, constructions, duplex layers, or assemblies providing a significantly improved balance of properties. The general technical approach and specific antenna window concepts will be at the discretion of the contractor.

AF86-165 TITLE: High Temperature Composite (HTC) Physicochemical Interaction to 4,000 F

DESCRIPTION: A new effort is underway to develop structural composites for potential application up to 4000 F in an oxidizing environment. This effort will require the formulation of a variety of advanced materials and systems in

defeating this hostile environment. The primary objective of this innovative research is to review, assess, and advocate appropriate simplified laboratory and analytical techniques for the rapid and relatively economical cataloging of critical materials interactions. The large investment in the processing and characterization of numerous specimens simulating, in varying degrees of realism, the cross-section of the HTC, justifies an alternate and more fundamental approach. The two-fold intent of this research is to: 1. aid future materials developers in using appropriate techniques for guiding HTC R and D, and 2. initiate the evolution of the techniques to a more sound, quantitative, and broad-base technology. The contractor should conduct a limited number of baseline and indicative experiments for selected techniques and reference materials to demonstrate feasibility.

AF86-166 TITLE: Synthesis, Characterization and Processing of New High Temperature Stable, High Performance Polymer Systems

DESCRIPTION: Improved approaches are sought for the synthesis and characterization of thermooxidatively stable polymeric materials specifically tailored in molecular structure for structural applications; i.e., new, improved matrix resins for composites, thermoplastics, adhesives, and molecular composites. Included are approaches to: 1. high molecular weight, processable polymers which will exhibit use temperatures in the region of 700 F or higher and be based on the chemistry of additional reactions, cycloadditions, or chemical rearrangements such that they can be cured to high strength materials without the unmanageable evolution of deleterious volatiles, and 2. polymers, prepolymers, or oligomers that can undergo low energy cures without the production of deleterious by-products to be chemically cross-linked to high polymer networks with excellent resistance to thermo chemical and mechanical environments and stresses. Approaches to probe network structure and other morphological features are sought to improve fundamental understanding of such polymeric systems. Characterization to determine physical and chemical properties from which to derive fundamental structure-property correlations and correlations with morphology are needed to guide synthesis research and to interrelate polymer (neat resin) physical and mechanical properties with engineering properties for developing processing chemistry. The generation of new polymeric materials for structural applications with more desirable balances between environmental stability, processability, mechanical behavior and costs are needed. Processing approaches for obtaining high temperature molecular composite compositions with superior performance characteristics are sought. Firm theoretical basis needs to be generated for predicting use properties from the molecular structures and morphologies of potential candidate polymers, classes of polymers and/or various types of polymeric compositions.

AF86-167 TITLE: Synthetic Liquid Space Lubricants

DESCRIPTION: Research is need to develop candidate liquid space lubricants based on synthetic hydrocarbon or synthetic hydrocarbon-like classes of fluids. Examples of these include: hydrogenated polyalphaolefins, alkyl benzene, and silahydrocarbons. Important properties that should be optimized are low vapor pressure/volatility, high viscosity index, kinematic viscosity at 40 C in the range of 90-150 cs, and good compatibility with normal bearing materials. The research shall consist of the synthesis and characterization of candidate liquid lubricants. The volatility/vapor pressure characteristics of candidate lubricants should be superior to (i.e., lower than) Apiezon C, a mineral oil based hydrocarbon space lubricant.

AF86-168 TITLE: High Temperature Engineering Plastic Sealing Materials

DESCRIPTION: Advanced technology is needed to broaden the temperature range of engineering plastics for chemical, thermal, and fluid aging stability of sealing materials in the 0 C to 400 C temperature range. Novel approaches are needed for the high strength reinforcement of engineering plastics and for the synthesis and polymerization of engineering plastics with 400 C thermal stability for use in advanced gas turbine engine fuel controls and hydraulic sealing systems. Initial considerations will not be limited by cost, but processability of the new or modified engineering plastics will be a factor.

AF86-169 TITLE: High Temperature Ceramic Coatings

DESCRIPTION: The Air Force is interested in developing new ceramic coatings that have: improved bonding to the substrate, the ability to be applied to large areas economically (i.e., an aircraft structure), and the tailorability of optical properties. Innovative approaches are needed to improve attachment methods while compensating for the thermal expansion mismatch between the substrate and the coating. New techniques are required to tailor the ceramic coatings' optical properties, such as varying the composition of the ceramics using the sol-gel process. The coatings' optical properties are to be optimized for applications in spacecraft thermal control and aircraft camouflage.

AF86-170 TITLE: High Temperature Space-Based Adhesives

DESCRIPTION: The Air Force has requirements for optically and ultraviolet transparent space stable adhesives that can withstand high temperatures for short periods. These adhesives should be able to withstand temperature limits of –150 C for at least an hour, + 600 C for approximately ten minutes, and maintain their mechanical, optical, and adhesive ability. The adhesives must be low out gassing over this range of application with space stability lifetimes of 7-10 years. The adhesive must be stable in vacuum, electron, proton, and ultraviolet irradiation at intensities normally present in space environments.

AF86-171 TITLE: Applications of Biotechnology to Materials Requirements

DESCRIPTION: The Air Force is interested in research and development directed toward applications of biotechnology to materials requirements.

This activity can include the following areas:

a. Biosynthetic methods to provide state of the art materials for Air Force structural, fluid, or electronic applications, utilizing resources that can be domestically produced.

b. Novel materials obtained from biological sources with properties that may satisfy current or future Air Force needs.

c. Biodegradation techniques appropriate to applications such as paint stripping or integrated circuit etching.

AF86-172 TITLE: Avionics Integrity: Integrated Environmentally Engineered Electronics

DESCRIPTION: The objective of this program is to establish very general life prediction equations for integrated circuits and multilayer printed wiring boards that are stressed by thermal cycling, humidity changes and vibrations. The life prediction equations should include all failure modes (cracked, solder joints, cracked plated through holes, corrosion, lifted wire bond, and others) experienced by the electronic devices under the applied stresses. The life prediction equations will be developed and verified by applying the three stresses given above to a number of selected integrated circuits and printed wiring boards. All failure modes must be established so that they will be included in these equations. The life prediction equations must be general systems. A successful demonstration on a selected electronic system must be accomplished.

AF86-173 TITLE: High Power for Space Applications

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

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than 10 kilovolts, response time less than 10 nanoseconds, and the lifetimes of greater than 1.0 million pulses per device.

b. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 microseconds, and an indefinitely long lifetime.

c. Repetitive opening and closing switches for pulse power output of between 10 and 100 kilovolts and 0.1 to 2.0 million amps. Response time must be less than or equal to 100 nanoseconds and the lifetime must exceed one million events.

d. High power, high voltage, high current density pulse conductors that are lightweight, high-strength and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed, as well as continuous high power without conductor failure.

e. High power and energy density rechargeable and nonrechargeable electrochemical power sources. These power sources should not produce effluents during storage and/or operation. A calendar lifetime of at least 10 years is desired with an active lifetime of 0.3 hours under random intermittent load conditions over the 10 year lifetime. Instant on-instant off capability is desired. Peak power density goal is 0.1 1b/kWh including all reactant, case, seal, terminal, connector, structure, and auxiliary weights. The power source must not produce any torque, thrust, moments, gyroscopic effects, or vibration external to itself.

AF86-174 TITLE: Turbine Engine Bearing Concepts

DESCRIPTION: In order to meet thrust-to-weight ratio goals of advanced engines, it is predicted that rotor speeds will need to increase in the order of 20% over current state of the art production military engines. Innovative approaches are needed for the design of rolling element bearings to obtain the life of current engine systems while operating at these higher speeds. Previous approaches have included: Series-Hybrid Thrust bearings, Dual Diameter Roller Bearings, hollow rolling elements and high-speed tapered roller bearings. Additional innovative concepts should be developed and analyzed in this research effort for their application to, and suitability for, turbine engine main shaft support.

AF86-175 TITLE: Fiber Weaving for Composite Components

DESCRIPTION: Fiber reinforced composite materials offer a design alternative that will enable the designer of gas turbine engine components the ability to develop lightweight, low cost, high performance engine components. The purpose of this effort is to reduce the fabrication costs and inherent flaws associated with components made from composite reinforced materials using angle ply, hand lay-ups, 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 orientations in the warp direction ranging from zero to 45 degrees depending on the structural requirements of the shaft. The desired fiber weaving effort shall address the costs of the angle weaving process and will compare this to current fiber weaving methods and lay-up operations. An assessment will be made to determine if the angular weaving process will provide a reduction in fabrication costs. It will be determined if an increased capability to fabricate components from composite materials is obtained and whether any limitations are imposed by the fiber on the weaving process.

AF86-176 TITLE: Liquid Ramjet Fuel Systems

DESCRIPTION: Fuel systems for liquid fuel ramjets must be capable of long term storage and acceptable operation over the entire temperature range specified for Air Force missile systems. In addition, the packaging of the fuel in the missile should maximize the use of the available volume. The objective of this program is to conduct analytical and experimental studies to develop unique approaches for the storage, packaging, and expulsion of liquid ramjet

fuels. Areas of particular interest include the use of fuel to cool missile electronics, co-storage of fuel and missile internal components to maximize use of available volume, atomization of slurry fuels, simple expulsion methods for slurry fuels at low temperatures.

AF86-177 TITLE: Semiconductor and Batteries for Aircraft and Missile Power Systems

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aircraft and missile power systems:

a. High temperature power semiconductor device with a maximum junction temperature of 300 degrees centigrade, low power dissipation, and the ability to switch 10 amps at 2.5 KW per device.

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

1. Rechargeable batteries that provide a gravimetric energy density of 100 watt hours/pound, volumetric energy density of 8 watt hours/cubic inch, power density of 300 watts/pound, 15 year life, 1000 charge/discharge cycles, energy efficiency of at least 80 percent, and a self-discharge rate of 10,000 hours or slower. The size range of interest is from 2 through 5000-ampere hours.

2. Active primary batteries for survivable avionics that deliver 30 or more watt-hours/cubic inch and at least 100 watt hours/pound at the 10 hour discharge rate with pulses that the 20 minute rate near end of life. The batteries must operate over the temperature range from –65 to +21- degrees Fahrenheit. The size range of interest is from 0.5 to 30 ampere hours.

3. Active primary batteries for ground and mobile power applications that provide over 400 watt hours/pound, over 25 watt hours/cubic inch, 100 hour or slower discharges, and a 15 year shelf life.

4. High power density primary reserve batteries for airborne applications that can provide peak power densities of at least 10,000 watts/pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with a shelf life of 25 years and no degradation. Other parameters of interest are: activation within 1 second or less by an electrical pulse, airborne environments, operation over the temperature range from –65 to +165 degrees Fahrenheit without any external heat source, gravimetric energy of 50 or more watt hours/pound, and volumetric energy density of 1 or more watt hours/cubic inch.

AF86-178 TITLE: Air Separation Module (ASM) for Aircraft Fuel Tank Protection

DESCRIPTION: On-Board inert gas generator system (OBIGGS) is a promising new technique for protecting aircraft fuel tanks from explosion hazards. It processes engine bleed air into a nitrogen enriched product that is used to inert the fuel tank ullage. The air separation module separates the incoming air into nitrogen and oxygen enriched sub streams. Presently, there are two concepts for separating air. The molecular sieve ASM uses an adsorption principle while the permeable membrane ASM operates using selective diffusion.

There is a need to improve the performance of the present air separation concepts or introduce a new approach having improved performance characteristics. Presently, it takes about 25 pounds of sieve material to produce one pound per minute (PPM) of 8% oxygen. Likewise, it takes about 28 pounds of fibers to produce one ppm of 9% oxygen. The USAF is seeking an order of magnitude improvement in these figures. A successful program would mean a substantial OBIGGS weight savings that would greatly enhance its applicability to future USAF aircraft.

AF86-179 TITLE: Turbine Engine Test Instrumentation Techniques

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are

limited by the problems associated with current structural instrumentation capabilities. The state of the art of structural instrumentation has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is commonly temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor.

For these reasons, new sensors/systems capable of surviving the harsh environments of a turbine engine, while providing accurate strain and/or metal temperature data, are required. Candidate sensors/systems should be capable of withstanding temperatures in excess of 1500 for at least 50 hours of engine test while detecting strain with at least 5% accuracy and/or temperature with at least 1% accuracy. Additionally, proposed techniques should have minimal influence on blade parameters and gas flow path.

AF86-180 TITLE: Long Life, Multi Megawatt Space Power Systems

DESCRIPTION: Military satellite space power systems at present utilize silicon solar cell arrays, battery or fuel cell energy storage and power distribution, and conditioning in the 28 volt range and at .5 to 5 kW power levels. Near term power system requirements are anticipated to be in the 10 to 50 kW range with peak requirements up by a factor of 10 or greater. Future power requirements are anticipated to be multi megawatts. Survivability and long life are required for all future missions. Technology needed to meet these requirements includes system and component interacting with the space environment and threats in all orbits. Enabling technology is needed to improve system performance, reduce weight and cost, and increase life to a minimum of 10 years. The following developments are needed:

a. Research and development of high power solar cell array technology is needed to enhance the survivability of the array and improve end-of-life efficiency and performance. Performance degradation can come from trapped particulate radiation, leakage, and arcing associated with high voltage solar arrays exposure to the space environment, thermal cycling causing fatigue of the cell to cell interconnects, and exposure to hostile weapon environments. Techniques are sought to improve solar cell and array efficiency and provide protection from hostile environments. Future solar power systems should also be less dependent on the ground station control and techniques are needed to provide autonomous operation of the solar array as part of a power system on a spacecraft.

b. Fully packaged rechargeable satellite batteries are needed with the following characteristics: 1. a usable specific energy of 100 watt-hours per pound under the following conditions: charge-discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, charge times of 5.25 to 22.8 hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 kW per pound and 2. a usable specific energy of 50 watt-hours per pound under the following conditions: charge-discharge cycle life of 30,000 cycles, calendar life of 5 years or more, charge time of 1 hour, discharge time of 30 minutes, and peak power capability of 1 kW per pound.

c. Spacecraft power system thermal management research is required in the areas of 1. steady and unsteady two phase heat transfer for application to power electronic cooling in the 300-400°K regime; 2. ultra light expendable radiator concepts and other heat rejection, transport, and storage techniques; 3. flow stability and heat transfer phenomenology related to zero-gravity two phase, unsteady high flux heat transfer process in cryogenic reactants; and 4. high temperature thermionic devices, high temperature thermal energy storage, and associated heat transfer mechanisms.

AF86-181 TITLE: Solid Fuel Ramjet and Ducted Rocket Propulsion for Missiles

DESCRIPTION: The objective of this research is to conduct analytical and experimental studies of advanced ramjet propulsion systems. These propulsion systems include the solid fuel ramjet and ducted rocket for strategic and tactical missiles. Technology areas of particular interest include efficient combustion of metalized fuels, throttling approaches, non-cylindrical engine designs, non-ejectable port covers and inlet covers, and flow visualization techniques applicable to water tunnel and bare wall combustion tests.

AF86-182 TITLE: Compression System Design Methodology

DESCRIPTION: A major trend in compression system hardware is the increased utilization of low aspect ratio blading, blisks, and three-dimensional design methodology. The primary and secondary flow system design capability must be extended fully into three dimensions to adequately exploit these trends. Therefore, there is interest in any new and innovative ideas addressing the above. Areas of prime importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation, trenching, labyrinth seals, and disc pumping), time unsteady features of the turbo machinery gas path, and secondary flow systems. Additionally, such phenomenological areas as water ingestion, ice ingestion, steam ingestion, duct ingestion, and full-face overpressure are of interest. Models accurately describing the effects of external influences, such as these, are of interest.

AF86-183 TITLE: Advanced Fuel Evaluation

DESCRIPTION: The potential of liquid hydrocarbon fuels as energy sources for advanced hypersonic vehicles must be addressed. From laboratory tests, naphthenic hydrocarbons have been demonstrated to have the potential for cooling and supplying energy to high-speed aircraft. The availability and potential of these fuels will be evaluated from currently available or near-term refining feedstocks or petrochemical products. In addition, novel-processing routes will be assessed as to their potential for producing suitable fuels. Small (pint or less) samples of candidate fuels will be produced and appropriate analyses will be performed to determine the quality of the fuels and the cost of production. Estimates will be projected to determine the availability, cost, and quality of this family of fuels as a function of time. The feasibility of such fuels could provide the Air Force with the higher energy liquid hydrocarbons that could cool advanced systems, increase heating value, and produce high energy gaseous fuels such as acetylene and hydrogen.

AF86-184 TITLE: Fuel Leak Identification and Characterization

DESCRIPTION: Fuel leaks into aircraft equipment bays and other dry bays containing potential ignition sources present a serious threat to the safe operation of aircraft systems. Fuel leaks with a leakage rate as small as a few micro-liters per minute must be repaired in order to prevent a hazardous vapor accumulation within such bays. Current practice for repairing such leaks entail visually locating the leak source and then determining the leakage rate by observing the growth of spot size during a six-minute time period. Depending on the leakage rate, repair action may be required immediately or scheduled at a later date during a normal maintenance cycle.

Because of the high density of equipment installed within dry bays and poor accessibility into such bays, visual identification of the leak source and determination of the leakage rate are extremely difficult and require a considerable amount of time. Therefore, a novel approach, which does not require visual inspection to identify and characterize leak sources, should be investigated. Such an approach could employ a wide variety of detection, electronic, and computational technology. A successful program would result in significant savings in leakage repair costs.

AF86-185 TITLE: Fuels for High Mach Aircraft

DESCRIPTION: Conventional liquid hydrocarbon distillate fuels cannot provide sufficient heat sink capacity to cool other aircraft and engine system components and tend to form deposits within critical portions of engine fuel systems when used at speeds above the Mach 2 to 3 range. Cryogenic fuels such as liquid hydrogen have excellent heat sink capacities but have undesirable low volumetric energy characteristics and storage and handling problems. Special liquid hydrocarbons which undergo catalyzed dehydrogenation reactions and vaporization to provide additional heat sink capacity have been studied in the laboratory but never tested in fuels are anticipated, based on laboratory tests. New, innovative fuels and fuel systems (e.g., hydride concept) for high Mach aircraft are needed that can provide adequate heat sink capacity, high gravimetric and volumetric energy densities, good combustion characteristics, long-term storage, ease and safety of handling, and costs comparable to present day fuels.

AF86-186 TITLE: Characterization of Carbon Deposits

DESCRIPTION: Synthetic esther-based lubricants used in aircraft turbine engines produce undesirable carbon deposits due to high temperature of some components. These deposits reduce overall system heat transfer efficiency and can result in filter, oil transfer lines and fuel/air/oil cooler blockage. A need exists for small scale techniques that can produce deposits under conditions similar to the environments found in turbine engine systems. Systematic test procedures are also required to characterize carbon deposits as to their morphology, accumulation rate, chemistry, etc., against the particular environment that produces the type of deposit. These techniques are required in order to more effectively characterize new lubricants' deposition characteristics and reduce lubricant qualification costs.

AF86-187 TITLE: Test Machine to Simulate Ball/Cage Contact for Solid Lubricated Rolling Bearings

DESCRIPTION: Design and fabrication of a test machine is suggested to realistically simulate the ball/cage contact found in solid lubricated rolling friction force and the amount of wear for various solid lubricant materials. Typically, friction and wear measurements have been made in an environment that is greatly different from that which the ball/cage interface is subjected to in real bearing situations. Therefore, an innovative approach will be required to realistically model a ball/cage contact situation. The simulated contact should be able to experience a realistic range of impact frequencies, normal loads, environmental temperatures, and rolling speeds. The data base established by operating such a machine would be very beneficial for the design and analyses of solid lubricated bearings.

AF86-188 TITLE: Antenna Window Instrumentation for RVs

DESCRIPTION: Develop techniques (instrumentation) to measure the antenna window response during a reentry vehicle flight test. Instrumentation is needed to measure thermal, structural and radar responses, among others. Of particular interest is the melt layer formed by the window material and the resulting shape change.

AF86-189 TITLE: Innovative Missions for High L/D Maneuverable Reentry Vehicles

DESCRIPTION: Describe a set of unconventional missions for highly maneuverable reentry vehicles. Develop a means for evaluating this mission set for a group of maneuvering reentry vehicles.

AF86-190 TITLE: Vehicle Trade-Off Analysis

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

AF86-191 TITLE: Kinetic Delivery of High Explosive Warheads

DESCRIPTION: The Department of Defense has considered the use of penetration munitions in a variety of scenarios. The major shortcoming lies in the fusing mechanism. Insufficient or excessive penetration of the munition can result in degraded performance. The thrust of this research should deal with accurate depth penetration over a variety of impact angles and ballistic impact velocities.

AF86-192 TITLE: Ballistically Delivered Target-Activated Weapons

DESCRIPTION: In the case of missiles or aircraft which become vulnerable to direct attack only during the initial period of their operation (e.g., missile just launched from a silo or a concealed mobile launcher), it can be advantageous to proliferate target-activated weapons, delivered by ballistic missiles, to the vicinity of the known or potential operating areas of the target weapon. A key to feasibility is the achieving of minimal weight for relatively short range target-activated weapons. Accuracy should also be addressed in the technical analysis.

AF86-193 TITLE: Gas jet Nose tip Flow field Analysis

DESCRIPTION: Analytical approaches to determine the flow field structure and heat transfer rates on the reentry vehicle gas jet nose tip/body are needed. The application of fast, large capacity computer systems and innovative (efficient) numerical methods to accomplish computational solutions to this problem are needed. Solution approaches for both ax symmetric and angle of attack cases should be considered.

AF86-194 TITLE: Active Cooled Nose tip Technology

DESCRIPTION: Innovative approaches to actively cool reentry vehicle nose tips using liquid, gas or other techniques are needed. Studies are needed to investigate these techniques, develop performance prediction methods, and computer aided design techniques.

AF86-195 TITLE: Meteorological Considerations for Reentry Vehicle Flight Testing

DESCRIPTION: Reentry vehicle testing requires accurate assessments of weather in the reentry corridor. Current methods of forecasting and measurements can predict cloud masses in the area of interest within a factor of two. Improvements in this capability have been dependent on development of new sensors, such as the airborne cloud radar and reconnaissance aircraft. To make maximum use of this new data, improvements are needed in the display and modeling of cloud data in the reentry corridor. Such improvements might include a numerical model for forecasting cloud motion and particle distribution in an atmospheric volume of 1000 cubic kilometers for a period of one hour.

AF86-196 TITLE: Transpiration Cooled Nose Tip Computer Aided Design Techniques

DESCRIPTION: The TCNT is comprised of 100-300 etched stacked platelets which are bonded together to form minute hydraulic passageways within the tip. The design of each platelet is currently performed by hand. Innovative CAD techniques are needed to reduce the time, effort, and cost to create a nose tip.

AF86-197 TITLE: High Temperature Bonds

DESCRIPTION: Many reentry vehicle designs suffer excessive thermal protection system thickness because the bonds lose strength at temperatures in excess of 400 C. Bonds capable of retaining their strength, and which do not outgas at high temperatures would allow heat shield weight savings. Bond interface materials include, but are not limited to, aluminum, carbon composites, and silica composites.

AF86-198 TITLE: Soviet Capabilities for the Weaponization of Directed Energy

DESCRIPTION: Define and project the Soviet capability to build and deploy directed energy weapons, i.e., radio frequency, charged and neutral particle beam, and laser weapons, especially for use in ballistic missile defense. Primary literature sources, open and classified, should be used for the assessment as well as finished estimates.

AF86-199 TITLE: Enhanced Lethality Kinetic Energy Projectiles

DESCRIPTION: Most nonnuclear (conventional) kill systems today employ kinetic energy as a destructive mechanism. A kinetic energy weapon must penetrate and destroy the object for which it is targeted. The lethality of the kinetic energy fragment is a relatively unexplored concept. Studies are needed to address the interaction of the fragment with the target, techniques to enhance lethality, materials, and fragment generation and configuration.

AF86-200 TITLE: Particle Beam Phemonology

DESCRIPTION: Identify effects of particle beam irradiation on missile electronics. Consider techniques to prevent neutral particle beam catastrophic single event upsets (SEU) and multiple event upsets (MEU) in missile guidance and computer electronics. Compare the effects of a nuclear environment to a particle beam environment for US missiles. Consider dose rates, total dose, circumvention levels, and SEU effects. Consider the feasibility of neutron circumvention techniques including detectors and algorithms.

AF86-201 TITLE: Particle Beam Mitigation Algorithms

DESCRIPTION: Develop software algorithms that could prevent catastrophic instruction errors for missile control and guidance update due to a particle beam threat.

AF86-202 TITLE: RF and High-Power Microwave Mitigation

DESCRIPTION: Identify effects of RF and high-power microwaves on missile systems. Address uncertainties and influence levels, and mitigation techniques and possible countermeasures.

AF86-203 TITLE: Universal Missile Kill Concept

DESCRIPTION: Identify universal kill concepts for DEW/missile engagement. Innovative concepts that are not completely design dependent are sought. Consider lasers, particle beams, microwaves, and other DEW concepts.

AF86-204 TITLE: Satellite Sensor Spoofing

DESCRIPTION: Define satellite sensor spoofing concepts to establish potential methods for confusing or masking sensor acquisition of missile launch.

AF86-205 TITLE: Innovative Techniques to Avoid Midcourse Defense Concepts

DESCRIPTION: Midcourse defense concepts seek to exploit the long free flight phase of ballistic flight in the vacuum of space to perform discrimination and engage threats with kinetic energy or directed energy weapons. Innovative concepts are sought to evade discrimination and/or vulnerability to midcourse weapon systems.

AF86-206 TITLE: Nuclear Hardened Precision Voltage Reference (PVR)

DESCRIPTION: The inertial instruments in the guidance equipment have electronic components susceptible to nuclear radiation. A precision voltage reference is extremely critical for maintaining accuracy. A nuclear hardened PVR is needed to increase probability of survival of an accurate guidance system.

AF86-207 TITLE: Life Cycle Cost Model

DESCRIPTION: There are no known life cycle cost models for ICBM guidance and control systems. An effort is needed to develop a LCC model to allow evaluation of system options.

AF86-208 TITLE: Electronic Parts Reliability & Nuclear Radiation Screening

DESCRIPTION: Parts screening is currently a costly process. Improvement in technique could greatly reduce costs.

AF86-209 TITLE: Future Trends in Semiconductor Hardening

DESCRIPTION: Evaluate present and future trends in semiconductor industry for nuclear hardening of electronics.

AF86-210 TITLE: Fusing Technology Application

DESCRIPTION: Investigate the application of fusing technology to long conductive line source region electromagnetic pulse (SREMP) protection.

AF86-211 TITLE: Unique Signal Devices

DESCRIPTION: Unique signal devices (USDs) are used to insure the missile and warhead cannot function without receipt of valid command code. Present devices are heavy, slow, expensive, and have hundreds of small moving parts. A reliable USD capable of passing nuclear surety criteria is needed.

AF86-212 TITLE: Guidance Update System (GUS)

DESCRIPTION: GUS I s a missile-to-satellite laser ranging guidance update system. A study is required to assess nuclear hardness of the GUS transceiver, identify countermeasures to the GUS. The nuclear hardness portion of the study should include identifying vulnerabilities to the various damage mechanisms, recommended tests and analyses where existing data are insufficient, and areas for specific technology development to improve resistance to nuclear weapons effects. Countermeasures should include those that may be employed to attack dedicated GUS satellites or interfere with GUS in-flight operations. Counter-countermeasures should be investigated for each technique defined.

AF86-213 TITLE: Optical Guidance and Homing Techniques

DESCRIPTION: Development of a guidance system capable of optical image (non-thermal) homing is desired. The system should be capable of locating targets from various orientations and have high course correct rates. Considerations such as size, weight, and power requirements must be included.

AF86-214 TITLE: Small, Hardened, Light Missile Computer Design

DESCRIPTION: Based on VHSIC microprocessor technology, develop designs that would support Advanced Missile Concepts requirements and not exceed 10 lbs in weight.

AF86-215 TITLE: MaRV/Booster Integrated Guidance System

DESCRIPTION: A MaRV requires an inertial guidance system to support terminal maneuvers. This task will investigate if such a system can perform the boost guidance function (one inertial guidance system instead of 2) which could result in considerable cost and weight savings.

AF86-216 TITLE: RV Terminal Update

DESCRIPTION: Accurate terminal guidance of RVs is essential to their proper mission performance. Reductions in impact errors are sought. One method considered utilizes a target designation system on the bus. Once targets have been acquired, this designation system would guide the RVs, in ther terminal phase, to their respective targets. This research should deal with identifying these guidance techniques and the technologies required.

AF86-217 TITLE: C3I Technology Survey

DESCRIPTION: Conduct a C3I technology survey based on a knowledge of the Soviet missile programs and within the context of current and projected shortfalls of C3I/Battle Management systems.

AF86-218 TITLE: Optical Processing for BMD

DESCRIPTION: Studies concerning the use of optical data processing techniques for Ballistic Missile Defense (BMD) are needed. The following areas should be addressed:

a. Applications of optical processing system for RV discrimination. Systems which use infrared, visible (reflected laser or natural) light or radar signals as input are of interest.

b. Optimal use of optical data processing in a BMD radar system design. Effective hybrid optical-digital systems for reducing or conditioning radar return signals as well as configurations capabhle of background and noise suppression, target feature enhancement and directional filtering are among those of interest. Waveform, architecture and internal implications are to be assessed.

c. Characteristics of a probe or airborne optical BMD system that use optical data processing. Implications for system architecture and performance are desired.

AF86-219 TITLE: High Altitude Sensor Technology

DESCRIPTION: This effort is to examine the unique and innovative approaches to vehicle sensor technology during the transatmospheric phase (100,000 ft – 500,000 ft) of its mission. The use of extendable/retractable sensor arrays for both electromagnetic as well as electro-optical sensors which permit greater performance in resolution, range, and power requirements than vehicle enclosed systems is an area of interest.

AF86-220 TITLE: High Altitude Synthetic Aperture Radar (SAR) Operations

DESCRIPTION: The use of SAR to support ballistic missile application requires the parametric development of envelop/boundaries for trajectory, altitude and pointing, velocity, and SAR footprints.

AF86-221 TITLE: Exploitation of Tactical Warfare Technology for Strategic Warfare

DESCRIPTION: A broad range of technologies have been developed for advanced tactical weaponry. It could prove quite valuable to explore the application of these technologies to ballistic missile warfare e.g., nonnuclear

weaponry, special radars for detecting armored vehicles. The technology should take a ballistic delivery system as the baseline and then expand on the system.

AF86-222 TITLE: Target Assessment Damage by Ballistically Delivered Sensors

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

AF86-223 TITLE: Resolution Requirements for Strategic Targets

DESCRIPTION: In support of BMO activities related to "intelligent" ballistic missile systems, a description of strategic targets in terms of resolution required for detection, identification, classification, recognition, etc. is required. These data, when combined parametrically with the time line associated with typical employment scenarios, could provide both processor size and processing speed requirements.

AF86-224 TITLE: Ground Mobile Target Discrimination Techniques

DESCRIPTION: With the proliferation of ground mobile targets in the recent years, investigate potential discrimination techniques for locating mobile targets from other similar nontargets or ground clutter. Technologies should be compatible with a ballistic missile delivery system.

AF86-225 TITLE: Signal Processing Techniques for Constant False Alarm Rate Detectors in a Dense Target Environment

DESCRIPTION: Radars and infrared systems are examples of modern detection systems that determine the presence of a target by comparing test statistic for a given resolution cell against an adaptive threshold. The BMO is interested in new estimation algorithms that are appropriate to a dense target environment and compares the detection performance in both a uniform noise and multiple target environment to those of existing detectors.

AF86-226 TITLE: Artificial Intelligence and Surveillance

DESCRIPTION: The detection of targets such as mobile systems, for real time targets provides a challenge for sensors and processing. Most surveillance functions, however, are the result of a long term viewing and data reduction history. The question is, can a low resolution, multi-waveband system be trained to detect and track targets of interest. Low resolution provides the advantage of allowing large areas of coverage for the surveillance system. Questions of waveband, resolution, target correlations for training sets, and systems synthesis need to be addressed.

AF86-227 TITLE: Laser Discrimination of Penetration Aids

DESCRIPTION: High power laser systems are being postulated and studied for possible strategic application as weapon systems to attack all phases of ICBM flight. From an energy requirement point of view, it is anticipated that RV discrimination may be a less ambitious yet significant role for lasers. The purpose of this study would be to evaluate mechanisms and system concepts of potential value for the negation of the offensive advantage achieved with current and postulated penetration aids.

AF86-228 TITLE: Implementation of Empty Silo Knowledge (Include Battle Management Plan and Required Retargeting Capabilities)

DESCRIPTION: Devise an optical C3 architecture and battle management strategy to implement empty silo knowledge. Assume acquisition and relay of knowledge to single location on the CONUS. Variables to include number and capabilities of management centers.

AF86-229 TITLE: Physical Security Threat to Mobile Missiles

DESCRIPTION: Define current and projected future physical security threats to mobile missile concepts. These include but are not limited to concepts such as hard mobile launcher, wide area mobile, and reloadable low-cost mobile.

AF86-230 TITLE: Intelligence and Force Employment Cycle (INFECT)

DESCRIPTION: Investigate all aspects of the Soviet INFECT for targeting Soviet technology (not mirror imaged US technology) in the areas of reconnaissance, data transmission, target identification, command and control (including C2 of the reconnaissance system), retargeting and delivery.

AF86-231 TITLE: Responsive Threats to Projected US ICBMs

DESCRIPTION: Examine in detail the technological and production implications of several responsive threats to projected US ballistic missile systems. (Specific threat to be determined by BMO/IN) Implications may include such technology areas as communications, positive command and control, reconnaissance, reliability, survivability, and accuracy.

AF86-232 TITLE: Assessment of Enemy Ability to Strike US Strategic Systems Without Warning in the 1990s and Beyond

DESCRIPTION: The US Strategic Systems, to one extent or another, depend upon strategic and/or tactical warning in order to operate at full effectiveness. This study will project US surveillance capabilities into the last decade of this century and project enemy capabilities to either circumvent these surveillance capabilities or negate their effectiveness.

AF86-233 TITLE: Missile Basing System Cost Data Base

DESCRIPTION: Develop an automated data base of missile basing system cost data for the various basing alternatives. This basing cost data base could be used in deriving cost estimating relationships (CERs) for support Independent Cost Estimates/Analyses (ICE/ICA).

AF86-234 TITLE: Investigation of Nonnuclear Hard Silo Kill Mechanics

DESCRIPTION: The BMO Hard Silo program is examining ways to harder missile silos against nearly nuclear bursts. However, possible ways of disabling a silo-based missile other than nuclear weapons should also be addressed.

AF86-235 TITLE: Verification of Ground Burst and High Explosive Tests Time Responses

DESCRIPTION: Determining an effectiveness means of verifying state-of-the-art responses from both nuclear ground burst tests (Mini/Misty Jade) and high explosive tests to incorporate the results from initial detonation (early time) to late time response. This effort should result in tying together the results into an improved state-of-the-art calculational effort to duplicate the complete mechanical nuclear response effects for the complete event.

AF86-236 TITLE: Dust-Induced Loading on a Hard Mobile Launcher

DESCRIPTION: Conduct conceptual dust-induced loading due to airblast studies on a conceptual mobile ICBM launch vehicle. Conduct conceptual designs on dust and debris hitting a mobile launch vehicle. Include particle velocities, densities, and erosion effects on the vehicle. Include particle velocities, densities, and erosion effects on the vehicle.

AF86-237 TITLE: Instrumentation and Soil Structures Media Interaction

DESCRIPTION: Develop new concepts for state-of-the-art instrumentation for measuring ground motions and airblast at extremely high pressure regimes (20,000 to 100,000 psi). Develop concrete and soil structures media interaction. This effort should provide an understanding of shear friction between the soil and a structure (i.e., missile silo).

AF86-238 TITLE: Axisymmetric Surface Test for Soil Material Properties

DESCRIPTION: Develop an axisymmetric surface test using high explosives to provide detailed soil engineering material properties. This effort should result in a cost effective method to characterize soil that survivable missile silos would be placed in.

AF86-239 TITLE: Multiple Airslap Loading on Silos

DESCRIPTION: Study the effects of multiple airslap loading on concrete silos and the surrounding media. Tasks would include study of post-attack conditions and their effects on subsequent loadings.

AF86-240 TITLE: ICBM Deep Basing Shock Isolation System Definition for Missile Transporter/Launcher Storage

DESCRIPTION: Survival of the strategic assets of deep base depend on shock isolation systems capable of withstanding large nuclear weapons effects at base depths. The systems have not been defined or studied in any detail. This effort will define the shock isolation requirements for the missile transporter/launcher while in storage, present a conceptual design and describe a low cost test program to demonstrate proof principle. A SECRET clearance will be required.

AF86-241 TITLE: ICBM Deep Basing Egress Muck Flow Tests

DESCRIPTION: There is no state-of-the-art theoretical method for computing muck flow parameters. Parametric muck flow tests varying mineral composition, water content, and muck chute angle could provide the data required to develop these design equations. Development of a muck flow modeling capability and verification of this model with test data will yield a valuable design tool.

AF86-242 TITLE: ICBM Deep Basing Rapid, Automated, Cost Effective Highly Inclined Blind Raise Tunnel Lining

DESCRIPTION: To meet mission requirements, an automated tunnel lining system is needed which can support an advance rate of 70 linear feet per hour for a highly inclined 15 ft inside diameter shaft. This effort will encourage innovative, cost effective, and reliable solutions to these requirements.

AF86-243 TITLE: ICBM Deep Basing Construction Tunnel Lining System

DESCRIPTION: To meet initial construction requirements for deep basing, a fast, cost effective tunnel lining system must be available. This effort will encourage innovative lining systems capable of 25 linear feet per hour for an 18 ft inside diameter tunnel.

AF86-244 TITLE: ICBM Deep Basing Missile Launch Mid Air Separation Demonstration Concepts

DESCRIPTION: The current deep basing missile launch concept calls for tunnel lining flyout followed by midair separation of the missile from the tunnel lining. This effort will define a low cost experiment/demonstration to be used as proof of principle of midair separation stability.

AF86-245 TITLE: Innovative Kill Mechanisms for Attacking Deeply Buried Hard Targets

DESCRIPTION: Develop plan to investigate innovative kill mechanism for attacking deeply buried hard targets. Evaluate these kill mechanisms by order of effectiveness as a function of target characteristics.

AF86-246 TITLE: Analytical Model of Motorcase Strength

DESCRIPTION: Develop analytical model to predict composite motorcase strength after cutting of some layers of the composite fibers.

AF86-247 TITLE: Structural Properties of Solid Propellants

DESCRIPTION: Identify methods of increasing structural strength of solid fuels to provide greater load carrying capacity of the total missile.

AF86-248 TITLE: Fast-Burn Booster Technology

DESCRIPTION: Fast-burn boosters experience higher loads while transitioning the atmosphere than conventional boosters. Previous studies have identified significant problems in areas of staging, stability, control and heating loads. Innovative ideas are being sought for drag reduction techniques and control while in boost phase. In addition, the impact of the higher heating and aerodynamic loads on the missile structure and materials needs investigation. This study may include part or all of the areas addressed by this topic. While primary emphasis should be on one (or all) of the previously mentioned areas, it is not limited to them.

AF86-249 TITLE: Effects of Depressed Trajectories on Ballistic Missile Defense

DESCRIPTION: A study to explore the effects of a depressed trajectory missile on a Ballistic Missile Defense. The study should address the possible effects on the defense sensor and its ability to respond.

AF86-250 TITLE: Advanced Concept Design Computer Codes

DESCRIPTION: A series of computer codes are required which allow quick turnaround design analyses for ICBMs and related weapon system concepts. These codes would include capabilities for performing booster sizing, plume impingement on deployed objects, simulation of powered flight/free flight and reentry trajectories (3 and 6 degrees of freedom), warhead simulation for Advanced Concept Ballistic Missile (ACBM) utility analysis, nuclear effects on ICBM design and nuclear effects of ICBM warheads on targets, structural and dynamics analysis for boost design, guidance error analysis and simplified CAD/CAM for ICBM external/internal profiles.

AF86-251 TITLE: Structural and Dynamic Analysis Simulation for ICBM Design

DESCRIPTION: Simplified Structural Analysis and Dynamic Analysis Codes for Missile and Deployed Object design Analyses. Development of a fast running 1000 node code for buckling, bending, and torsion design analyses and for model response analyses. Should be to include the capability for environments associated with the high temperatures and pressures expected with the Hot Missile and Slow Missile design concepts. N-Mode design analysis is required to satisfy anti simulation concerns for the dynamic analysis related to exo-atmospheric deployments.

AF86-252 TITLE: CAD/CAM for ICBM Advanced Concept Design Analysis

DESCRIPTION: Development of CAD/CAM Software. This software would be developed to support quick turnaround design analyses and would be used in conjunction with some of the previously mentioned design codes such as the booster sizing, the plume impingement, and the trajectory analysis codes. Outputs would be missile internal/external profiles, subsystem designs and descriptions, sequence of events charts, graphs/plots of missile and trajectory parameters, etc. Nodal graphs and dynamic response graphs would be required.

AF86-253 TITLE: Slow Missile Booster Design Analysis

DESCRIPTION: Slow Missile Booster Analysis with focus on unique approaches for defeating space based sensors and all weapons. The Slow Missile Concept expands the action time of each stage or has coast times between stages to keep the apogee of the total missile below the 80 km altitude which was found to be critical for evasion of beamed weapons. A MaRV would then fly within the atmosphere to the target. Suppression of the IR signature and/or evasion maneuvers for land based defenses would also be studied.

AF86-254 TITLE: Unique Design for Boost Deployments

DESCRIPTION: Unique Designs for Boost Deployment of Reentry Vehicles and Penetration Aids. Mechanical concepts for the deployment of many objects from Post-Boost Vehicles with changes in the allow deployment times ranging from hundreds of seconds for exo-atmospheric deployments down to seconds for endo-atmospheric deployments (Starburst type deployments). Additional concepts would include how to provide necessary velocity and attitude control which could vary from each object having its own mini-bus to having everything deployed from a single bus. Deployments would include trade-offs between Ballistic Reentry Vehicles and MaRVs with full contingents of penetration aids.

AF86-255 TITLE: Innovative Techniques to Avoid Discrimination and/or Vulnerability in the Deployment Phase

DESCRIPTION: Traditionally, deployment of weapons and penetration aids from a ballistic missile has been a methodical, time consuming procedure dependent on accuracy requirements. Defense system operations during this phase could exploit this potential offense vulnerability problem. Impact and requirements on mission objectives have to be considered.

AF86-256 TITLE: Computer Generated Target/Weapon Interaction Graphics

DESCRIPTION: Conventional weapons create complex interactions with their targets in the process of attempting the destruction of the target. The objective of this topic is to investigate the use of computer generated sequential graphics to display dynamic target/weapon interaction.

AF86-257 TITLE: Nuclear vs. Conventional Kill Mechanisms

DESCRIPTION: Both nuclear and conventional type munitions are available for use on ballistic missile systems. Evaluate the effectiveness of selected conventional munitions against nuclear weapons performing the same mission.

AF86-258 TITLE: Creation and Maintenance of Long-Range Planning Management Information System

DESCRIPTION: Good long-range planning requires access to large quantities of existing information on program cost, schedule and effectiveness. Most long-range planning is hamstrung by the sheer time and effort required to amass and update this existing data. Definition of a system which make this information rapidly accessible to planners is required.

AF86-259 TITLE: Conformal Array Antenna Characteristics

DESCRIPTION: Formulate and verify expressive characterizing response of conically conformal antennas. The formulations should enable the evaluation of the impact of varying both geometric and electronic/parameters of the array. The expressions should be verifiable experimentally and experiments defined to effect of such a validation.

AF86-260 TITLE: Optical Materials Development

DESCRIPTION: Materials should be examined and developed to effect various responses to reentry heating. Both emissive and reflective materials should be investigated as well as the range of signature variation possible with a given material.

AF86-261 TITLE: Wake Augmentations

DESCRIPTION: Investigate the feasibility of passive wake augmentation/modification concepts for small decoys and reentry objects.

AF86-262 TITLE: Improved Small Batteries

DESCRIPTION: Batteries to provide high power (100 to 1000 watts) for a time period of 2-5 minutes are required. Weight must be less than one pound. The batteries must be able to survive rocket launch, space and reentry environments.

AF86-263 TITLE: Optical Countermeasures

DESCRIPTION: Propose and investigate countermeasures to optical threat systems. Frequencies are mainly in the IR range, although visible range may be considered. Approaches may be active or passive. Countermeasures may fool, jam avoid, or destroy optical sensors. Countermeasures must address optical sensors which scan track and discriminate. Novel concepts desired.

AF86-264 TITLE: Space Based Side Lobe Jammers

DESCRIPTION: Design and evaluate a satellite based sidelobe jammer system. Jammer(s) may counter space based and/or land based radar and optical systems. Assess survivability and feasibility.

AF86-265 TITLE: Dual Beta Jammers

DESCRIPTION: An aero design is needed for very small jammers which may be deployed over a radar at a medium to high Beta (aero coefficient), but which must quickly attain a much lower Beta.

AF86-266 TITLE: Nuclear Effects on Penetration Systems Effectiveness

DESCRIPTION: Incorporate existing efforts into assessing total effective blackout on penetration systems effectiveness.

AF86-267 TITLE: Post Boost-Vehicle Fractionation as a Penetration Aid

DESCRIPTION: A study to explore the possible benefit of intentional fractionation of a post-boost vehicle as a penetration aid. The study should address the various scenarios that would offer the best effect against a ballistic missile defense.

AF86-268 TITLE: Methods for Ground Testing Optical Properties of Chaff

DESCRIPTION: A reliable technique for ground testing the optical properties of chaff is needed.

AF86-269 TITLE: Optical Signature Simulation/Optical Pen Aid Effectiveness Codes

DESCRIPTION: The research would develop critical input scenarios to the Optical Signature Code (OSC).

AF86-270 TITLE: Anti-Simulation for Penetration Aids

DESCRIPTION: Anti-simulation techniques for exo-endo penetration aids. Mathematical approaches to using multi sensors for discrimination against deployed objects using anti-simulation (dissimulation) would be explored. Environmental aspects, materials for deployed objects and tactics should be defined.

AF86-271 TITLE: Radar Scattering Properties of Aerosols

DESCRIPTION: Aerosols are generally considered as optical maskers. Microwave properties will depend on both the particle and bulk properties of the aerosol cloud, as well as the relative wavelength of the incident microwave energy. Characteristics of aerosols ranging from reflective (high conductivity) to absorbing (dielectric) are of interest. Characteristics of scattering properties, supporting data and computer simulation software are of interest.

AF86-272 TITLE: Low Altitude Dispersal Techniques

DESCRIPTION: There has developed a need for a method to disperse up to 1000 small objects of approximately 10 lb total weight from a small reentry vehicle at low altitudes. A study is needed to define various feasibly concepts such as explosively expelling the objects from the base region of the vehicle. The study must address the

aerothermodynamic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

AF86-273 TITLE: Chemical Warfare Agent Detectors and Alarms

DESCRIPTION: There is need for fieldable technologies for point detection and measuring of chemical agent vapors in air. Specific needs are for 1. sensitive and selective reagent system for colorimetric, fluorescent, chemiluminescent and other chemical and enzymatic techniques for measuring the nerve and blister agents, and 2. reagent packaging systems (such as agent active (a) chemically impregnated film and tapes, (b) coatings for fiber optics (c) coatings for electronic sensors, etc.) These systems would be the basis for developing real-time microelectronic chemical agent detectors/monitors, industrial hygiene type dosimeters, and detector sprays.

AF86-274 TITLE: Development of Persistent Chemical Warfare Uptake Stimulants

DESCRIPTION: Realistic training in a chemical warfare environment requires the use of a chemical uptake stimulant that has chemical properties representative of the particular warfare agent, good detectability, and be safe for human use. Per fluorinates aromatic and highly fluorinated blood substitutes compose a group of chemicals with chemical stability in vivo and are easily detectable in pictogram quantities. Chloropentafluorobenzene has been identified as a candidate uptake stimulant for non-persistent chemical agents; however, the development of uptake stimulants for persistent agents needs to be accomplished. The requirement is for a chemical with good detectability by gas chromatography with electron capture detection, a vapor pressure of approximately 0.002 mmHg at 25 degree C, be absorbed by inhalation and through the skin, and be biologically inert.

AF86-275 TITLE: Automatic Filter Change Indication Analysis

DESCRIPTION: In the event of a chemical warfare attack on an air base, personnel will be required to perform tasks in a vapor contaminated environment. There is no known method that will detect agent breakthrough in made filters worn by personnel. Thus, individuals are very dependent on the filter life and scheduled changes of the filters. The objective of this effort is to quantitative MCU-2P filter saturation using theoretical calculations and verify the quantitative estimates by stimulant tests. In addition, the contractor will analyze the current filter change procedures and determine the cost and operational effectiveness of an automatic filter change indicator. The product of the effort will be recommendations for the use of an automatic filter change indicator for personal mask filters.

AF86-276 TITLE: Chemical Warfare Stimulants for Don/Doff Experimentation

DESCRIPTION: This work should examine chemical compounds for applicability in don/doff experimentation. The ideal stimulant would have the same physical characteristics as any one of the chemical warfare agents. The characteristics of concern are disseminability (viscosity), off gassing (volatility), and the ability to be mechanical transferred and decontaminated (surface tension and chemical activity). In addition, the compound should be detectable in small quantities by standard chemistry practices, and should not be interfered with by commonly occurring environmental conditions. Alternately projects in this area should examine detection methods for stimulants currently in use.

AF86-277 TITLE: Application of Cognitive Science to Crew Station Design

DESCRIPTION: Mission requirements for future airborne weapon system place increasing demands on the system operator, particularly in terms of decision making/problem solving activities. One approach to relieve this problem is to employ the use of artificial intelligence (AI) to accomplish some of the decision making formerly performed by the crew. This approach offers new challenges to the crew station designer, since the interface between new crew and the system must now accommodate the transfer of preprocessed information and decisions from on-board expert subsystems, as well as raw data. It is envisioned that the interface will have to support a high level, abstract dialogue, as well as the current type and level of information exchange. Accordingly, increased attention must be given to the design of the crew station from the perspective of cognitive engineering.

An emerging discipline, known as Cognitive Science, has made significant advances in formulating cognitively based principles of work station design, especially in the area of display format construction. Several of these principles have been applied recently in the analysis and design of work stations in process control industries.

Research and exploratory development is needed to apply and extend the advancements of Cognitive Science into the design of future crew stations. Specifically, the goals of the research are to develop validated design principles and methods from Cognitive Science perspective for use during conceptual design engineering. As a minimum, the methods should consist of 1. analysis tools to facilitate development of cognitively sound crew station concepts; 2. evaluation metrics to access the quality of a design in terms of speed/accuracy, problem formulation ability, coordination among AI sources, crew situation awareness attainment, and in general, dialogue quality; and 3. operator workload and total system performance.

AF86-278 TITLE: Techniques for Bioelectrical and Biomagnetic Sensing from Humans

DESCRIPTION: Electrical activity from humans has a long history of use to measure and body's response to environmental stimuli. Data analysis techniques have greatly improved in the past years while sensor technology has remained essentially the same. There is a need in both laboratory and "real world" environments for sensing techniques that are highly sensitive, reliable and easy to apply. Problems of long duration wearing, skin reactions, subject acceptance and artifact minimization must be overcome in order for a usable new generation of sensors to be made available. New technologies for electrical, ionic, magnetic, and any other detection methods should be considered from these techniques currently available. The advantages of new methods over currently available ones would have to be demonstrated in order to convince potential users of their superiority.

AF86-279 TITLE: Improved Neck for Ejection System Testing Manikins

DESCRIPTION: The neck structures of ejection system and crash/impact test manikins have limited human-like biofidelity in their response to vertically and horizontally applied accelerations. Increasing interest in the effects of changes in the stressed transmitted through the neck and in head motion due to the encumbering of the head with various life-support, protective and performance-enhancing equipment has resulted in a requirement for the development of an improved mechanical neck structure. This structure must provide proper human=like, three-dimensional kinematics of the head for horizontally and vertically applied accelerations; possess provisions for readily modifying internal resistance to flexion; have integrated, multi axis force transducers for measurement of transmitted forces; and be designed to be compatible with current state-of-the-art testing manikins. Initial emphasis is on design concepts, methods of mechanical implementation and demonstration of the feasibility of the approach. The program is expected to lead to prototype fabrication; testing for response and compliance with overall testing manikin requirements; and a final refined design suitable for multi production purposes.

AF86-280 TITLE: Biofeedback System for the Treatment of Motion Sickness

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on subsystems on or an integrated system for the utilization of biofeedback for the amelioration of motion sickness susceptibility, syncopal susceptibility, optokinetic distress. The subsystem which might be addressed are sensors and sensor ensembles to include sensors with some signal processing capability, downstream signal transduction and/or microprocessors, circuitry to deliver appropriately treated data streams to minicomputers, A to D and D to A conversions required for minicomputer analysis and display biofeedback signals on-line in near real time to practitioners and patients, and circuits and hard wire ensembles to record data streams for storage on tape and floppy mediums. Integration should address any combination of the subsystems listed above. Full integration should have the objective of a turn-key package. The scope of this topic description is interdisciplinary.

AF86-281 TITLE: Improved Techniques for Human Tracking of Moving Targets

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on techniques to enhance the speed and accuracy of human tracking of moving targets. The analogue of this tasks is the tracking of an adversary in an air-to-air engagement by military pilots of high performance aircraft. The effort should address the motor side of sensory-motor function as the primary focus, but may also address the sensor (display) side as the secondary focus. Applications should be targeted on the utility of the technology to identify military pilots with potential for enhanced tracking, the use of the technology as a training tool, and potential for incorporation into future cockpit systems.

AF86-282 TITLE: Psycho physiologic Test Battery for Pilot Selection

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine (USAFSAM) is seeking innovative research and/or engineering development on a battery of measures which will yield psycho physiologic profiles of sufficient sensitivity and specificity to reflect modest and/or subtle individual differences. The intended application of this battery of measures is to identify superior performs in the operation of vehicles in motion requiring high levels of skill in sensory-motor performance and cognitive functioning, and specifically to identify superior military pilots of high performance aircraft. A secondary application is to assess progress during special training programs for enhanced cognitive function, as well as unique training for increased situational awareness. The scope of this topic description is multidisciplinary.

AF86-283 TITLE: Analysis of Chemical Agent Resistant Coatings

DESCRIPTION: Contamination avoidance is probably the best option available when performing duties in a Chemical Warfare agent contaminated environment. Personnel can avoid contamination by knowing what is contaminated or, lacking that information, knowing that surfaces needed to be contacted are already decontaminated. The potential usefulness of chemical agent resistant coatings for air base surfaces and materials is very high because personnel could perform aircraft maintenance and sortie generation in a liquid hazard free environment. The objective of this analysis is to identify surface characteristics on air base equipment, machinery and surfaces involved in sortie generation, identify chemical agent resistant coatings under exploration, and determine the compatibility of the coatings with the air base surfaces. The compatibility criteria to be used include detoxification efficiency, material effects, application difficulty, and equipment functional decrement. The product of the effort would be a matrix of each chemical agent resistant coating versus the established criteria. In addition, recommendations on new chemical agent resistant coatings will be made.

AF86-284 TITLE: Modern Training Model Concepts

DESCRIPTION: Much Air Force training rests on principles of learning as they were expounded half a century ago. These Thorndike-era principles were derived more from animal learning than from human learning, which makes them largely mechanistic in nature. Resulting training programs focus on objective aspects of learning and largely ignore the medicinal processes that underlie performance. Even so, training is usually fairly successful, but primarily because training developers and instructors go far beyond the mechanistic model of learning. The positive results obtained by instructors spring from their personal experience and intuition that a lot more goes on during kill acquisition than the purely observable behaviors that are the primary focus in current application of the Air Force Instruction System Design (ISD) process. With the present high level of interest in the Air Force regarding total training system design, an improved conceptual framework is needed to guide the use and design of aircrew training devices at all levels. Dr. William Spears (Seville Training Systems Corporation) recently completed a program with Naval Training and Equipment Center (MTEC) to develop a rationale for the design and use of part-test and lot-fidelity training devices (technical report). Cognitive and motor skills were analyzed in terms of modern information processing concepts to understand the mediational process involved in performance. The major purpose of this proposed effort would be to lay a foundation for the design of low-cost devices based on functional equivalence rather than on the more traditional concepts of fidelity. Within the context of emphasizing information processing/cognitive science approach, specific products would be:

a. Guidelines (in a handbook format) for designing training to make effective use of each level of training device in the context of an overall training system.

b. Feasibility assessment of further development for specific levels of training devices.

c. Recommendations concerning 1. research required to fill in gaps in knowledge, 2. changes in the Air Force ISD process to accommodate the newer developments referred by Dr. Spears in the TR referred above and 3. a potential demonstration of the concepts developed in this effort.

AF86-285 TITLE: Pilot Judgment Skills Test Battery

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace (USAFSAM) is seeking innovative research and/or engineering development of technology to measure judgment skills and to train for enhanced judgment skills. The target population is the superior military pilot of high performance aircraft. The resulting measurement battery must meet at least 90% specificity and sensitivity, to include demonstration that the cognitive functions being measured are unique to judgment skills, with little overlap with other cognitive skills such as information processing and decision making. The training package must have demonstrated utility (with a small number of subject), and must be amenable to implementation on a microprocessor having CRT display and keypad for responses. Required first generation software should be provided.

AF86-286 TITLE: Preprocessor for Theater Simulation Air Base Resources (TSAR) and Theater Simulation Air Base Resources Using Input for Ada (TSARINA) Logistics Models

DESCRIPTION: TASR and TASRINA are very detailed Monte Carlo logistics requirements insulation models written in FORTRAN 77. The data bases for these models are difficult to acquire and require many man/computer hours to digitize in form acceptable by the models. A need exists to develop user-friendly methods and procedures to build data bases for these models. The methods/preprocessors need to be developed for use on a VAX-compatible computer/microcomputer in the form of menu-driven, relational data bases to account for interrelationships in the models. The database must be capable of being updated and self documenting. In addition, menu driven command and communication routines are required to exercise these data bases on VAX 11/780 and NAS 7000 (IBM Compatible) mainframes. The command routines should facilitate editing and reiteration of the relational data bases for sensitivity and costing analysis.

AF86-287 TITLE: Graphic Post Processors for TSAR and Dyna-METRIC Logistics Models

DESCRIPTION: The TSAR and Dyna-METRIC models are being used to quantify wartime resource requirements and interactions throughout the logistics community. These models have a significant shortfall for users; both lack user definable graphical representation of output data. This graphical representation would significantly extend the management utility of the models and aid model analysis and interpretation. Both the TSAR and Dyna-METRIC models are no resident on the VAX 11/780 and NAS 7000 (IBM compatible) computers. Estimated effort would require model installation, user surveys, literature searches, software development, demonstration.

AF86-288 TITLE: Icing Monitoring Equipment

DESCRIPTION: The propulsion test units conduct simulated altitude testing of turbine engines with inlet air temperatures ranging down to –80 degree F. Ice formation on inlet ducting and engine components, with subsequent ingestion by the engine, is a potential hazard at these low temperatures. Instrumentation currently in use of warn of potential or actual icing conditions include pressure drop measurements across the inlet screen, air stream dew point temperature measurements and vibrating reed ice detectors installed directly in the engine inlet. Each of these instrument systems has limitations in either response, reliability or safety. Additional techniques are needed which will reliably provide a warning at the initial onset of icing. These techniques should operate at air stream

temperatures of –80 F to +40 F. The air flow velocities are form 0 to 600 FPS at pressures from 2 to 20 PSIA. Operations up to 1000 hours total in vibration environments to 10 g's peak from 20 to 2000 Hz without service are needed. Penetration holes (up to 3" diameter) in the metal ducting immediately in front of the engines are permissible. The engines are installed in an enclosed test cell with space around the inlet ducting limited to approximately 3 feet in all radial directions.

AF86-289 TITLE: Smoke Generator

DESCRIPTION: Flow visualization through the use of smoke injected into an air stream is required to map airflow patterns. Such mapping is needed to understand freejet nozzle flow, exhaust diffuser flow, and test cell secondary flow.

The smoke generator output must be sufficient to make a ½ in. diameter stream tube visible to the eye, TV cameras, and film cameras in a 150 ft/sec air stream operated at pressure levels from 14.7 to 35 psia. There should be no deposits as a result of smoke impingement. White smoke is most desirable, but colored smoke would also be acceptable. The smoke generator should be designed to provide periodic volumes of smoke for up to 30 seconds with 10 second delays between discharges, ad be capable of continuous discharges up to 5 minutes. The maximum distance the smoke would travel is 10 feet. While it is understood that smoke can be irritating to the eyes and lungs, the smoke should otherwise be harmless and easily filtered with common breathing air masks.

AF86-290 TITLE: Radiant Heating Augmentation System

DESCRIPTION: The requirement for simulation of high heating loads on aerodynamic vehicles has caused AEDC to pursue development of a radiant heating augmentation system for the Aerothermal Tunnel C (Mach = 4). The system should be capable of delivering heating rates in the range of 150 to 700 BTU/ft sec to a conical body of 20 inches in length and seven inches in base diameter for run times of one to three minutes. The heating distribution delivered by the system should be remotely variable along the body. The heater should be capable of operating in the highly turbulent back flow region of the Tunnel C Aerothermal test section and should provide shielding, insulation, etc. to protect the basic facility from the high thermal loads generated by the heater. Aerothermal Tunnel C has a 25 inch nozzle exit diameter supersonic freejet expanded in a 50 inch diameter test section.

AF86-291 TITLE: IR Target Simulator

DESCRIPTION: In IR sensors which are being developed for future surveillance satellites will be capable of cracking and discriminating many objects in their field of view. In order to provide a ground test capability which can simulate an infrared scene of moving objects, there is a reed to develop an IR scene generator. One concept is to provide a mosaic array of heater elements which can be selectively addressed. This could be viewed by the surveillance satellite and the tracks of targets could be programmed in the scene generator by sequentially addressing the appropriate heater elements. Because of the need for high resolution, the heater elements must be very small (less than 2mils) and closely spaced. Techniques for producing such heater arrays might be found in silicon chip etching and thin film sputter coating technology.

The objective of this project will be to develop the techniques for producing mosaic heater arrays whose elements can operate in the temperature range from 20 K to 600 K. The eventual goal being to provide a large fault free array (less than 10 to the sixth elements) of individually addressable heater elements.

AF86-292 TITLE: Boundary Layer Transition Detector

DESCRIPTION: A transition detection device is required whose output is easily interpreted ad minimal modification to model or flight vehicle is required for its installation. The ideal candidate is one wherein no cutting or drilling of the model surface is required so that one installation is good for all flow conditions. The presence of the device should not cause boundary layer transition, and the output should give a positive indication that the

boundary layer is laminar, transitional, or turbulent without requiring extensive expertise on the part of the user. If available, this device would be used extensively by companies and government agencies involved in wind tunnel and flight testing. These measurements are not made routinely at this time because of the high cost and questionable interpretation of the techniques currently available.

AF86-293 TITLE: Small Particle Generator Development

DESCRIPTION: AEDC has a requirement to develop a system which can generate small particles in the size range of 0.05 to 0.5 microns. Ideally the generator would generate mono disperse 0.1 micron particles. A narrow gaussian distribution would be acceptable. These particles would be introduced into wind tunnel flow, they would acquire the velocity equal to the air velocity surrounding them. These particles may be either solid or liquid. The particle rate of generation should approach an approximate order of magnitude of 10 particles per second or a material mass flow weight an approximate order of magnitude of 10 grams per second. Evaporation rates in high temperature air may become a factor for some liquids. The maximum air temperature where the liquid droplets would be utilized should be left to be determined as part of the development effort. Wind tunnel conditions with air temperatures as high as 1000 F are potentially useful where the dwell time for the particles would be of the order of 100 milliseconds or less. Liquid particles may be impossible to use at the higher temperatures in spite of the short dwell time.

Previous experience with seeders using solid particles of aluminum oxide and magnesium oxide has demonstrated that size distributions occur in a way that indicates particle agglomeration is a problem. Experience with liquid seeding using olive oil at AEDC is limited, however better results were obtained with liquid than with solid particles for high flow velocities.

AF86-294 TITLE: Technique for Local Oscillator Laser to Follow Frequency of Transmitter Laser Heterodyne Laser Light Detection and Ranging (LIDAR)

DESCRIPTION: Several heterodyne LIDAR systems use a laser tuned to a particular frequency, as a transmitter, to probe the atmosphere for chemical species. The laser energy is reflected back into a photovoltaic detector, where it is mixed with local oscillator laser radiation of a different frequency (on the order of a 50 megahertz (MHz) offset from the transmitting laser frequency) to generate an intermediate frequency (IF) for final signal processing.

Massachusetts Institute of Technology, Lincoln Laboratory (MIT-LL), has developed a carbon monoxide (CO) transmitter laser which can be rapidly tuned over the entire P-branch of the CO band (on the order of milliseconds (ms)). However, the local oscillator has not been able to change frequencies with the transmitter to give a stable IF.

The product desired is a technique to have a CO local oscillator laser which automatically tracks a CO-transmitting laser frequency as it is rapidly switched in frequency. The local oscillator laser may be a separate laser, or it can be part of the beam from the transmitter laser. The techniques must be demonstrated on at least a laboratory-bench scale. It must apply to LIDAR systems which use CO laser transmitters, such as the one developed by MIT-LL, or a commercially available laser which can (or can be modified to) change frequencies electronically on the order of milliseconds (ms). A successful technique will solve two problems that exist in current heterodyne LIDAR systems:

1. It will negate the need for two transmitters and two local oscillators for true dial capability.
2. The rapid tuning capability will increase the confidence level in identifying a single chemical species and could also provide a capability to identify multiple species in short measurement time (i.e., seconds).

AF86-295 TITLE: Equivalent Material Properties for Reinforced Concrete

DESCRIPTION: A requirement exists for developing equivalent material properties for reinforced concrete to be used in finite element analytical models. The research effort and approach will apply conservation of strain-energy theoretical concepts to reinforced concrete materials. An equivalent isotropic material model will be developed, using Young's modulus, Poisson's ratio, and the volume percentage of steel reinforcement. Their equivalent material properties will be used in finite element analytical models and compared with existing experimental results

from previous tests. These data can be supplied by the Air Force. The effort will include state-of-the-art assessment of applicable literature and research in this area.

AF86-296 TITLE: Dynamic Soil Analysis by Intergranular Association

DESCRIPTION: Dynamic soil analysis from vibrations, explosions, or earthquakes involves constitutive properties (i.e., stress-strain relationships) as inputs to analytical models. Existing constitutive properties are semi-equipped, at best, as one good technique now exists to develop dynamic constitutive properties. This effort will develop a soil dynamic response (i.e., deformations, consolidation, liquification, etc.) model based on intergranular movement during excitation, tracking each particle (or particles – i.e., grants of soil) during the dynamic period of interest. This technique has never been done, nor suggested in the literature.

AF86-297 TITLE: Biodegradation of Jet Fuel in Groundwater

DESCRIPTION: Shallow aquifers, typical of the military bases in coastal regions, have been contaminated by fuel spills and leaks from tank farms, pipelines, and service stations. Cleanup of these aquifers is required, and cost effective methods are sought. The objective of this research is to investigate the use of in situ biological treatment to clean up spill sites. Efforts should focus on development of methods used for evaluation of biological treatability of contaminated groundwater. An Air Force base with an identified spill site can be selected for aquifer material and groundwater collection to determine: 1. the contaminants – floating fuels or soluble components; 2. the microbial community present; and 3. the nutrient additions necessary for biological degradation of the contaminants. Small microcosm studies could be conducted to characterize the activity of the microbial community on the contaminants present. The end-product of this project should describe methods required for preliminary evaluation of contaminated sites for biological treatability.

AF86-298 TITLE: Surfacant Effects on Equilibrium Partitioning of Volatile Organic Contaminants (VOCs)

DESCRIPTION: The Air Force is investigating packed-tower aeration, plus other aeration technologies, to remove volatile organic contaminants (VOCs) from groundwater. The removal efficiency depends, in part, on the degree of air/water contact and the active surface area on the packing media for mass transfer. If he wetted part of the packing, the active area, could be increased by wetting agents, such as surfactants, the removal efficiency could be increased. However, since surfactants are surface-active, they may reduce mass transfer by limiting partitioning of selected VOCs under static (equilibrium) conditions in aqueous solutions. Some VOCs of interest are tetrachlorathylene, trichloroethylene, toluene, benzene, n-pentane, and tetraclorethane in concentrations of approximately 1 mg/L at ambient temperatures. These data on surfactant effects will help the Air Force determine if surfactant-enhanced aeration is feasible.

AF86-299 TITLE: Crack Growth in Cementitious and Asphaltic Materials

DESCRIPTION: Crack propagation in pavement systems is a major problem for the Air Force, because it increases maintenance and reduces durability. Fracture mechanics provides a means for determining the causes of failure in materials which have been subjected to below-design stresses. These failures begin with existing microscopic cracks in the material. As loads are applied, these become larger, propagating through the structure until fracture occurs. A basic model is needed to explain and predict crack growth. This model, based on projects of crack growth, will help suggest measures for preventing or mitigating such growth.

AF86-300 TITLE: Aeration Techniques for Removing Volatile Organic Contaminants

DESCRIPTION: The Air Force is investigating various aeration techniques, such as packed-tower air stripping, to remove VOCs from groundwater. While these devices are relatively effective, they suffer from several drawbacks: 1 inefficient use of packing media, where only a fraction of the packing's surface is wetted sufficiently for mass

transfer; 2 high-horsepower blowers to move large quantities of air through the packing and achieve intimate air/water contact; 3 very dilute exhaust streams which may require additional, expensive pollution controls, and 4 large buildings or towers which require considerable land area. The research objective is to suggest new, alternate, or innovative ideas on aeration techniques, technology, or procedures. These ideas should address minimizing energy usage while maximizing mass transfer (removal efficiency). Appropriate concepts include rearrangement of tower internals, redesign on existing hardware, or other new ideas in aeration techniques. These concepts should be bench-scale tested, using relatively volatile and nonvolatile organics, such as tetrachloroethylene and tetrachloroethane, to prove the concept of the idea, but not as performance demonstration. This study will aid the Air Force in investigating new aeration techniques, or modifying existing technologies to remove VOCs from ground waters.

AF86-301 TITLE: Infrared Inspection Method (NDI) for Flame Spray Coatings

DESCRIPTION: Aircraft engine Technical Orders call for specific coating acceptance on specific parts. Some may be more critical than others and may require extensive testing. Increasing cost sand quality requirements are causing timely part production to become more difficult. The objective of this topic is to develop an NDI (nondestructive inspection) method using infrared to eliminate costly destructive methods currently in use. Coating standards such as specified in T.O. 2-1-111, Section XIX, should be used. Defects are classified for percentage of porosity, excessive oxides, cracking, interface, bonding, and excessive grit particles.

AF86-302 TITLE: Metal Processing Using the ND:YAG Laser

DESCRIPTION: An opportunity exists to develop new applications that exploit the particular properties of the ND:YAG laser. These properties include focused energy application, non-contact processing, narrow kerf, minimal heat affected zone, rapid cutting of non-reflective materials, pin-point drilling, fusion welding, welding of dissimilar metals, and localized heat treating. Laboratory tests have shown that the unassisted ND:YAG laser has the capability to cut a hard, tough, high temperature resistant allow (Hastelloy-x) at the minimum rate of 12 inches per minute (IPM) compared with a 1 IPM cutting speed using conventional numerically controlled 3 axis milling machines. Additional productivity benefits result from the narrow kerf and reuse of the patches that have been cut out. The objective of this topic is to identify specific ND: YAG laser applications for cutting, drilling, welding, and localized heat treating of aeronautical components that require overhaul, to determine process parameters for the ND: YAG laser, and to analyze any residual effects of the laser.

AF86-303 TITLE: Robotics in Propeller Blade Grinding

DESCRIPTION: Procedures employed for current propeller blade grinding create a hazardous and unpleasant environment of aluminum dust, which permeates the surrounding work area. In addition, blades are too heavy to be handled by one man. The objective of this topic is the design and implementation of a mechanized system for grinding propeller blades in rework. Contour following, material removal, and smoothness are critical criteria.

AF86-304 TITLE: Electromagnetic Compatibility Versus Corrosion Control

DESCRIPTION: On many new weapon systems, good corrosion prevention techniques are being eliminated in favor of the ultimate in electrical conductivity between system components. EMI and EMP requirements are often cited as rationale for limiting the extent of corrosion protection. The objective of this topic is to establish a method to allow electromagnetic pulse (EMP) and electromagnetic interference (EMI) protective measures to coexist with corrosion prevention/control measures for aerospace equipment. EMI and EMP requirements need to be examined in order to determine realistic electrical conductivity requirements followed by the identification, evaluation, and optimization of corrosion prevention materials and processes that can coexist with these realistic EMI and EMP requirements.