Research and Technology Operating Plan SUMMARY

FISCAL YEAR 1975 RESEARCH AND TECHNOLOGY PROGRAM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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INTRODUCTION

This publication represents the NASA Research and Technology program for FY 1975. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Operating Plans) used for management review and control of research currently in progress throughout NASA. The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities. We believe also that this publication can help to expedite the technology transfer process.

The RTOP Summary is arranged in five sections. The first section contains citations and abstracts of the RTOPs. Following this section are four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

The Subject Index is an alphabetical listing of the main subject headings by which the RTOPs have been identified.

The Technical Monitor Index is an alphabetical listing of the names of individuals responsible for the RTOP.

The Responsible NASA Organization Index is an alphabetical listing of the NASA organizations which developed the RTOPs contained in the Journal.

The RTOP Number Index provides a cross-index from the RTOP number assigned by the NASA responsible organization to the corresponding accession number assigned sequentially to the RTOPs in RTOP Summary.

As indicated above, responsible technical monitors are listed on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contacts which might be disruptive to on-going research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the RTOP Summary would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration
Office of Aeronautics and Space Technology
Resources and Management Systems Division (RM)
Washington, D.C. 20546

Dr. Alan M. Lovelace
Associate Administrator for
Aeronautics and Space Technology
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The objectives of this research are to define and quantify those ride-environment properties, particularly motion and vibration, that determine ride quality and associated passenger acceptance pertaining to air transportation systems. Research studies are being conducted to develop data appropriate for establishing criteria for ride-environment requirements and for aircraft operational limits relevant to aircraft attitude, accelerations, and angular motions. Included are: field studies to obtain data aboard scheduled airline systems as well as other vehicles; studies under controlled conditions aboard research aircraft including in-flight simulators; laboratory studies using ride-motion simulators under very closely controlled conditions; and analytical studies of experimental data to model the phenomena and to develop criteria. Supporting efforts will be carried out as required to develop appropriate study methodology, subjective response opinion questionnaires, portable ride-measuring instruments, laboratory simulators, and analytical procedures.
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The objectives of this research are to define and quantify those ride-environment properties, particularly motion and vibration, that determine ride quality and associated passenger acceptance pertaining to air transportation systems. Research studies are being conducted to develop data appropriate for establishing criteria for ride-environment requirements and for aircraft operational limits relevant to aircraft attitude, accelerations, and angular motions. Included are: field studies to obtain data aboard scheduled airline systems as well as other vehicles; studies under controlled conditions aboard research aircraft including in-flight simulators; laboratory studies using ride-motion simulators under very closely controlled conditions; and analytical studies of experimental data to model the phenomena and to develop criteria. Supporting efforts will be carried out as required to develop appropriate study methodology, subjective response opinion questionnaires, portable ride-measuring instruments, laboratory simulators, and analytical procedures.
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and will provide flight data in new areas which are beyond
groundbase simulator capabilities. The effort is coordinated with
other Government agencies and industry for the purpose of having a
common basis and understanding from which ride quality
criteria may be established. Passenger responses to turbulence
encounters aboard commercial aircraft will be correlated with
aircraft motions and turbulence levels to permit mathematical
modeling.

W75-70006 504-09-31
Langley Research Center, Langley Station, Va.
FLIGHT MANAGEMENT SYSTEMS
G. B. Graves 804-827-3745
(768-81-01)
The objective of this research is to specify the crew
responsibilities, flight procedures, control, and display requirements
for advanced transport systems. The concerted effort underway
to improve the safety and efficiency of advanced transport systems
will require research in both hardware and human elements to
systematically carry out the above objective. Therefore, the present
work will take the following approaches: (1) develop tools and
techniques that will define the crew responsibilities and measure
their workload, (2) apply these tools and techniques to assess
current and contemplated flight systems, and (3) develop analytical
techniques that will assess advanced system requirements,
human operation, and predict cockpit displays and controls needed
for a satisfactory flight management system.

W75-70007 504-09-32
Ames Research Center, Moffett Field, Calif.
AIRCREW PERFORMANCE AND AVIATION SAFETY
H. P. Klein 415-965-5094
This program will investigate pilot training, and performance
measurement/evaluation problems, and will explore the
relationship between aircrew performance and the causation of
aviation accidents and incidents. General aviation and civil air
transport operations will be considered. Specific objectives are
to: (1) determine human factors involvement in air transport
critical incidents; (2) evaluate and compare shared and monitored
approach philosophies of air transport flight deck crew management;
(3) develop training technology for general aviation communica-
sions skills; and (4) develop technology for the measurement
and evaluation of pilot cognitive skills. A behavioral model for
use in analyzing and classifying pilot errors is currently being
developed at Ames. This model will be used to structure interview
techniques for collecting data from pilots and training personnel
about critical events in otherwise routine transport operations.
Objective performance data will be collected during standard
and monitored low visibility approaches in a transport simulator
flown by experienced airline crews. A part-task simulator for
training radio communications skills will be designed and evaluated
using general aviation student pilots. A GAT-1 simulator will be
modified to permit real time preformance measurement. Standard
mission scenarios will be used to study pilot cognitive behavior
in simulated and actual flight.

W75-70008 504-09-33
Ames Research Center, Moffett Field, Calif.
FLIGHT MANAGEMENT SYSTEMS - PILOT/SYSTEM INTERFACE AND PROCEDURES
H. P. Klein 415-965-5094
This program will investigate flight management and
crew/system interaction mechanisms and requirements for
advanced aircraft. The program will develop working specifications
for a fully integrated airborne flight system to be fabricated and
flight tested by the end of the decade. Special attention will be
given to safety, human factors, and full system simulation. The
objectives are to (1) determine system/pilot communication
requirements; (2) determine pilot-system communication requirements and device specifica-
tions for entering alphanumeric data and system commands; (3)
integrate the results of objectives 1 and 2 in the design of a
flight deck system for commercial transport application; and (4)
fabricate and flight test an integrated flight deck to demonstrate
operational utility. Full-flight integrated cockpit simulation is being
developed in the Ames Biotechnology Simulation Facility that
involves piloted full mission profiles from take-off to landing.
The simulation development is an in-house effort with some
contracts to provide necessary computer programming and
supportive studies as required. Evaluations will be made of the
effects of the pilot-system interface and cockpit environment on:
(1) the pilot's ability to be constantly apprised of past, present
and (predicted) future system status; (2) the pilot's ability to
monitor the system for exceeding performance tolerances or
system failures; and (3) the pilot's ability to make decisions and
execute them in an accurate and timely manner.

W75-70009 504-09-34
Flight Research Center, Edwards, Calif.
FLIGHT MANAGEMENT RESEARCH
W. R. Winter, M.D. 805-258-3311
This flight test program is primarily piggy back on other
flight research programs. Pilot taskload is analyzed and the
psychophysiological response of the aircrew is correlated with
total flight performance. The objectives of this program are: (1)
to evaluate aircrew performance by correlation of workload and
psychophysiological response with performance so that predictive
models can be formulated; (2) evaluate a high g seat configuration
in flight in a low g mode utilizing existing aircraft and evaluate
pilot performance; and (3) evaluate and compare performance
of the pilot utilizing a closed circuit TV display in the cockpit,
to his performance utilizing the same displays in a remotely
piloted vehicle.

W75-70010 504-09-41
Langley Research Center, Langley Station, Va.
FLIGHT SIMULATION TECHNOLOGY - SIMULATION TECHNIQUES
G. B. Graves 804-827-3745
The objective of this RTOP is to contribute to the technical
advancement of flight simulators as applied to aeronautical
research, development, and flight training. The approach of new
operational requirements for simulators to support Langley
Research Center programs provide the motivation and laboratory
environment for significant contributions to the advancement of
simulation technology. Interagency involvement with the applica-
tion of the differential maneuvering simulator also provides
valuable insights into the needs for improved simulator capability
for flight training and pilot proficiency, as well as for the support of
research programs. This RTOP will cover both in-house and
contractual studies which address current constraints in simulator
equipment, the formulation of simulation math models, and the
linkage of the two to provide effective simulations. Results of
the effort will be documented in NASA Technical Notes and
contractor reports and will be applied to simulations of interest to
Langley Research Center.

W75-70011 504-09-42
Ames Research Center, Moffett Field, Calif.
SIMULATION TECHNOLOGY FOR AERONAUTICS
H. P. Klein 415-965-5094
The objectives of this RTOP are to provide a scientific and
technical base of information that will allow the valid, reliable
and economic substitution of simulators for actual flight operations
in aeronautical research, development and crew training. Specific
objectives are: (1) provide an understanding of pilots' perception
and processing of complex visual, motion and auditory stimuli;
(2) provide evaluations and engineering development of computer
driven graphic displays, including full color systems, high contrast
CRT's and multiplanar displays, and (3) provide a simulated
ground station and develop and evaluate critical display concepts
for RPRV systems. During FY-75, (1) in-house pilot perception
objectives will be continued, (2) a specially CRT displays) for aircraft flight manage-
ment in the 1980's, and define the content, format, location,
function, and pilot procedures for such displays; (2) determine
pilot-system communication requirements and device specifica-
tions for entering alphanumeric data and system commands; (3)
integrate the results of objectives 1 and 2 in the design of a
flight deck system for commercial transport application; and (4)
fabricate and flight test an integrated flight deck to demonstrate

The objectives of this RTOP is to provide improved materials, both metallic and nonmetallic, for use in advanced air-breathing power plants, particularly for aeronautical applications. Materials are sought that offer improvement not only in technical performance but also in economy in terms of costs and life. The classes of materials to be investigated include directionally solidified eutectics, dispersion strengthened alloys, protective coatings, and ceramics. Property improvements are sought by basic changes in materials per se, e.g., alloy compositional changes, and by process changes applied to existing and new materials. Material improvements are judged by the usual relevant property measurements. In addition, highly promising materials are evaluated by exposure to simulated turbine engine environments. The ultimate materials evaluation for gas turbine engines is accomplished by engine testing of components fabricated from newly developed materials. In addition, efforts will be directed toward improving analytical techniques that are used to analyze and characterize these materials.

W75-70018  505-01-32
Ames Research Center, Moffett Field, Calif.
**FIRE-RETARDANT AND LASER COUNTERMEASURE MATERIALS FOR MILITARY PROGRAMS**
Dean R. Chapman  415-965-5065

The objectives of this research are: to apply state-of-the-art and advanced aerospace derived fire-retardant and laser resistant
materials and technology developed at NASA Ames to support current and future DOD survivability programs and other related military efforts where materials and material technology is required: to provide a database and technology for survivability. improvements in aircraft, aircraft ordnance, missiles, and surface vehicles; and to assist the military, when requested, in the actual survivability design of a specific system and to assist with the implementation of the design. Assistance will be provided the military to reduce the vulnerability of flight and missile systems when subjected to an induced fire environment and to provide laser hardened materials for selected applications. This capability achieved by active participation on survivability/vulnerability committees in the DOD Joint Technical Coordinating Group/ Aircraft Survivability (JTG/AS), by direct contract with specific survivability groups of each of the services, by developing advanced fire retardant materials, laser countermeasures materials, and fire related technology which will enhance the survivability of military systems. The development of advanced fire and laser ablation technology and its application will be coordinated with the respective military (DOD) agencies.

W75-70019 505-01-34
Lewis Research Center, Cleveland, Ohio.

COMPOSITES
R. H. Kemp 216-433-4000
(743-32-24)
The overall objective of this research is to develop fiber and laminate composite materials, structures, and components for various aeronautical propulsion applications. The higher mechanical properties and reduced weight of the composites in comparison to monolithic engineering materials make them particularly attractive for advanced aircraft designs such as fan blades, compressor blades, and wing and engine components such as fan and compressor blades, guide vanes, and sound suppressors. Recent efforts show that the application of composites to these components is highly cost-effective. Composites being considered include resin matrices reinforced with graphite, boron, Kevlar 49, and glass fibers. In addition, aluminum and titanium matrices reinforced with boron and SiC fiber are being studied. A new advanced composite resin-matrix composite material, polyphenylenequinoxalines to provide increased temperature capability over the conventional epoxy materials. In the metal matrix work, emphasis is placed on the development of processable polyimides and polybenzimidazoles to provide increased temperature capability over the conventional epoxy materials. In the metal matrix work, emphasis is placed on the development of fabrication processes and the improvements of impact resistance. A further objective of this research is to develop fire retardant polymers for use as matrix materials having low or no toxic combustion products.

W75-70020 505-01-34
Langley Research Center, Langley Station, Va.

COMPOSITES AND ADHESIVES
G. W. Brooks 804-827-2042

The objective is to develop new or improved lightweight polymeric, composite and metallic materials that have longer lifetimes, greater reliability and improved structural efficiency in aeronautical structures. The work will consist of research aimed at improvement of structural resins and adhesives through systematic variation in the polymer molecular structure, determination of behavior of new or advanced filamentary composite materials containing either resin or metal matrices, and improvement of new or improved fabrication methods for metal-matrix and resin-matrix composite materials. Research will also be directed at repair technology of composites including detection of flaws, determination of critical flaw sizes, development of appropriate repair procedures, and evaluation of the effectiveness of the repairs on composite repair procedures, and evaluation of the effectiveness of the repairs on composite behavior. Studies of interfacial reactions and diffusion processes in advanced metal-matrix composites with emphasis on degradation as a function of temperature, stress and environmental corrosion will also be made. These studies will help to identify new or advanced materials for aeronautical structural applications and will provide important data on the behavior, capabilities and limitation of such materials.

W75-70021 502-02-11
Langley Research Center, Langley Station, Va.

ADVANCED CONCEPTS FOR COMPOSITE STRUCTURES
G. W. Brooks 804-827-2042
(505-02-42)
The objectives are to find innovative ways to apply composite material to obtain higher performance in aerospace structures, and perform advanced studies and demonstrate performance by test. The approach taken was to continue studies to develop lightweight aircraft wing structures. Under a grant, MIT students are developing an integrated preliminary design system to optimize the performance of a light sailplane. The design of compression-resistant wing skins will be investigated. A horizontal stabilizer will be fabricated using a mold developed from an airfoil section already tested in a wind tunnel to verify its aerodynamic performance. Continues studies to develop composite ribbon material which will significantly enhance transverse stiffness and strength of composite laminates. An improved substrate for rectangular-shaped filaments will be studied and attempts to improve processing of silicon carbide filaments will be explored. Multiple ply unidirectional laminates will be fabricated with both resin and metal matrices. Elastic constants and failure strengths will be determined by test. Initiate studies of composite energy storage wheels useful for both aerospace and civil sector applications. Other configurations have indicated composites have high performance potential as energy storage devices. Efforts will be to perform tradeoff studies on advanced composite concepts such as spoked wheel, tension shell or isotensoid structures to determine most practical, reliable configuration. If funding permits, detail design effects such as dynamic stability and fail safe design techniques will be investigated and a demonstration vehicle will be constructed and tested.

W75-70022 505-02-12
Langley Research Center, Langley Station, Va.

HYPERSONIC VEHICLE STRUCTURES
G. W. Brooks 804-827-2042
R. H. Kemp 216-433-4000
(743-32-24)
Research and development is being carried out to establish a technology base from which the structures and thermal control systems for hypersonic vehicles can be developed. Included in the program are both experimental and analytical efforts on engine and airframe structure concepts which will withstand the rigors of extended and repeated use in a hypersonic environment. Research data obtained from experiments will be verified design and analysis methods, establish design guidelines, and provide guidance for future research efforts.

W75-70023 505-02-12
Flight Research Center, Edwards, Calif.

HYPERSONIC VEHICLE STRUCTURES TECHNOLOGY
Roger A. Fields 805-258-3311

The program will attempt to experimentally validate significant hypersonic-vehicle structural concepts and investigate flight-loads and stresses measuring techniques for these structural concepts as they apply to the HRA.

W75-70024 505-02-13
Langley Research Center, Langley Station, Va.

CIVIL AVIATION - CRASHWORTHINESS
G. W. Brooks 804-827-2042

This RTOP is the NASA portion of a joint FAA/NASA General Aviation Crashworthiness Program to provide the analyst or designer with a proven analytical methodology for prediction of collapse of a structure under crash conditions. To achieve this objective, analytical and experimental studies will be performed to define the basic mechanisms involved in crash behavior. This technology, coupled with research on improved energy dissipation concepts will be applied to current general aviation aircraft to evaluate potential improvements in survivability for specific crash envelopes. There are three major research in this program: full-scale crash simulation testing, nonlinear structural analyses necessary to predict total collapse of the vehicle, and evaluation of energy absorption concepts for specific component design. Both analytical and experimental methods will be used to develop expertise in these three areas. Analyses will include both simplified procedures for estimating energy absorption capabilities and more
complex computer programs for analysis of general airframe response. Under the crash program these analyses will be developed to provide the designer with methods for predicting accelerations, load, and displacement histories of collapsing structures. Full-scale tests of typical structures as well as tests on structural components will be used to verify the analyses and to demonstrate improved design concepts.

W75-70025 505-02-21
Langley Research Center, Langley Station, Va.

LOADS, AEROELASTICITY AND STRUCTURAL DYNAMICS
G. W. Brooks  804-827-2042

In order to predict flutter and other aeroelastic phenomena more accurately, research will be conducted to improve aeroelastic analysis methods, to provide accurate unsteady transonic aerodynamics, and to validate rotor dynamic analysis. The feasibility of increasing the Mach number range of the transonic dynamics tunnel will be explored. In order to improve and validate aeroelastic loads analysis programs, various load prediction techniques (including FLEXSTAB) will be evaluated and improved for integration into computer systems such as ATLAS and IPAD. In order to develop methods for predicting acoustic loads, structural response, and noise transmission through aircraft structures, methods for analyzing panel response with a thick boundary layer will be developed and compared with experiment. Noise transmission through aircraft structures will be studied.

W75-70026 505-02-21
Ames Research Center, Moffett Field, Calif.

LOADS, AEROELASTICITY, AND STRUCTURAL DYNAMICS
H. M. Drake  415-965-5880
(743-36-01; 766-72-02)

The objective of this research is to provide improved prediction methods and data that apply to several dynamic load and aeroelasticity problems involving aircraft. In the area of dynamic loads, investigations will be conducted to study the flow fields and pressure fluctuations within and in the vicinity of cavities (such as open ports and bomb bays), protuberances, and turrets on aircraft. Means of eliminating cavity resonances and alleviating high-intensity local dynamic loads will be sought. With respect to aeroelasticity, both analytical and experimental investigations will be conducted to develop and validate computational methods for prediction of panel flutter including the effects of the boundary layer. Improved methods for predicting aeroelastic loads will be incorporated in FLEXSTAB including gust loads and active control loads capability. Experimental investigations of unsteady pressures on oscillating semispan wings will be investigated at transonic speeds and studies will be conducted of the flutter and divergence of oblique wings.

W75-70027 505-02-22
Langley Research Center, Langley Station, Va.

DRONE FLIGHT PROGRAM
G. W. Brooks  804-827-2042

The objectives are to provide flight data for comparison with results from various prediction methods and for cases where analyses are known to be inadequate. Emphasis will be on measurements of transonic aerodynamic loads and flight demonstrations of active control systems for load alleviation and flutter suppression. Flight testing techniques will be developed using drone-type vehicles to gather the desired data. An aeroelastic research wing will be provided with its flutter boundary within the flight envelope when flown on a Firebee 2 vehicle. First flights will be aimed at measuring aerodynamic loads in the transonic range, then active control systems will be incorporated for flight assessments of their performance in alleviating loads and suppressing flutter. Flights will be made cooperatively with the Flight Research Center.

W75-70028 505-02-22
Flight Research Center, Edwards, Calif.

PROJECT DAST
Berwin M. Kock  805-258-3311
(505-06-44)

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Project DAST (Drones for Aerodynamics and Structural Testing) is a technology development program that will provide data that will lead to a better understanding of unsteady aerodynamic loads and flutter at transonic speeds. The program is a combined theoretical, wind-tunnel and flight-test activity and is a joint LaRC/FRC program. The flight-test activity is the subject of this RTOP. A supercritical wing will be installed on a Firebee 2. This wing will be at a platform representative of transport aircraft. The wing will be designed to be flutter critical within the normal flight envelope of the modified Firebee 2. A system will be installed to provide the necessary flutter damping. The vehicle will be instrumented to measure wing pressures, accelerations, and strains. The vehicle to be modified will be the Firebee 2 used in the capability development program currently underway at FRC.

W75-70029 505-02-23
Flight Research Center, Edwards, Calif.

FLIGHT LOADS MEASUREMENT TECHNIQUES
J. M. Jenkins  805-258-3311

The problem currently approached in this RTOP is to work toward a solution as to how to avoid the fatigue sensitive attachment problems resulting from spotwelding strain gages to titanium structures. Weldable strain gages possess the most advantageous high temperature attachment characteristics. The resources of this RTOP will be directed toward developing, under R and D contract, a method to accomplish a metal to metal attachment for weldable strain gage configurations on titanium structures.

W75-70030 505-02-24
Flight Research Center, Edwards, Calif.

FLIGHT RESEARCH OF A STRUCTURAL MODE CONTROL SYSTEM (SMCS, I.E. MODAL SUPPRESSION SYSTEM)
Jim M. McKay  805-258-3311

This RTOP is to: (1) investigate the improvements in total dynamic response of a flexible aircraft and the potential benefits to ride qualities, handling qualities, crew efficiency, and reduced dynamic loads on the primary structure; and (2) evaluate the effectiveness and performance of the SMCS which uses small aeroelastic surfaces at the vehicle nose to provide damping to the structural modes.

W75-70031 505-02-31
Langley Research Center, Langley Station, Va.

FATIGUE AND FRACTURE
G. W. Brooks  804-827-2042
(743-32-02)

The research is conducted through a combination of analytical development, experimentation, and supplementation of in-house work by contracts and grants. Some specific goals are to improve life prediction techniques, to devise ways to predict the residual strength of reinforced sheet structures, to develop nonlinear fracture mechanics methods for ductile structural materials, to verify techniques to compress test times for fatigue tests of heated structures, to improve ways to predict rates of crack growth in flawed structures, to establish the long-time fatigue behavior of composite materials, and to devise ways to apply reliability methods to aircraft structures where the number of structures tested is limited by cost. To the degree possible, the work anticipates the design problems and materials that will be encountered by advanced subsonic and supersonic aircraft, vertically- and short-take-off-and-landing aircraft.

W75-70032 505-02-41
Langley Research Center, Langley Station, Va.

COMPOSITE MATERIALS APPLICATION TO AIRCRAFT STRUCTURES
G. W. Brooks  804-827-2041
(505-01-31; 743-32-22; 766-74-01)

The objective is to conduct research on composite materials to resolve problems that may hinder their application, to develop the technology required for their utilization in future aircraft structures, and to establish confidence in the use of composites through longtime flight service of structural components on
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commercial transport aircraft and Army helicopters. The work consists of the following: (1) develop analytical methods to improve understanding of composite materials, evaluate behavior under various environmental conditions, develop concepts, fabrication, and nondestructive evaluation technology; (2) fabricate and test critical components to demonstrate performance; (3) conduct engineering studies to determine anelastic problems; (4) establish repair techniques for flawed or damaged structure; (5) develop applications to operational aircraft such as the CH-54B helicopter, B-737-L-1011, and DC-10 commercial transports; and (6) determine maintenance experience with flight service applications. Both in-house and under contract will be undertaken. The results of these studies will provide new technical information and flight-service experience that will develop confidence required to permit early application of filamentary composites in aircraft structures.

**W75-70033**

505-02-42

Langley Research Center, Langley Station, Va.

**DESIGN TECHNOLOGY FOR COMPOSITE STRUCTURES**

G. W. Brooks 804-827-2042

(505-02-11)

The objective is to develop base technology necessary to confidently design composite structural components. Develops methods of predicting the strength of composite components. The approach taken was to advance methods of predicting the strength and stability of laminates, panels and stiffened components will be applied to new test data. Analysis will be applied to define the limitations of conventional test methods, and to develop more satisfactory test methods. Development of a strong in-house program for design and test of aircraft components will be continued. Designs for wing compression covers will be developed using advanced methods. A large series of graphite panels with either open or closed sections will be designed, fabricated and tested in the LaRC Structures Laboratory. Effort will include industry-developed as well as NASA-developed designs. Data will be generated over a large range of loading to provide a substantial NACA-type data bank upon which to base designs. A parallel program for wing shear webs will be continued. Optimum design curves will be developed over a wide loading range for both sandwich and stiffened shear web designs. Maximum strength of large graphite webs will be determined in a series of tests at Langley. A design for a 4' by 8' composite aileron will be developed for the L-1011 aircraft. Aileron will be of sandwich construction with design goal of being lighter than the metal flight structure, yet cost competitive with it. Subject to NASA approval, a successful design could be a candidate for flight service on five commercial aircraft. To support this effort, in-house evaluations of the resistance of composite sandwiches to low-velocity impact will be continued. Effort this year will be focused in determining the residual strength of impact-damaged sandwiches.

**W75-70034**

505-02-51

Langley Research Center, Langley Station, Va.

**STRUCTURAL ANALYSIS AND DESIGN METHODS**

G. W. Brooks 804-827-2042

The objective was to advance state-of-the-art for the analysis and design of aerospace structures by developing new or refined analysis techniques. Perform theoretical and experimental studies to demonstrate the effectiveness of new methods. Apply advanced analysis to generate meaningful design curves. Develop rapid methods of sizing structural components to meet multiple load conditions and aeroelastic constraints. The approach taken was to continue support of development of advanced computerized analysis of shell-of-revolution structures using methods which are foolproof in requirements for user skills because of the use of integration (the 'field' method) for solutions rather than more numerically uncontrolled algebraic solutions. Continue support and improvement of analysis tools which determine linear/nonlinear stress behavior and vibration characteristics of two-dimensional shell structures to critical aeroelastic problems as required. Conduct theoretical and experimental studies of stability of shells with cutouts to validate analysis and provide data to guide studies of complex configurations. Study effects of imperfections in shell structures to generate more rational design procedures. Continue development of methodology to permit more effective use of computer-aided techniques for structural design. Perform basic studies of structural synthesis methods to develop more efficient search techniques to identify optimum designs. Investigate applications and modifications of analysis/design codes such as SPAR and ATLAS to help define best techniques for functional design codes.

**W75-70035**

505-03-11

Langley Research Center, Langley Station, Va.

**BASIC NOISE RESEARCH**

G. W. Brooks 804-827-2042

(505-10-26: 505-06-23)

The objective of this research is to provide a data and technology base for reducing aircraft propulsion generated noise with minimum weight performance and economic penalties. Included in this objective is the location of sound sources in flow fields tracing the emission paths, through refraction, propagation, and scattering, the improved efficiency of acoustic suppression materials and treatment technology, the design of low noise propellers for general aviation aircraft, and the development of a unified data acquisition system. Both theoretical and experimental studies are involved and work will be accomplished in-house and under contract. Emphasis is placed on substantially improving analytical and experimental methods as well as equipment and facilities for subsonic and supersonic jet noise research; work will continue on optimum jet exhaust noise suppressor designs. The effects of the atmosphere on noise propagation will be studied using a high instrumented tower. This work will also include precision measurements and calculations of the sound fields inside finite ducts with inlets with varying cross sectional areas, and with and without acoustic treatment materials. Results of in-house analytical duct propagation and radiation studies, acoustic measurements in the ANRL test duct, and of contract and grant study programs will be inputs to the development of a program for predicting the acoustic performance of engine flow ducts. Noise and performance measurements of a shrouded propeller design will be conducted in the Full-Scale Tunnel. Studies will also be undertaken to evaluate the influence of forward flight on propeller noise with a turboprop short-haul airplane.

**W75-70036**

505-03-11

Lewis Research Center, Cleveland, Ohio.

**BASIC NOISE RESEARCH**

E. W. Conrad 216-433-6886

(505-15-18: 505-03-12)

This RTO covers work directed toward understanding the basic principles and phenomena involved in the generation, propagation and suppression of turbomachinery, jet, jet-surface interaction, and core noise. The work combines in-house analytical and experimental studies with a number of university type grants and contracts to form a coordinated basic noise research program that is structured to permit aeroacoustic specialists to carry out investigations of several years duration, if appropriate. The work is directed toward providing a broad base of understanding and knowledge of the various noise areas through fundamental, analytical and experimental studies. This foundation will provide a fundamental base for reducing aircraft propulsion generated noise with minimum weight, performance, and economic penalties.

**W75-70037**

505-03-11

Ames Research Center, Moffett Field, Calif.

**BASIC NOISE RESEARCH**

H. M. Drake 415-985-5851

(505-06-23)

This research is directed at improving the understanding of the fundamentals of aerodynamic noise generation and propagation. The primary objective is to develop improved and/or new methods of predicting noise generated in jet exhausts and noise propagation through and around aircraft. The research will involve both analytical and experimental studies of aerodynamic noise generation in propulsion systems. The research on noise generating mechanisms in jet flows will include
detailed studies of hot and cold jets, combustion and core noise, and noise suppression effects of swirling flows and advanced mixer suppressor nozzles. The acoustics of aircraft engine duct systems are being investigated to establish practical high Mach number throat inlet design concepts. Computer algorithms, which were developed for predicting the propagation of plane waves in variable area ducts with general area and velocity distributions are being extended to include the effects of spinning modes, duct liners, and finite duct lengths. To assess the effect of the atmosphere on the propagation of aircraft noise, a theoretical effort is being conducted on wave propagation in a turbulent medium. The relative importance of the coherent and incoherent wave due to the presence of a simulated aircraft noise field propagating through the real atmosphere will be investigated. The results of the analytical study will be compared with selected small scale experiments.

W75-70038  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

BASIC NOISE RESEARCH
R. R. McDonald 213-354-6186

The general objectives of this RTOP are (1) to characterize the fluctuating quantities and obtain a relationship between the fluctuations and the density and frequency spectrum of the noise radiated from jets, (2) to find methods of reducing jet noise by controlling the shear noise sources, and (3) to determine how core flow disturbances increase the radiated noise from jets with the ultimate goal of developing efficient means of reducing jet noise emission by reducing core flow disturbances. Experimental measurements of the perceptible noise level are made with pairs of microphones at several locations in the surroundings of high temperature jets emerging from a nozzle. Crossed laser beams, set up as a schlieren system, are projected through the jet and probes are used to acquire information that characterizes the fluctuating density and pressure. The relationship between the fluctuating density and the noise is established from the respective autocorrelation functions. The tests are conducted in an anechoic chamber. The following major effects of core flow disturbances on the generation of noise radiated from a supersonic jet will be examined: (1) the oscillation of the inviscid jet boundary and Mach wave structure, (2) the effect on the mixing layer structure (particularly large scale eddies), (3) shock wave oscillation, and (4) entropy fluctuation interactions.

Available theories will be examined with particular attention focused on scaling properties of the different disturbance-noise interaction processes. The distribution of information to be studied include oscillating pressure, composition, and temperature.

W75-70039  
Lewis Research Center, Cleveland, Ohio.

NOISE TECHNOLOGY
E. W. Conrad 216-433-6369

The objective of this research is to provide data and a technology base directed toward improved understanding of noise generation mechanisms and improved correlation and prediction techniques for reducing aircraft propulsion noise with minimum weight, performance and economic penalties. Research is performed on fan, core and combustion noise generation and its suppression and shielding. Fan noise research will be conducted in the six-foot fan acoustic test room and in W-2 as well as by contract. Several acoustic parameters (such as reduced fluctuating stator lift, reduction of mpt's in transonic and supersonic fans by means of shock swallowing and shockless rotor blades reduced rotor stator interaction, and boundary layer bleed) will be evaluated. Combustion noise research will be conducted to determine internal and far field noise spectra. Jet noise generation and methods of shielding jet noise will be examined. Forward velocity effects on STOL engine-over-the-wing configurations will be evaluated. Fly-over acoustic tests will be conducted for three sound suppression nozzle configurations. New ideas for noise generation mechanisms, reduction, suppression, and measurement will be investigated and improved correlation and prediction techniques will be established. Sonic and hybrid inlets will be studied and evaluated experimentally to optimize noise reductions with regard to performance losses, operational limitations imposed, and system economics as effected by weight, complexity, reliability and maintenance.

W75-70040  
Ames Research Center, Moffett Field, Calif.

BASIC NOISE TECHNOLOGY
B. H. Wick 415-965-5036

(505-10-12)

The RTOP covers acoustic and performance research on lift fan propulsion systems. Lift fan propulsion systems require special consideration because of the desirability of limiting depth and weight which restricts acoustic treatment. In addition the fans operate in severe distortion which affects performance and increases noise. For the former difficulty, detailed knowledge of noise sources in lift fan turbomachinery are required. For the latter, detailed integration studies are required. The program proposed for FY 1975 continues the studies to understand lift fan noise sources. This includes a continuation of analytical studies, the fabrication of experimental gear to isolate the noise caused by the hub supports and the tip turbine, a theoretical and experimental study of inlet turbulence and the effect of inlet shape, and an experimental investigation of the noise of a VTOL jet directed perpendicular to the free stream flow.

W75-70041  
Flight Research Center, Edwards, Calif.

PROPULSION NOISE REDUCTION
T. W. Putnam 805-258-3311

The technical objective is to investigate by means of full-scale flight and ground tests the noise generated by various aircraft, and propulsion systems. The various noise sources are to be identified, and in addition, the effects of shielding ground proximity and atmospheric conditions on the noise spectra received at a given position relative to the noise source will be determined. The noise of various aircraft for static conditions, during takeoffs, landings, and flybys will be measured at ground stations.

W75-70042  
Lewis Research Center, Cleveland, Ohio.

NOISE FOOTPRINT PREDICTION
M. F. Valerino 216-433-6280

Based on theoretical and experimental knowledge of aircraft component source noise and noise propagation, first-generation noise prediction models are formulated for incorporation into the forthcoming NASA Aircraft Noise Prediction Program being developed at Langley Research Center for noise footprint prediction. The specific aircraft noise areas of major technical effort are: Fan/Compressor, Turbine, Jet, Flap, Combustion, Duct Acoustics, and Shielding/Reflection. The noise prediction models are formally documented as NASA publications. Those research areas critical to the improvement of noise prediction are identified and specific research programs to obtain the improvements are suggested. The work is structured to permit convenient validation, improvement and updating of the prediction models as additional information is developed.

W75-70043  
Langley Research Center, Langley Station, Va.

NOISE FOOTPRINT PREDICTION
G. W. Brooks 804-827-2042

The objective of this work is to develop and verify an integrated, state-of-the-art Aircraft Noise Prediction Program (ANOPP). A wide range of activities will be undertaken to assure that the most advanced, yet widely accepted, prediction methods are implemented. The areas of flyover noise measurement noise data reduction techniques, airport and aircraft operating procedures, data base maintenance, component noise sources and source noise modeling, shielding, reflection, propagation, and computer sciences will be continuously reviewed and updated.

W75-70044  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

BASIC POLLUTION RESEARCH
R. R. McDonald 213-354-6186

In part I, photochemical processes related to pollution of the upper atmosphere by high-flying aircraft are being studied,
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with emphasis on the effects of such pollutants on the stability of the ozone layer. The work is experimental in nature and involves laboratory measurement of steady state ozone concentrations under simulated stratospheric conditions. Relationships between stratospheric pollution and urban air pollution are being studied, with the objective of formulating a unified model of photochemical pollution applicable to all regions of the atmosphere. In part II, the specific objective is to study, model and analyze the particle size spectrum and spatial distribution in a jet contrail. The effort consists of several sub-tasks which encompass a review of current related work, theoretical analysis and modeling, computer programming and simulation, and comparison with available experimental data. On completion, a final report and a computer program and its documentation will be made available.

W75-70045
Langley Research Center, Langley Station, Va.

BASIC POLLUTION RESEARCH
E. S. Love 804-827-2893

The objective of this work is to investigate the effect of combustion kinetics, temperature, pressure, mixing, and nature of the fuel on the production of gaseous and particulate pollutants in hydrocarbon-air combustion systems. The results of these studies will be used to assemble more reliable chemical kinetic schemes for describing hydrocarbon combustion and predicting pollutant formation (NOx and soot) in gas turbine combustors. These studies will be made using laboratory flame burners, a chemical shock tube, and a jet-stirred combustor.

W75-70046
Lewis Research Center, Cleveland, Ohio.

EXHAUST EMISSION POLLUTION REDUCTION
R. A. Rudey 216-433-4000
(743-34-21)

The objective is to develop, evaluate, and demonstrate the technology required to reduce modern gas turbine aircraft engine exhaust emission pollutants to levels complying with current and future environmental air quality standards with minimum adverse effects on performance, weight and complexity. Various techniques for reducing pollutant emissions are being investigated both in-house and under contract in full scale combustor rigs, combustor segment rigs, and basic flame-tube type rigs. Four major multi-phased contract efforts are being used to develop and demonstrate, in modern aircraft engines, advanced combustor concepts that are aimed at reducing the pollutant emissions to levels equal to or less than those established by the EPA for engines manufactured after 1979. These programs do or will include candidates engines from all designated classes covered by the EPA standards for civil aviation aircraft. In-house and contract efforts to explore high pressure-high temperature advanced combustor designs, fundamental modeling and combustion pollutant formation studies, identification of odors, and non-invasive measurement techniques are also being conducted.

W75-70047
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GAS TURBINE ENGINE POLLUTION REDUCTION TECHNOLOGY
R. R. McDonald 213-354-6186

New (unconventional) combustor design concepts for application to aircraft gas turbines are being evaluated for their potential for providing significantly reduced pollutant emissions. Reducing oxides of nitrogen while maintaining efficiency and combustion is emphasized. The central conceptual approach is to minimize NO formation rates by reducing flame temperature and by promoting off-stoichiometric burning. The primary objective for FY-75 is to complete an experimental evaluation of the potential of H2-enriched, JP fuel-air mixtures to provide for very lean combustion, hence, significantly reduced NOx emissions. A secondary objective is to commence exploratory experiments on the feasibility of incorporating a H2 generator as an integral part of the combustor.

W75-70048
Langley Research Center, Langley Station, Va.

EXHAUST EMISSION REDUCTION-INTERMITTENT COMBUSTION AIRCRAFT ENGINES
E. E. Kempke 216-433-4000
(770-54-02)

The overall objective of this program is to establish and demonstrate the technology necessary to safely reduce general aviation intermittent combustion engine exhaust emissions and noise to meet EPA/FAA 1979-1980 standards with minimum adverse on cost, weight, and fuel economy. With the advent of more restrictive standards on the pollutant emission and noise of aircraft piston engines and the drive to conserve our natural resources, there is a need to determine and develop better ways of handling the diverse but related areas. A comprehensive program comprising contract work by the primary engine manufacturers as well as a Lewis Research Center in-house technology effort has been established. Work performed under contract to the engine manufacturers will be directed to establish near term solutions while in-house work will concentrate on longer term solutions such as alternative engines and concepts requiring additional technology.

W75-70049
Lewis Research Center, Cleveland, Ohio.

INTERACTIONS OF EXHAUST EMISSIONS WITH ATMOSPHERE
R. A. Rudey 216-433-4000
(505-03-32)

The concentration of various particulate and gaseous pollutants in the region of the atmosphere between 20,000 and 40,000 feet will be measured by employing sampling devices on 747 commercial air transports. These measurements will be used to establish baseline data on the contaminants in the atmosphere in order to deduce the contribution of jet aircraft to atmospheric pollution, and basic studies will be conducted to develop and better understand the factors involved in the formation and dispersion of jet engine pollutants. This information may then be used to determine the necessary steps required to reduce pollution by jet aircraft. Components to be measured include carbon dioxide, carbon monoxide, oxides of nitrogen, oxides of sulphur, ozone, water vapor, and total particulates.

W75-70050
Ames Research Center, Moffett Field, Calif.

ATMOSPHERIC EMISSION INTERACTION
D. R. Chapman 415-965-5065

The objective of this research is to provide basic models of jet aircraft engine pollution and wakes for use in the assessment of the impact on the atmosphere engine pollution and wakes for use in the assessment of the impact on the atmosphere of jet-powered aircraft operations. The models will be used to support the Stratospheric Jet Wake Experiment and will, in turn, be modified by the experimental data obtained in that flight experiment. Production of pollutants from jet aircraft engines is being studied by computer modeling the chemically reacting flow through the engine, and the subsequent dispersion and chemistry in the wake. Hydrodynamic dispersion models of the wake will be combined with the chemical models to describe the concentrations and distributions of exhaust products within the wake for long distances behind the aircraft. Sets of chemical reactions with appropriate reaction rates are being provided to the chemical models. Because basic equation sets have already been developed and integrated into the model, special emphasis is now being applied to organic reactions and their rates which may influence exhaust chemistry. The models will be used to describe the chemistry and wake dynamics of the YF-12 aircraft in support of the Stratospheric Jet Wake Experiment.

W75-70051
Langley Research Center, Langley Station, Va.

ATMOSPHERIC EMISSION INTERACTION
E. S. Love 804-827-2893

The objectives of this work are as follows: (1) to resolve questions pertinent to the formation of HNO3 in the stratosphere due to wake chemistry and dynamics; (2) to investigate the role of water vapor emitted by aircraft on temperatures and chemistry within the aircraft wake region or flight corridor and
to determine the role of water vapor in the formation of HN03, and (3) to systematically investigate the scattering properties of aerosol layers associated with the lower stratosphere. An investigation of the formation of HN03, and the role of water vapor in this formation, and on the temperature structure of the flight corridor, will be carried out. Use will be made of existing submodels developed at LaRC for the thermal code, at the Aeronautical Research Associates of Princeton, Inc. (ARAP) for the wake submodel, and at Aerospace Corporation for a 2-D Transport code. With these codes, the required parametric studies will be carried out. The properties of the stratospheric aerosol layers will be determined by systematic experiments conducted with the LaRC 48-inch LIDAR, by comparison of experimentally measured backscatter functions with accepted aerosol models, and with the aid of experimental measurements of depolarization.

W75-70052
Langley Research Center, Langley Station, Va.

INLETS AND NOZZLES
R. E. Bower 804-827-3285

Studies of locations of the engine power plant in various positions on the airframe will be conducted in order to achieve better integration with the airframe and to exploit any favorable jet interference effects which may enhance the wing lift performance efficiency or permit vectoring of the jet exhaust to improve performance and control of the aircraft. For the exhaust nozzle, investigations will be made to determine a means of improving the internal and external performance of both uninstalled and installed nozzles and to explore the integration procedures for incorporating the exhaust system into the fuselage or pods. General experimental and theoretical research studies will be conducted to improve the understanding of the flow phenomena associated with boattail/jet/empennage interference. Experimental research on axisymmetric nacelles and rectangular inlets will be conducted for correlation with analytical results and design procedures will be developed from this information.

W75-70053
Ames Research Center, Moffett Field, Calif.

INLET TECHNOLOGY
Hubert M. Drake 415-965-6116
(505-06-14; 505-06-11)

The objective of this research is to provide information needed in the design and operation of efficient air induction systems for subsonic and supersonic aircraft. The specific areas receiving attention are: (1) a general understanding of basic flow problems encountered (flow fields at inlet entrance, boundary layer growth, interaction with shocks, separation, bleed etc.) and derivation of mathematical design procedures; (2) more detailed studies of two general classes of inlets, two-dimensional and axisymmetric; (3) continuous up-dating of available computer programs derived to aid in inlet design; and (4) flow distortion and fluctuations at the compressor face to define those characteristics of the inlet flow distortion that affect engine operation and correlate them with engine stall margin. The research studies are both analytical and experimental, and involve in-house, grant, and contract efforts.

W75-70054
Lewis Research Center, Cleveland, Ohio.

INLET AND NOZZLE TECHNOLOGY
D. N. Bowditch 216-433-4000

Improved analytical and experimental design methodology for inlets and nozzles will be generated to achieve higher performance with increased propulsion system stability. These results will minimize future development effort and cost of advanced civil and military aircraft. Computer analysis programs for predicting both internal and external flows will be synthesized inhouse and by contracts and grants. These programs will make it possible to analyze combined viscous and inviscid flows and, in some cases, three-dimensional flows. A matrix of inlets and nozzles will be tested for comparison with theory and to provide design trade information for optimization of aircraft configurations. The compatibility of the inlet and nozzle with the turbine engine and airframe will be investigated to develop inlet-engine-nozzle compatibility methodology. Experimental testing will take place in 10x10, 8x6, on the F106 aircraft and in a static thrust stand, CE22.

W75-70055
Lewis Research Center, Cleveland, Ohio.

FAN AND COMPRESSOR TECHNOLOGY
M. J. Hartmann 216-433-4000
(724-12-01)

Approaches to improve efficiency, operating range, distortion tolerance, durability, and reliability, and to reduce weight, volume, and cost of the wide variety of fans and compressors required for advanced propulsion systems will be investigated. Analytical methods to improve accuracy of performance prediction to reduce the time, cost and risk of incorporating advanced fans and compressors into future engine development programs will be developed and compared to experimental data obtained in advanced single and multistage compressors. Both in-house and contract efforts are required. The major program thrusts are to: (1) extend fan stage pressure ratio; (2) improve fan performance with low noise design and devices; (3) improve distortion performance; (4) evolve design/analytical/evaluation method; (5) determine matching requirement of high pressure stages; (6) extend core stage pressure ratio; and (7) improve performance of small centrifugal compressors.

W75-70056
Lewis Research Center, Cleveland, Ohio.

TURBINE TECHNOLOGY
D. Poferl 216-433-4000

The turbine program includes research on turbine aerodynamics, turbine cooling and turbine life. Each of these areas are inter-related, and it is not practical to conduct research in one area without consideration of the other areas will be affected. Advanced cooling schemes for very high gas temperature operation will require increased use of film cooling. The effects of this and other types of cooling air discharge are being investigated from the standpoints of heat transfer, aerodynamics, and blade life. Heat transfer, fluid flow, aerodynamics, and life investigations are underway for a variety of convection and film configurations for turbine sizes ranging from those for helicopter engines to high spool turbines for turbofan engines. Fundamental heat transfer investigations on film cooling are also continuing. Turbine cooling problems become much more severe at the very high heat fluxes that are encountered with turbine inlet temperatures in excess of 3000 F, and high gas pressures encountered with compressor pressure ratios in the range from 30 to 40. Design and fabrication of a turbine rig to investigate the heat transfer and structural problems encountered with these high temperature, high pressure turbines is being accomplished using Coff funds. In addition, investigations are being made on multi-stage turbines with work factors from 3 to 5 for application to high bypass ratio lift or cruise engines.

W75-70057
Lewis Research Center, Cleveland, Ohio.

COMBUSTION AND AUGMENTATION SYSTEMS TECHNOLOGY
R. A. Rudy 216-433-4000
(505-03-32)

The objective is to establish the technology necessary for combustors and augmentors to achieve high performance and good durability at operating conditions typical of advanced commercial and military gas turbine engines. A swirl-can combustor is being developed for use in the High Pressure Facility (HPF) both as a heat source combustor for the turbine rig and also as a research combustor. A variety of new combustor concepts will be investigated; first in a rig at low pressure, then further refined in design and tested as full annular designs in ECRL-1 at pressures up to 120 psig, and finally tested in HPF at pressures up to 580 psig. This effort will be supported by research on liner film-cooling, jet penetration and mixing, fuel injection, vaporization and premixing and various diffuser and cold flow model tests. Several designs of small combustors of the reverse flow and axial flow types will be designed and tested for performance and emission characteristics. An augmentor program will study ways of improving augmentor performance.
of turboprop engines by investigating a variety of new design approaches.

W75-70058 505-04-41
Lewis Research Center, Cleveland, Ohio.

DRIVE SYSTEM MECHANICAL COMPONENTS TECHNOLOGY
W. J. Anderson 216-433-4000
(506-16-22)

The objectives of this work are to advance the technology for bearings, seals, gears, shafts, lubricants, and lubrication systems to achieve increased effectiveness, life, reliability, efficiency, and low weight in the high temperature, high pressure, and high speed environments of gas turbine engines, and mechanical power transmission systems. Basic materials, development, design theory, analysis and experimentation will be performed for extreme conditions with lubricants, lubrication systems, component materials and component designs for bearings and seals of advanced aircraft turbine engines to achieve efficient performance, reliability and extended life. Materials, fabrication techniques, designs and lubrication techniques for gearing will be developed. Analytic techniques for balancing, determining and controlling the dynamic behavior of shafts and rotors will be developed and corroborated experimentally to provide better design tools for high speed turbomachinery, shifting and transmissions. New transmission concepts will be developed.

W75-70059 505-05-11
Flight Research Center, Edwards, Calif.

DYNAMIC BEHAVIOR AND CONTROL TECHNOLOGY
Wenhed D. Painter 805-258-3311

The objective of this effort is to flight test an integrated propulsion control system (IPCS) on an F-111E airplane. The IPCS program objectives are to: (1) demonstrate the control of a state-of-the-art propulsion system using a digital computer and associated interface equipment; (2) evaluate the improvement in steady-state and transient propulsion system performance due to IPCS; and (3) evaluate the changes in compatibility between the engine and inlet. (Staff margin change): This is a joint USAF/NASA program in accordance with the Memorandum of Understanding dated 6 September 1972. The IPCS will be designed and fabricated by the Boeing Company under a contract from the USAF. Engine tests will be conducted by NASA Lewis Research Center with flight tests at FRC in October 1975. A baseline flight test program to define the performance of the standard F-111 propulsion system is planned for July 1974.

W75-70060 505-05-11
Lewis Research Center, Cleveland, Ohio.

DYNAMIC BEHAVIOR AND CONTROL TECHNOLOGY
D. I. Drain 216-433-4000

The objective is to improve the understanding and prediction of propulsion system dynamics behavior so that it can be controlled at its maximum performance and yet be able to accommodate sudden and unexpected disturbances safely and reliably. The approach is to apply the methods of dynamic analysis and simulation to establish the characteristics of airbreathing propulsion systems. Control theories and concepts will be developed and applied to achieve improved performance and operation of the system. Special control hardware, such as servos, instruments, and actuators, will be developed as required. Experiments with components and complete systems will be performed to validate the methods and concepts developed for propulsion system control.

W75-70061 505-05-21
Lewis Research Center, Cleveland, Ohio.

ENGINE TECHNOLOGY
J. Povolny 216-433-6624
(505-04-31; 505-04-11)

The objective is to conduct research subprograms on the latest advanced subsonic and supersonic military and civil engines with the emphasis on increasing the understanding and technology base of the various technical disciplines involved so that designers can better predict the performance of advanced or modified engines and components. Particular emphasis will be placed on seeking an understanding and solution of the dynamic interaction problems associated with propulsion systems. The subprograms will include considerations of investigations in the areas of aeromechanical instability, fan-compressor system performance, inlet distortion and component (including inlet) interactions, engine control dynamics, and the performance and characteristics of the various other components. This program is primarily concerned with those technical areas which are causing the most problems, or where there is the most discrepancy between theory and prediction and actual performance. Engines currently included in this program are the NASA Quiet Engine, J-58, J-85, F-100, and JTBD Refan.

W75-70062 505-05-22
Lewis Research Center, Cleveland, Ohio.

V/STOL ENGINE TECHNOLOGY
Raymond J. Rulis 216-433-4000
(738-13-01)

The objective of this RTOP is to advance the technology of engine systems required for future STOL and VTOL aircraft. In particular to develop improved understanding and solutions to the problems associated with the integration of the engine into the aircraft system. In addition, to provide the technology base for engine components, inlet and exhaust systems, that is unique to and required by STOL and VTOL aircraft systems. Particular emphasis will be placed on developing the technology which will satisfy the stringent acoustic goals proposed for these aircraft systems. The desired technology base will be brought forth through component development and test programs of components; engines; and engine, nacelle, and wing systems as required.

W75-70063 505-05-23
Lewis Research Center, Cleveland, Ohio.

QUIET, CLEAN GENERAL AVIATION TURBOFAN
E. William Conrad 216-433-4000

This RTOP is to cover Lewis activities in preparation for the initiation of the Quiet General Aviation Turbofan (QCGAT) program currently being proposed as a new start for 1976, to meet future environmental requirements with economic viability and low fuel consumption. Principle activities will include two study contracts to manufacturers of small turbofan engines to provide information to NASA required for program initiation. Such information includes (1) suitable engine quieting through application of technology derived for large engine programs, (2) application of clean combustor technology to reduce emissions of these small engines, (3) consideration of other factors involved in improving the applicability of small turbofans to the general aviation field (reduced cost, airplane safety, etc.) and (4) formulation of project programs directed at achieving the objectives of the QCGAT program, including scheduling, risk assessment, cost, etc. These contract efforts will be supported by appropriate in-house activities related to the program definition.

W75-70064 505-05-24
Lewis Research Center, Cleveland, Ohio.

MMVRA PROPULSION SUPPORT
Warner L. Stewart 216-433-4000

- This RTOP is to cover LeRC activities in support of the Multi-Mission VTOL Research Aircraft (MMVRA) program being initiated under joint NASA/Navy sponsorship and currently, within NASA, under the responsibility of Ames Research Center. The support includes: (1) further study of lift fan engines suitable for this aircraft; (2) propulsion support to the contractors involved in the aircraft studies; (3) generation of appropriate engine information to provide a base for formulating the fan package development and the procurement of engines for the research aircraft; and, (4) assistance to Ames as required, in its technology programs where propulsion is involved.

W75-70065 505-05-31
Lewis Research Center, Cleveland, Ohio.

LOW-COST SMALL ENGINE TECHNOLOGY
Lawrence Macioce 216-433-4000
(505-04-21; 505-04-31; 505-05-11)

An effort is being made to establish a general base of low-cost
engine technology which could be directly applied to turbojet and turbofan engines in the 500 to 1000 pound thrust range. Such engines would be suitable to a wide range of general aviation aircraft and expendable military engine applications, where in both cases broader use of gas turbine engines is currently inhibited by their cost. Contribution to small gas turbine engine cost reduction technology is being made by simplification of the engine configurations, reduction in size and the number of stages required and use of low cost materials. In addition, use of novel construction and fabrication techniques for axial flow compressors and turbines is being investigated. The feasibility of these low cost approaches has been and will continue to be demonstrated by the fabrication and testing of low cost components in component rigs and existing test bed engines, where applicable basic low cost technology will be transferred to the private sector by adapting concepts to production engines allowing large production considerations to impact sub-component design.

**W75-70066**  
Langley Research Center, Langley Station, Va.  
**HYPersonic PROPULSION TECHNOLOGY**  
R. E. Bower 804-827-3285

Research program is directed at the development of concepts for airframe-integrated scramjet engines and the associated basic technology. Component development investigations are conducted inhouse at LRC on inlet, combustor, and nozzle designs applying to flight Mach numbers from 3 to 10. These results are incorporated in complete subscale hot engines models on which experiments are conducted at Mach 7 in the LRC Scramjet Facility and at Mach 4 in the AEDC APTU Facility. More basic research is conducted on H2 fuel injection, mixing, and combustion in both 2-D and axisymmetric flow fields for both wall and steam injection in order to advance prediction and design techniques. Inhouse program is augmented in some areas by R and D grants and contracts. Design studies on flight weight, fuel-cooled engine structures and systems are conducted in parallel with the aerothermal program. Program generally is focused on definition of experimental scramjet engine for flight tests on research airplane. Studies of low speed thrust devices are conducted primarily inhouse for the purpose of synthesizing complete propulsion system concepts for hypersonic vehicles.

**W75-70067**  
Ames Research Center, Moffett Field, Calif.  
**HYPersonic PROPULSION RESEARCH**  
Herbert W. Drake 415-985-5876  
(501-24-05; 505-03-11)

This is a continuation of the investigation of advanced hypersonic inlet flow fields to develop the methodology for predicting the internal flow (i.e., shockwave boundary layer interactions, etc.) in hypersonic inlet systems needed for efficient and stable scramjet engine system design. Experimental and analytical studies of hypersonic inlet flows will be conducted in which the effects of coupling between the inlet, fuel injection system and combustor will be evaluated, and in which fuel injection and combustor pressure rise are simulated so that the effects of these factors on mixing, flow distortion and inlet performance can be determined. A body of detailed internal flow data, urgently needed to enable assessments of analytical methods, will be obtained. The study will be conducted on an in-house and contract basis in phases thru early FY-78.

**W75-70068**  
Langley Research Center, Langley Station, Va.  
**HYPersonic RESEARCH ENGINE**  
Ernest A. Mackley 804-827-3675

This program is responsive to the NASA Level IV Specific Objective titled Hypersonic Propulsion, which can be found in the NASA PASO Documents. To define a practical high performance, Mach 3-8 liquid hydrogen ramjet engine of the HRE and by measuring in wind tunnel tests the aerothermal and thrust performance at Mach 5, 6, and 7 of the AIM. The engine structures thermal performance and low cycle fatigue characteristics were evaluated during Mach 7 testing conducted in the 8-foot High Temperature Structures Tunnel. The AIM tests were conducted at Mach 5, 6, and 7 in Lewis Research Center/Plum Brook Station's Hypersonic Tunnel. The data analysis is to be completed and the results reported. The objective is to advance the technology of hypersonic airbreathing propulsion systems and to evaluate the requirements for future research. The superior fuel economy of airbreathing propulsion requires that such systems be re-examined in light of current technology for application to any new hypersonic atmospheric flight mission.

**W75-70069**  
Lewis Research Center, Cleveland, Ohio.  
**ADVANCED PROPULSION SYSTEM CONCEPTS**  
R. J. Weber 216-433-4000

In-house and contracted studies will be performed of engine cycle, component, complete propulsion systems, and integrated engine/airframe combinations applied to representative airplane missions. The object of the studies is to determine desirable engine component and system design characteristics for future aircraft and to identify technology deficiencies and profitable areas for research. The studies will explore the opportunities for satisfying environmental and nature resource constraints and their related impact on propulsion system selection and engine performance. Representative topics include concepts for reducing fuel consumption, variable-subsonic transports and variable-cycle engines for supersonic military aircraft.

**W75-70070**  
Ames Research Center, Moffett Field, Calif.  
**COMPUTATIONAL AERODYNAMICS**  
Leonard Roberts 415-965-5861  
(501-06-05; 501-06-08; 505-06-31; 505-06-15)

This RTOP is to develop and apply analytical and numerical procedures which can be used for study of complex aerodynamic flow fields at subsonic, transonic and supersonic flight speeds. The procedures will apply to two and three-dimensional configurations and will include consideration of inviscid flows, viscous effects and flow through heterogeneous and/or stratified media. Flow field studies in the subsonic, transonic, and supersonic speed regime will continue covering inviscid and viscous laminar and turbulent flows with and without separation using finite difference, relaxation technique, and integral method solutions. The Ames Finite-Element Wing-Body Aerodynamics Computer Program will be modified to incorporate multiple bodies and vertical surfaces. Some of the computational methods that are under development or nearing completion will be tested and/or modified for use in the aircraft synthesis program (ACSINT) being used to study various vehicle concepts. The computer codes will be compared against a more simplified existing code and implemented in ACSINT, if accuracy or computation time is enhanced. Additional emphasis will be given to the subsonic speed regime, particularly in applying numerical analysis techniques to three-dimensional flows occurring on blown flaps, augmentor wings, multi-element wings and other high-lift configurations.

**W75-70071**  
Langley Research Center, Langley Station, Va.  
**COMPUTATIONAL AERODYNAMICS**  
P. J. Bobbin 804-827-2627  
(505-06-14; 505-06-15)  

The objective of this RTOP is to develop the capability to analytically predict complete aerodynamic characteristics of complex three-dimensional aircraft configurations, now obtainable only by extensive wind tunnel tests (constrained by Mach number and Reynolds number limitations, sting and wall interference effects) to a degree that preliminary design concepts can be evaluated and screened with reduced tunnel test time and cost. The approach of analytical and numerical procedures will be developed for the prediction of pressure distributions, aerodynamic characteristics, flow fields, skin friction and heat transfer for inviscid, viscous and coupled inviscid-viscous flows with attached and separated boundary layers, detached lee side flows with vortex formation and other interactions. Both linear and nonlinear, exact and approximate flow equations will be applied as
appropriate. Mathematical techniques required typically depend on the problem; however, finite-element, finite-difference relaxation, time-asymptotic, characteristics and integral methods are the most commonly used for solving nonlinear problems. Linear problems will generally be solved by the distribution of various types of singularities whose strengths are determined by the solution of a matrix equation. Several problems requiring large computer storage will be programmed for the interim STAR with particular emphasis on efficient solution algorithms.

**W75-70072** 505-06-11
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
**COMPUTATIONAL AERODYNAMICS**
R. R. McDonald 213-354-6186

The objective of this RTOP is to develop a new theory of differential systems, and to apply it to achieving a systematic understanding of selected important equations of continuum mechanics. The methods being developed are especially applicable to coupled sets of nonlinear ordinary and partial differential equations, where results previously have been found by ad hoc methods. Examples are (1) invariance transformations, (2) general similarity solutions, (3) characteristics, (4) integral conservation theorems, (5) functional variable transformations and discovery of superposition principles, and (6) variational principles. Of these, (3), (4), and (6) are of direct applicability in writing programs for numerical computation. (5) and (6) are the most active current areas of research in applied mathematics. The method is based on the modern calculus of exterior differential forms, and is especially appropriate for nonlinear equations such as occur in describing aerodynamic flows. The systematic structure of the theory also allows the use of computer symbolic analysis. In past joint work at JPL and IIT, a unique set of programs was developed for non-commutative algebraic manipulation of differential forms. The most recent work under this task has been (1) in the application to coupled sets of ordinary differential equations, in showing how Hamiltonian structures may always be found for these, and (2) in discovery of transformations generating multiple 'soliton' solutions to nonlinear dispersive wave equations. Such equations occur not only in classical fluids, but in plasmas, solid-state devices, laser optics, and new superconducting computer elements. Work is in progress in applying the theory to the systematic discovery of variational principles for nonlinear flows. These are used in relaxation type computer calculations, and have previously been discovered only by ad hoc methods.

**W75-70073** 505-06-12
Ames Research Center, Moffett Field, Calif.
**DEVELOPMENT OF COMPUTATIONAL AERONAUTICAL CODES FOR ILLIAC**
Dean R. Chapman 415-965-5065

The overall objective is to develop efficient computer programs for solving fluid dynamics problems on the Iliac and large serial computers. A wide variety of fluid flows is to be simulated, from low subsonic to hypersonic speeds, for steady and unsteady, inviscid and viscous flow over two- and three-dimensional configurations. Specific objectives include the solution of transonic flow around wings, wing-body combinations, and lifting airfoils, the latter for unsteady flow; viscous flows including vortices, separation, and shock-wave boundary-layer interactions; and the nature and effects of turbulence. New-numerical methods will be developed and analyzed with emphasis on those especially suited for parallel processing. The programs will be written in CFD Code for processing on the Iliac; however, by use of translators, it will be possible to debug and execute these programs on serial computers. The most efficient and reliable programs will be selected for final documentation and dissemination.

**W75-70074** 505-06-13
Ames Research Center, Moffett Field, Calif.
**PHYSICAL MODELING AND VERIFICATION OF ILLIAC COMPUTER CODES**
Dean R. Chapman 415-965-5065

This RTOP is to perform fundamental experiments specifically designed to verify two- and three-dimensional Iliac codes and to provide the necessary modeling of the physics of turbulent flows to be included in these codes. The Reynolds number domain will extend from the relatively low values of conventional wind tunnels up to the practical range of existing and future aircraft for the transonic and supersonic speed regimes. The flows to be studied will include pressure gradients, separation, and shock interaction regions. Initial objectives are to perform experiments relevant to the development and verification of two advanced transonic computer codes currently being developed. A two-dimensional viscous code will be evaluated by comparing surface pressures, skin friction, and velocity fields obtained from numerically simulated flows with experimental values for swept wings in supercritical flow regimes including shock-induced boundary-layer separation. A three-dimensional inviscid code, capable of adequately treating highly sweptback local shock waves will be evaluated by comparing surface pressures with measurements on highly swept airfoils at sufficiently high Reynolds number to suppress dominant viscous effects. A study will be conducted at moderately supersonic speeds of the turbulent boundary layer with pressure gradient and/or separation induced by (1) an impinging normal shock wave and (2) a wedge ramp. The measurements will length Reynolds numbers to 300 million to provide turbulent shear stress and kinetic-energy turbulence models needed for computer code development and verification.

**W75-70075** 505-06-14
Langley Research Center, Langley Station, Va.
**VORTEX LIFT**
R. E. Bower 804-827-3285

Technical objectives of this RTOP are to perform basic research related to various flows which generate vortex lift as required to carry out the following OAST program objective major thrusts:
(1) develop the capability to analytically predict complete aerodynamic characteristics of complex 3-D aircraft configurations to a degree that preliminary design concepts can be evaluated and screened with reduced wind-tunnel test time and cost; (2) provide prediction techniques that will allow accurate assessment of a vehicle's high angle-of-attack flight characteristics; also criteria that will yield an expanded high angle-of-attack maneuvering capability for military fighters. The approach, both in-house, contract and grant research will be utilized to accomplish the objectives. The in-house effort will include experimental studies using various wind tunnel facilities and analytical studies based on application of finite element techniques and on the application of the edge suction analogy. A flow-through strain-gage balance will be constructed to allow in-house capability to study overall forces related to the jet-augmented vortex-lift concept.

**W75-70076** 505-06-15
Ames Research Center, Moffett Field, Calif.
**TURBULENT BOUNDARY LAYERS**
Hubert M. Drake 415-965-5861
(505-06-11; 505-06-31)

This RTOP is to conduct analytical and experimental investigations of turbulent boundary layer flows under conditions where our present understanding of such flows is inadequate. These conditions include (1) flows over highly curved surfaces providing severe adverse pressure gradients (with and without bleed or mass injection), (2) flows in the immediate region of, and downstream of, shock-wave boundary-layer interactions, and (3) flows subject to variation of edge entropy. The flow may be attached or separated in any of the foregoing cases. These results will be utilized to obtain by mid FY-77 empirical turbulence models for use in advanced computer programs for calculating complete flow fields including regions in which viscous effects play a predominant role.

**W75-70077** 505-06-15
Langley Research Center, Langley Station, Va.
**TURBULENT BOUNDARY LAYERS**
R. E. Bower 804-827-3285
(505-06-11; 505-06-13)

The RTOP presents research to significantly improve our ability to predict the behavior of general turbulent shear flows including turbulent boundary layers and free mixing flows for aeronautical design purposes. Includes theoretical and experimental research on turbulent boundary layers, free mixing layers, and recirculating
flows including effects of compressibility, pressure gradients, mass and heat transfer and three-dimensional flows on turbulence modeling. Studies to include interaction of turbulent boundary layers and shock waves, the development of physical models of turbulent shear, structure of separated turbulent flows and examination of methods for reducing turbulent skin friction drag in subsonic and supersonic flows. A coordinated theoretical and experimental program in which theoretical turbulence models are postulated based on the physics of the situation, with inputs from carefully conducted experiments which measure (1) surface shear and heat transfer and (2) detailed structure of turbulent flows obtained by standard techniques and by means of hot wires, lasers and other advanced measurement techniques. Detailed data and turbulence models are used to develop and verify several large numerical codes including computational methods for three-dimensional boundary layers, three-dimensional mixing, and vortex and separated flows.

W75-70078 505-06-16
DEVELOPMENT OF ADVANCED FLEXSTAB PROGRAM
H. M. Drake 415-965-5880 (766-72-02; 743-36-01)

The aerelastic deflections experienced by large supersonic aircraft both in steady state and maneuvering (perturbed) flight have a major impact upon performance, stability, control, the internal loads arising from such deflections. A major objective of this research is to develop improved analytical methods and to incorporate such improvements in the FLEXSTAB system of computer programs for calculating stability and control of flexible aircraft. Both longitudinal and lateral-directional motions are included. Modifications planned that will provide improved lateral-directional results, more complete load information, effects of active controls, and improved representation of nonlinear aerodynamics. As modifications are made, the FLEXSTAB program will be validated by comparing computed results with experimental measurements from both flight and wind tunnel tests.

W75-70079 505-06-21
AMES RESEARCH CENTER
NONSTEADY AERODYNAMICS
H. M. Drake 415-965-5880

The principal objectives of this research are to obtain an improved understanding and definition of the unsteady aerodynamic pressures and forces associated with aircraft buffet as affected by aerodynamic and geometric parameters, to obtain an improved understanding of the interaction of the aircraft buffet to the unsteady aerodynamics, to develop methods of predicting buffet intensity and wing rock, and to develop means of extending the buffet boundary. Wind tunnel tests, verified by selective flight tests, will be conducted to obtain unsteady loads, pressures and model response characteristics for conditions from buffet onset through maximum buffet and wing rock onset. Additional wind tunnel parametric studies will be made to assess various approaches toward alleviation of buffet and wing rock.

W75-70080 505-06-22
AMES RESEARCH CENTER
WAKE VORTEX MINIMIZATION
B. H. Wick 415-965-5033 (766-70-01; 505-08-21)

To obtain both short range and long range aerodynamic solutions to the aircraft operational hazard caused by aircraft trailing vortices, investigations will be made to determine: (1) the fundamental mechanisms involved in vortex generation and decay, (2) the components of vortex velocity and turbulence up to large distances behind a wing for various conditions of angle of attack, wing sweep, flap deflection, etc., and (3) vortex dissipation resulting from variations in span loading, trailing devices and mass injection, etc. The approaches to be used are: (1) theoretical studies, and experimental investigations utilizing wind tunnels and water tunnels, (2) development of improved equipment and techniques for wind tunnel and water tunnel investigations, and (3) application of promising vortex alleviation devices, and spanwise load variations to models of specific transport aircraft and their experimental evaluation.

W75-70081 505-06-22
Langley Research Center, Langley Station, Va.
WAKE VORTEX MINIMIZATION
R. F. Bower 804-827-3285 (766-70-01)
The objective of this RTOP is to develop wake vortex minimization devices that are acceptable for routine aircraft operations. The approach of laboratory and flight tests conducted over the past 18 months have established the feasibility of modifying the trailing vortex system of an aircraft by aerodynamic means. Laboratory testing and flight tests will continue to investigate new concepts and to develop an alleviation system that will allow safe and economic operation of aircraft with separation distances of 2 nautical miles.

W75-70082 505-06-23
AMES RESEARCH CENTER
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY
AIRFRAME AERODYNAMIC NOISE
B. H. Wick 415-965-5036 (505-03-11)
The objective of this RTOP is to provide the necessary data and to determine the design principles necessary to reduce airframe noise by 10 db in the next decade. As a first step in this process, the major sources of airframe noise will be identified by performing extensive measurements in such large scale wind tunnels as the 40- by 80-foot wind tunnel and the 7- by 10-foot wind tunnel. Additional small scale testing on specific noise sources will be conducted in the 25- by 35 cm acoustic test apparatus. Noise sources to be investigated will include turbulent boundary layers, vortex systems and wakes, separated flows, landing gears, and high lift devices. Special diagnostic techniques are under development for discriminating the desired noise signal from the extraneous noise generated in the wind tunnel environment. As a parallel effort, a feasibility study of a low-noise tow facility for measuring airframe noise will be conducted. A theoretical effort for predicting the noise generated by solid bodies in an airstream is also underway. A better understanding of the fundamental mechanisms will be used to design incise experiments which will reduce aircraft noise to acceptable levels. Noise reduction techniques will be verified in a series of wind tunnel tests on models of existing aircraft and representations of future aircraft.

W75-70083 505-06-23
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
AIRFRAME NOISE
R. R. McDonald 213-354-6186

The objective of this task is to identify and to seek to reduce the sources of noise produced by the external, i.e., non-propulsive, components of aircraft. The experimental portion of the work is to be accomplished through wind tunnel testing. The flow fields to be studied for noise generation are chosen to represent separated flows over wheel wells and cavities, behind steeply-deflected control surfaces, behind blunt objects, and in the trailing vortex of a lifting wing. Scale models will be tested in the second phase of the work. The theoretical effort will utilize existing computer programs to describe the noise production.

W75-70084 505-06-23
Flight Research Center, Edwards, Calif.
AIRFRAME AERODYNAMIC NOISE
P. L. Lasagna 805-258-3311

The technical objectives are to obtain an understanding of the fundamental mechanisms involved in the generation of noise from other than propulsive sources by the airflow over the airframe of an aircraft in flight, and to investigate methods whereby such noise could be effectively reduced without undue design penalties. In addition to theoretical studies, flight tests will be made using a series of airplanes to measure the ground noise of each airplane while descending along a landing approach path with the engines off. In so far as practical, the flight speed and configuration of each airplane will be varied to ascertain the effects of flaps, slats, cavities, etc., on the noise spectrum and level. Initial tests were done with an Aero-Commander. Testing is now being continued with the Jet Star and CV-990.
The objectives of this research are to determine the design principles and provide the necessary data on airframe (i.e., nonpropulsive) noise to insure that the CARD policy study goal of reducing aircraft noise by 10 db per decade can be achieved. The aerodynamic factors that control the generation, magnitude, and radiation of aerodynamic noise will be studied to determine the means by which they can be reduced. The effort will concentrate on identifying airframe noise sources in both the clean and approach and takeoff configurations, such as from the fuselage, empennage, wings, high lift devices, landing gear, and other protuberances, and wheel well cavities. Studies will be conducted on scale models and components by mathematical modeling and by testing in quiet wind tunnels. Airframe noise prediction techniques will be developed for comparison with flight test data from jet transports and with the model and component wind tunnel results. Aerodynamics design concepts for minimizing airframe noise will then be defined from analytical predictions and demonstrated in flight tests.

The objective is to provide a broad base of safety-oriented technology for identifying and defining the hazards associated with aeronautical systems and establish criteria for aircraft design and operating techniques leading to reduction in accidents, loss of life and injuries, and loss of equipment. The approach will be to define, recommend, and support research activities that provide solutions to problems impacting on the safety of aviation; cooperate with other NASA Centers and Lewis Divisions to exploit unique facilities and engineering talents necessary for addressing these safety problems; and coordinate research results with the FAA, NTSB, DOD, other interested government agencies, and the aviation industry. Specific areas of current research activities include lightning hazards, rotor burst protection, high-energy brakes, and aircraft fire prevention and protection.

The technical objectives are: (1) to improve our ability to predict the aerodynamic efficiency (or performance) of vehicles which move through the atmosphere and (2) to define how the efficiency of airfoils or complete vehicles is influenced by geometry, Reynolds number, surface roughness and texture, and free stream and local flow conditions. In addition, experimental research on turbulent boundary layer phenomena will be conducted including the effects of compressibility, pressure gradient, heat transfer and surface roughness, and the interaction of turbulent boundary layers and shock waves and separated flow phenomena. Overall and incremental drag of powered and coasting vehicles will be defined by the accelerometer and/or dynamic analysis methods augmented by the stabilized glide and rate of sink methods. Airfoil performance will be defined by conventional pressure distribution techniques, boundary layer rakes and trailing wake probes augmented by flow visualization where required. Pressure distribution techniques will also be used in assessing boattail and base drag and in studying means of reducing these components of drag.

This RTOP covers experimental investigations on airfoils, components, and configurations for advanced subsonic, transonic, and supersonic aircraft. The objectives of this research are: to provide basic aerodynamic information on advanced and/or improved airfoils, to improve the basic understanding of complex flows, such as flow separation on multi-element high-lift wing configurations, and to determine the potential configuration advantages of the antisymmetric wing concept for use on various configurations. This work will be primarily experimental and will be conducted in-house. Complementary theoretical investigations are covered in RTOP 505-06-11.

The objectives are to provide improved airfoils and multi-element high lift airfoils for advanced subsonic aircraft and transonic executive and commercial transports, and improved blade element airfoils for new performance capability for advanced military and commercial transport rotary-wing aircraft. Improvements are sought in the areas of basic aerodynamic performance, high lift and controls performance, and stall behavior. The work will be an intermix of both experiment and applied theory and will provide: (1) measurements of aerodynamic characteristics for selected configurations, (2) upgraded predictive aerodynamic analysis, (3) generation of airfoil design methodology for both subcritical and supercritical aerodynamic regimes, and (4) stimulation of new and unique design concepts, theoretical methods, and experiment techniques. Examples include new supercritical airfoils, general aviation airfoils, leading and trailing edge high lift devices, and new rotorcraft blade sections. In addition, the work includes improvements in existing research facilities and techniques together with development of new and unique capabilities. These new capabilities are specifically directed toward achievement of high quality data at intermediate and very high Reynolds numbers, such as are obtainable through cryotechnology.

Research was made to improve the understanding and prediction of boundary layer stability and transition. The importance of transition behavior to aerodynamic heating and its influence on thermal protection systems, aircraft lift-drag ratios, missile observables, and vehicle dynamics was also noted. Emphasis will be on understanding the role of the fundamental factors that affect transition as measured in ground facilities and in flight in order to improve the correlation of such measurements and to establish a base of information for design applications. Means will be investigated for the control of the wind tunnel environment to more closely simulate the conditions of flight. Using models of simple geometry, such as slender cones, the effects of the disturbance environment on transition as measured in wind tunnels and ballistic ranges will be identified and evaluated. Attention must be given to disturbances introduced by model surface and structure as well as the tunnel environment. Through boundary layer control and other disturbance suppression devices, a quiet supersonic tunnel which would suppress adverse environmental disturbances is to be developed. The program is primarily experimental but with close coordination with theoretical support and is directed toward understanding of fundamental processes. Such a quiet facility is also needed for supersonic application of drag reduction techniques such as compliant walls and laminar flow control.

The general objectives of this research is to develop by FY-77, improved transonic wind tunnel test techniques in order to ensure reliable correspondence between viscosity-dependent data obtained from scale-model tests and that from full-scale flight tests. Tunnel wall constraints, flow quality and means for simulating higher Reynolds number flows through the use of heavy gas mixtures will be investigated analytically and experimentally.
The technical objective is to provide the technology for improved transonic flight test capability for experimental prediction of performance and flight characteristics of conceptual or new aircraft designs. In-house, contract, and grant supported research utilizing both analytical and experimental approaches will be used to accomplish the objective with the efforts being concentrated in the following specific areas: (1) cryogenic wind-tunnel technology and studies in direct support of the Transonic Research Tunnel project, (2) research on magnetic suspension and balance systems for the elimination of model support problems and studies of the combined application of the superconducting coil balance and cryogenic tunnel technologies, and (3) research on transonic tunnel walls designed to minimize interference and the development of improved wall interference correction methods.

**VEHICLE DYNAMICS - STALL/SPIN/HIGH ALPHA CHARACTERISTICS**

R. E. Bower 804-827-3285

The primary emphasis in this program is to provide a basic understanding of the aerodynamic characteristics of aircraft at high angles of attack through the development of improved theoretical methods supported by static and dynamic wind-tunnel tests. Also through the application of the test results to develop new criteria for designing vehicles capable of performing controlled maneuvers over an expanded angle-of-attack envelope. Investigations to evaluate various experimental concepts for determining dynamic characteristics of aircraft at high angles of attack and to examine the cause and effect of asymmetrical forces occurring at high alpha's and the limitations of controls that restrict the allowable alpha beta maneuvering envelope. Alternate control methods and the use of unique devices for coping with the upsetting forces will be evaluated.

**HANDLING QUALITIES - CRITERIA FOR HIGHLY AUGMENTED VEHICLES**

Dr. H. A. Rediess 805-258-3311

The overall objective of this effort is to advance the fundamental knowledge of flight dynamics and to exploit this knowledge to develop methods for optimizing specific flight control or performance goals and to improve flight test analysis techniques. Analytical studies, computer simulations and flight tests are being performed both in-house and under research contracts and grants to meet this objective. The range of command responses of augmented aerospace vehicles that optimizes the pilot-vehicle performance for specific missions or a specific task within a mission will be investigated. The main emphasis will be to investigate criteria for desired command responses that are meaningful to the systems designer and not needlessly restrictive as to the system concept employed. This activity will also study and document the relationship between the stability and control characteristics of aircrafts in general and the pilot's assessments of the handling qualities, through the use of simulators (both fixed-based and airborne) and the actual airplanes. Effects of turbulence on the flying and ride qualities will be of major concern. Certain aspects of wake vortex encountering dynamics will be studied through theoretical analysis, simulation and flight tests to assess the hazard involved and the ability of alleviating the upset by use of an automatic control system.
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

To develop the basis for improved methods for specifying acceptable aircraft behavior under these circumstances, work is underway to develop and validate more accurate models of atmospheric turbulence; (2) develop the aircraft performance algorithms for aircraft with severe ride qualities problems, e.g., light wing loading STOL airplanes, (3) refine existing ride quality criteria for application to future large military or civil aircraft, where structural mode excitation may have a first-order effect on both ride and handling qualities, and on pilot/aircraft performance, and (4) develop improved displays, autopilot modes and pilot procedures for severe turbulence encounters with advanced short-haul transport aircraft. This work will be accomplished by means of analytical and piloted simulator studies, both in-house and under grant or contract. Completion of objective (1) under grant to the University of Washington (FY-73 funds) is planned. Objective (2) will be accomplished in-house by a NAS-NRC postdoctoral associate. Research related to objective (3) will be continued by both in-house and contract personnel on the VARD simulator. Objective (4) will be accomplished by means of a contract study on either the VARD or another suitable ARC simulator.

W75-70100 505-06-93
Langley Research Center, Langley Station, Va.
ADVENTIVE CONTROL APPLICATIONS
G. B. Graves 804-827-3745
(766-75-02: 742-73-01)

The objectives are: (1) to develop a broad base of technology in advanced control systems which make available to the designer the ability to improve the performance of aircraft by reducing the size of stabilizing surfaces, by allowing a wider choice of configuration and wing loading, by avoiding undesirable flight regimes which might impose hazardous loads or loss of control, and by making the aircraft less sensitive to turbulence and gusts; and (2) to investigate and encourage the adoption of techniques allowing maximum utilization of these principles by incorporating these considerations in the early design stages of an aircraft. Analytical studies will be made to investigate the application of several aspects of modern control theory to airplane dynamics and control systems synthesis. These studies include methods for decoupling the airplane responses to individual control inputs, the development of synthesis techniques for complex multivariable control systems which operate over a wide range of flight conditions, the application of adaptive control techniques, and the application of gust-alleviation systems. Simulation studies were utilized to investigate the effect of promising systems on pilot opinion and handling qualities.

W75-70101 505-07-11
Ames Research Center, Moffett Field, Calif.
APPLICATION OF CONTROL AND GUIDANCE THEORY TO THE AUTOMATIC AND MANUAL CONTROL OF FUTURE STOL AND VTOL AIRCRAFT
H. W. Bradford 415-965-5567
(768-83-01: 501-23-33)

The purpose of this research is to extend and apply advanced linear and nonlinear modern control theory techniques to the guidance and control of STOL and VTOL aircraft. Major efforts are made to: (1) develop methodology and algorithms for generating fuel, time and noise optimal trajectories of STOL and VTOL aircraft operating in an advanced air traffic control environment, (2) create a flexible real-time terminal area simulation to evaluate the impact on the future air traffic system of the optimal 4D guidance system, (3) verify the guidance system design through an experimental flight program using the STOLAND system on the augmentor wing jet STOL aircraft, (4) design a full flight envelope autopilot (FFEAP) which recognizes all the fundamental aircraft nonlinearities and uses a digital computer to process basic aerodynamic force and moment data and compute essentially open loop control sequences for following ATC trajectory commands, (5) verify system performance by an experimental flight program using the STOLAND system (substantially modified) on the augmentor wing jet STOL aircraft, (6) apply FFEAP design technique to tilt rotor aircraft, and (7) investigate concepts for fault-tolerant aircraft control systems.

W75-70102 505-07-12
Langley Research Center, Langley Station, Va.
JOINT UNIVERSITY PROGRAM ON AIR TRANSPORTATION SYSTEMS
G. B. Graves 703-827-3745
(768-81-01: 791-93-51)

The primary objective of this effort is to foster development of a university research capability across the disciplines that involve the avionics and flight control systems of aircraft and their interaction with the air traffic and airport operating environments. A secondary objective is to encourage university interest in interdisciplinary education that will provide engineers and scientists capable of attacking the system problems involved in these areas of air transportation. Efforts to further improve communications and interactions between the schools, and to foster initiation of complementary research projects will include joint quarterly meetings of the principal investigators, the production and exchange of video recordings of technical lectures, and the extension of the contract between Litcheford Systems, Inc., and the Universities. Some NASA, FAA, industrial, and aircraft user-operating organizations will participate in briefings for program coordination.

W75-70103 505-07-21
Flight Research Center, Edwards, Calif.
GENERAL AVIATION FLIGHT CONTROL SYSTEM AND DISPLAYS
Shu W. Gee 805-258-3311
(760-60-05)

This program is a coordinated effort to provide avionic system technology, development, and criteria that will continue the improvements in safety and utility of all aircraft, particularly general aviation type aircraft. Various new concepts in flight control, navigation, and display systems are being investigated through the use of simulators and flight vehicles that will reduce the pilots workload and enhance his performance by applying human factors engineering to system design. Emphasis will be on low cost designs for general aviation.

W75-70104 505-07-22
Langley Research Center, Langley Station, Va.
ANTENNA AND RECEIVER TECHNOLOGY
G. B. Graves 804-827-3745

The increase in air traffic that is occurring in the U.S. today is rapidly outmoding some of the current avionics systems in use. Work in being conducted on a national basis to define new system configurations and to upgrade existing systems to provide improved performance in these areas of traffic surveillance and control, landing guidance, and aircraft navigation. The problems associated with the introduction of new or improved avionics systems consists of: (1) meeting the more stringent performance characteristics usually required, (2) providing equipment at a cost suitable for general acceptance by the civil aviation fleet, and (3) providing for the retrofit of new equipment on existing aircraft. Work will be conducted to apply the latest technology to solve these problems, such as: the development of low profile antennas which can be mounted on the skin of an aircraft with a minimum of structural penetration, and the development of a class of digital communications receivers which are optimized with respect to both the thermal receiver noise and multipath interference.

W75-70105 505-07-31
Langley Research Center, Langley Station, Va.
HIGHLY RELIABLE CIVIL AIRCRAFT COMPUTER TECHNOLOGY
G. B. Graves 804-827-3745
(768-55-02)

This program will provide the research needed to begin the development of a highly reliable fault-tolerant flight control computer system. Ultra-reliable fault-tolerant computer system architectural concepts will be defined: formal mathematics will be developed to describe the error detectability and system diagnosability of fault-tolerant systems; new measures for reliability assessments will be precisely defined; and in-house investigations of off-the-shelf computer systems will be performed.
to validate reliability improvements obtained from special hardware organizational concepts and software redundancy management techniques.

**W75-70106** 505-07-41

Langley Research Center, Langley Station, Va.

**AUTOMATED VTOL AVIONICS**

G. B. Graves 804-827-3745

(768-82-02; 766-75-02; 505-10-23)

This effort will derive and validate the advanced avionics technology required for reliable, all-weather operations of a viable short-haul transportation system in the 1980's. Technology developed under this RTOP along with coordinated efforts in aerodynamics (505-10-23) and operating systems (768-82-02) are the major elements of an integrated LRC program with the ultimate goal to develop and demonstrate operational capability of VTOL as a short-haul transportation system. The navigation, guidance, and control requirements for enroute, terminal area, and approach and landing of VTOL aircraft will be determined with emphasis on automatic operations. New technology will be used to develop low cost and reliable radio-inertial navigation systems, displays, sensors, and to evaluate hemispheric coverage landing guidance systems. Designs of functionally integrated systems will be implemented in prototype hardware and flight tests will be conducted to evaluate and demonstrate systems performance. The VTOL guidance, navigation, and control requirements, and concepts will be investigated by extending previous analytical studies, simulation, and flight experiments to include automatic flight and landing operations.

**W75-70107** 505-08-10

Langley Research Center, Langley Station, Va.

**KNOWLEDGE OF ATMOSPHERIC PROCESSES**

E. S. Love 804-827-2893

The purpose of the program is to generate a quantitative understanding of the atmospheric particulate radiation environment as a function of altitude, latitude, and solar activity. To develop such an understanding requires a knowledge of the basic nuclear process as related to its transport within the earth's atmosphere. To this end, experiments to measure reaction cross sections will be performed and reaction models developed to interpolate between experimental data points. Basic studies will also be made to ascertain solution techniques of the transport equations which are appropriate for this study. As our understanding of the atmospheric radiation processes, analysis of radiation environmental considerations for high altitude aircraft, of historic carbon dioxide content in the atmosphere for the assessment of climatic impact, and of the radiation belts, will be made. Basic data for a satellite radiation monitoring system for the protection of occupants of high altitude aircraft will also be generated during the progress of this study. The main objective is to determine biological doses in different depths in the atmosphere for all latitudes and solar activity, and to further the concept of radiation monitoring via satellite for commercial SST operations. Also to explore the relationship of atmospheric radiation to other geophysical phenomena (such as atmospheric CO2 content). Another objective was to investigate the relevant nuclear processes via experiments to be performed at Berkeley (LBL) and further develop the nuclear cross sections and transport through in-house experimental studies to determine historic concentrations of atmospheric CO2 by the relation to radiative phenomena will also be conducted.

**W75-70108** 505-08-10

Flight Research Center, Edwards, Calif.

**KNOWLEDGE OF ATMOSPHERIC PROCESSES**

L. J. Ehrenberger 805-258-3311

The objective of this work is the definition of the atmospheric conditions in which turbulence, temperature transients, potential pressure attimetry problems and excessive wind shears occur. The major emphasis is the atmospheric environment of supersonic aircraft. Development and acquisition of sensors needed to measure these phenomena are also included. Results of this work will be applicable to aircraft systems design as well as flight operations routing and scheduling. Observations of these phenomena are obtained from instrumented aircraft test flights.

The associated meteorological conditions are analyzed and studied both in-house and on contract.

**W75-70109** 505-08-10

Marshall Space Flight Center, Huntsville, Ala.

**KNOWLEDGE OF ATMOSPHERIC PROCESSES**

G. H. Fichtl 205-453-3168

(501-08-10)

The objectives of this RTOP are: (1) the definition of the steady-state wind and turbulence environments applicable to the design of aeronautical systems, (2) the feasible modification of fog at airports, and (3) the development of techniques and procedures whereby the knowledge of the natural environment can be better utilized for the safe operation of aeronautical systems. The first objective shall be accomplished through the development of models of atmospheric boundary layer flow properties, namely (1) steady-state wind profile, (2) steady-state and instantaneous statistics, (3) statistics of turbulence and the conditions which lead to turbulence will be developed. The second objective, through analytical and laboratory tests relative to the life cycle of fog. Techniques shall be developed whereby potential candidates for the dispersal of fog can be evaluated rapidly and in a cost effective manner. The third objective will be accomplished by developing potential requirements, criteria and procedures for the reporting of atmospheric parameters to pilots prior to take-off and prior to the final approach.

**W75-70110** 505-08-11

Ames Research Center, Moffett Field, Calif.

**NEUTRON ENERGY SPECTRA AND DOSE RATES AT AIRCRAFT ALTITUDES**

C. A. Syverson 415-865-5222

(501-08-10; 970-21-63)

Measurements will be made of neutron energy spectra at aircraft altitudes using improved instrumentation and analysis techniques. The data will aid in resolving controversies reported in the literature concerning the shape of the spectra and the relative contribution of fast neutrons to the total neutron dose. The validity of existing computer codes for calculating neutron fluxes will be tested. Variations in the spectra with time at a given reference point in the atmospheric environment as a function of altitude and latitude will be measured. The contribution of fast neutrons to the total neutron dose and the percentage of the dose contributed by neutrons will be measured. A capability for determining the effect of a solar flare on the neutron flux and radiation dose at aircraft altitudes will be developed. The approach to these objectives will include the collaborative effort of several laboratories in developing improved dosimetric instrumentation and methods of analysis. Ames aircraft will be used in a series of 3 or 4 flights per year to establish baseline spectra at approximately 45,000 feet over the Center. Changes in the flux with altitude and latitude will be determined on other flights. Theoretical calculations of the expected fluxes will be obtained from consultants for comparison with the experimental data. A solar flare dosimetry package will be developed which will be flown quickly to a reference altitude if a solar flare occurs.

**W75-70111** 505-08-20

Langley Research Center, Langley Station, Va.

**AIRCRAFT OPERATING EXPERIENCES**

R. E. Bower 804-827-3285

Statistical data on the operational experiences of general aviation aircraft are being collected and analyzed. Data are obtained by NASA VG and VGH flight recorders from airplanes involved in representative operations of general aviation aircraft usage. The information obtained provides: (1) a continuous basis for comparing actual airplane loadings with design loadings, and thereby a check on the adequacy of design criteria; (2) a means of detecting unanticipated operational practices; and (3)
provides a bank of data useful in the design and development of airworthiness requirements for new types of airplanes.

W75-70112  505-08-21
Lyndon B. Johnson Space Center, Houston, Tex.

DEVELOPMENT PROGRAM OF IMPROVED AIRCRAFT CABIN MATERIALS
R. W. Bricker  713-483-3166
(501-38-19)

The effort defined in this RTOP is a continuation of work originally started in FY-73. During FY-73 and FY-74 numerous small scale materials flammability tests and three full-scale tests on a 737 aircraft fuselage were conducted. Additionally, a contract to develop high temperature aircraft insulation was awarded. However, some of the work that was planned for FY-74 was deferred for lack of funds. The work planned for FY-75 and covered by this RTOP will finalize the insulation development, procure fire resistant windows, refurbish the aircraft fuselage with the improved materials and conduct a full-scale external fuel fire test.

W75-70113  505-08-21
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

AVIATION SAFETY R AND T - FIRE TECHNOLOGY
R. R. McDonald  213-354-6186

The objectives of this RTOP are to reduce the flammability of materials in and around an aircraft. Both the fuel and the polymeric materials of the cabin interior and secondary structure will be modified to accomplish this purpose. Fuel additives will be developed which will markedly reduce the mist formed when a tank or line is ruptured, with a consequent reduction in the fireball which can form on ignition. A secondary objective will be to perform thermodynamic calculations to determine flame temperatures and theoretical combustion products for the proposed modified aircraft materials and to determine flammability regimes as functions of oxygen partial pressure and ignition energy.

W75-70114  505-08-21
Ames Research Center, Moffett Field, Calif.

AVIATION SAFETY RESEARCH AND TECHNOLOGY
Dean R. Chapman  415-965-5065

The objectives are: to develop and evaluate prototype fire-safe aircraft interior and fuselage structures for current and future aircraft utilizing fire-resistant materials and other fire control systems such as detectors and fire extinguishants in order to provide an increased probability of human survivability in fires where there is minor fuselage damage; and to evaluate fire extinguishing technology for engine nacelles and fuel lines. The program consists of three elements: crash fire survivability, aircraft interior fire safety, and aircraft component evaluation such as windows. In the first area, studies and appropriate tests will be conducted to evaluate the use of fire-retardant composites as secondary fuselage structures and to define other benefits obtained by the use of these materials. In the second area, prototype studies of sensitive cabin areas such as lavatories and cargo compartment will be conducted to assess the fire threat level that current structures can withstand, and to develop and evaluate fire-resistant composites, detector and quenching systems that can control and contain the fire. The third area involves the development and evaluation of fire-resistant and antistatic aircraft windows.

W75-70115  505-08-22
Langley Research Center, Langley Station, Va.

HAZARD AVOIDANCE AND ELIMINATION
R. E. Bower  804-827-3285

The objective is to provide basic technology for the improvement of the level of safety in aircraft operations with regard to natural atmospheric phenomena and aircraft-induced hazards. Experimental flight research and analytic studies are to be conducted in areas of aircraft trailing vortices and slant-range visibility measurements.

W75-70116  505-08-22
Ames Research Center, Moffett Field, Calif.

AVIATION SAFETY RESEARCH AND TECHNOLOGY - WAKE
Hazard
L. Roberts  415-965-5066
(766-70-01)

The trailing vortex systems generated by aircraft can be hazardous to other aircraft following along or near the same flight path. A three phase program involving piloted moving-base simulation will be conducted to provide a data base to assist the FAA in establishing safe separation distances. A hot-wire anemometer system will be employed to gather basic data in flight on vortex behavior for various aircraft types. Certain of these results, in which the velocity data and response are measured simultaneously, will be employed in validating the modeling of aircraft response to vortex encounter for use in the simulations.

W75-70117  505-08-22
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

HAZARD AVOIDANCE
R. R. McDonald  213-354-6186

The objective of this effort is directed toward improving aircraft safety. A practical approach to marking trailing vortices generated by large aircraft will be investigated, with emphasis placed on injection of non-polluting particulates. Several candidate marking materials and techniques will be identified based on consideration of their requirements and characteristics. These will then be subjected to an in-depth analytical evaluation, so that one or more promising candidate concepts can be embodied in a working model for demonstrations in FY-1975.

W75-70118  505-08-22
Marshall Space Flight Center, Huntsville, Ala.

AVIATION SAFETY RESEARCH AND TECHNOLOGY/HAZARD AVOIDANCE AND ELIMINATION
E. A. Weaver  205-453-4629

Using the laser Doppler technique, systems and instrumentation will be developed for measuring natural and induced atmospheric flow phenomena concentrating on aircraft wing tip vortices and clear air turbulence (CAT). This will be accomplished as follows: (1) perform system feasibility studies, design studies, analyses and tests with laboratory ground based laser Doppler instrumentation to determine operational requirements, specifications, constraints and capability; (2) develop and test two- and three-dimensional systems for measuring atmospheric flow, concentrating on aircraft wing tip vortices; and (3) develop and test a laser Doppler clear air turbulence detection system as appropriate on the ground and aboard an aircraft, evaluating test data and the findings as the basis for system modification to assure overall system performance goals.

W75-70119  505-08-30
Langley Research Center, Langley Station, Va.

CROSSWIND LANDING FOR STOL OPERATIONS
R. E. Bower  804-827-3285

The objective is to investigate STOL crosswind landing problems and methods of extending the crosswind limits for landing. A flight investigation will be conducted to determine the relation between airplane control, airplane response, piloting techniques, flight safety margins, and crosswind limits during STOL-type landing operations. A crosswind landing gear will be designed, built, and flight tested. Studies also will be made of control concepts such as the use of an all-moving vertical tail for crosswind landing control.

W75-70120  505-08-31
Ames Research Center, Moffett Field, Calif.

AIRCRAFT SYSTEMS OPERATIONAL SAFETY AND EFFICIENCY IMPROVEMENT
Dean R. Chapman  415-965-5065

The objectives are: to improve aircraft performance and safety on the runway through the utilization of improved materials in aircraft tires and brake linings; to develop and evaluate new elastomer formulations for use in tires on high performance aircraft having superior wear and safety properties compared to state of the art tires; and to develop and evaluate composite materials based on aromatic carbonaceous compounds which could serve as long wearing and improved frictional materials for aircraft brake linings. Tread vulcanizates consisting of new and improved...
elastomers either alone or in polyblends with natural rubber and/or cis polybutadiene will be evaluated for thermal-oxidative stability and physical properties. Optimization of polymer structure and rubber compounding will be sought in order to yield elastomeric materials having improved tread wear and safety characteristics over state of the art tread formulations. Aircraft tires will be retreaded with improved elastomer stocks and then evaluated in commercial airline service as well as in special runway traction tests. Failure modes of tire carcasses and treads will be studied. Brake lining composites will be molded of para-polyphenylene, polybismaleimide and branched polyethylene. The processing and formulation parameters will be investigated, and the key properties, namely, friction, wear, thermal - oxidative stability, determined. Selected composites will be tested on a full scale dynamometer.

W75-70121 505-08-31
Langley Research Center, Langley Station, Va.
AIRCRAFT GROUND PERFORMANCE
G. W. Brooks 804-827-2042

Aircraft operations on prepared runways under adverse weather conditions and on certain unprepared surfaces present requirements on braking and steering systems, tires and runway that are vital to aircraft safety and passenger comfort as well as being necessary to procedures for alleviating airport congestion. The objectives of programs covered by this RTOP are: (1) to improve the performance of braking systems, (2) to improve the performance and lifetime of pneumatic tires, (3) to develop new landing gear systems that would permit operations on unprepared fields, including water, and permit continuous use of prime runways for all-weather operations, (4) to evaluate tire cornering behavior with and without braking such that high-speed turnoffs can be designed to increase the flow of traffic at congested airports, and (5) to relate the character of the runway surface to aircraft braking and steering performance. Research to meet these objectives will employ full-scale aircraft, landing gear systems and subsystems, and scaled pneumatic tires. The test facilities will consist of Aircraft Landing Loads and Traction Facility, airport runways, including the landing research runway at Wallops Station, ground test vehicles, flight-type aircraft simulators, and various laboratory equipment.

W75-70122 505-10-11
Langley Research Center, Langley Station, Va.
GENERAL AVIATION AERODYNAMICS
R. E. Bower 804-827-3285

The objective is to develop and demonstrate advanced technology that will permit the design of general aviation aircraft that are safer, more productive, and clearly superior to foreign competition. This work will be accomplished by analytical studies, model tests, and flight tests to develop and demonstrate improved airfoil sections, wing designs, control characteristics, handling qualities, stall/spin characteristics, ride comfort, and pilot information.

W75-70123 505-10-12
Ames Research Center, Moffett Field, Calif.
GENERAL AVIATION - TECHNOLOGY
Leonard Roberts 415-965-5066

The objective of the research was to provide advanced technology for general aviation that will permit the design of future aircraft that are safer and more productive. Advanced wing designs will be developed having improved low-speed control and stall characteristics combined with improved cruise drag and stability. Stall envelopes of existing light aircraft will be expanded and improved through wind tunnel testing of various aerodynamic and control system modifications. In addition, promising future aircraft configurations will be studied which have potential for inherent or imposed stall immunity.

W75-70124 505-10-13
Flight Research Center, Edwards, Calif.
FLIGHT DYNAMICS - CONTROL AND DISPLAY
S. W. Gee 805-258-3311

The technical objectives are: to identify and demonstrate the optimum levels of stability control, and handling qualities for general aviation aircraft that can be achieved through the application of modern control technology, and to define minimum system characteristics that permit realization of these levels. Flight and simulator studies will be continued in control display interactions. Degradation of system and component performance will be used in addition to mixing control modes between axes in order to define minimum system characteristics will be explored. Studies will be made of benefits, including direct lift/drag control devices in a flight path command mode of control.

W75-70125 505-10-21
Ames Research Center, Moffett Field, Calif.
HELIPOWER AERODYNAMIC PERFORMANCE, DYNAMICS AND NOISE
B. H. Wick 415-965-5044
(505-10-22: 791-93-22)

This RTOP covers research on performance, dynamic loads, stability, control system, and noise characteristics of advanced edgewise rotor concepts and configurations. Analyses will be followed by large scale wind tunnel tests to evaluate these configurations and provide a data base to improve analytical techniques. A dynamic properties evaluation of the new rotor test article will be completed to insure applicability to a wide variety of rotor systems. The baseline rotor will be tested. Procurement of a pressure/boundary layer instrumented rotor will be initiated. A follow on test of the effects of rotor geometry on noise will be initiated. The controllable twist rotor will be tested to determine performance/stress trade offs. Analysis and preliminary design of multicyclic flap systems for vibration/stress suppression will continue. The blade/vortex interaction study will be continued, and a rotocraft drag reduction study will commence. Design and fabrication of optical elements for a laser velocimeter for application to rotor inflow studies in the 40- by 80-foot wind tunnel will be completed. The small scale feasibility experiments on the reverse velocity rotor are in progress. Analysis and reporting of the results will be accomplished during the first quarter of FY-75.

W75-70126 505-10-21
Langley Research Center, Langley Station, Va.
HELIPOWER AERODYNAMICS
R. E. Bower 804-827-3285
(505-10-23; 505-10-26: 766-79-01)

Analytical and experimental studies will be made to identify factors contributing to the aerodynamic and structural characteristics of rotors. University grants and contracted studies will be continued to define wake geometry and analytical procedures which include wake characteristics in predicting airloads, structural response and aerodynamic performance. In-house experimental studies will be continued to better define unsteady local-flow parameters significant in the prediction of rotor blade section lift and drag. Analytical, wind tunnel, and whirl tower investigations will be made to determine performance, dynamic loads, vibrations, and wake flow characteristics of advanced rotor concepts, rotocraft configurations, and tail rotor arrangements. These studies will be coordinated with the airfoil development research under RTOP 505-06-31, and with the rotor aerelastic and acoustic studies under RTOP 505-10-26. Note: This program will, in general, be carried out jointly with the Langley Directorate of the Army Air Mobility Research and Development Laboratory.

W75-70127 505-10-22
Ames Research Center, Moffett Field, Calif.
TILT ROTOR AIRCRAFT AERODYNAMIC PERFORMANCE, DYNAMICS AND NOISE
B. H. Wick 415-965-5044
(505-10-21; 791-93-22)

This RTOP covers activities in research and supporting technology for the tilt rotor aircraft program to provide a sound base for definition of performance dynamic loads, stability, control systems and noise characteristics of advanced tilt rotor concepts and configurations. The basic in-house dynamic stability theory completed last year will be updated with an improved representation of blade elasticity and extended to include the capability.
for feedback control system synthesis using optimal control theory. Contracted analyses and tests will be conducted to determine tilt rotor gust response and means for gust alleviation and blade load suppression. Generalized feedback controller studies will be contracted based on cantilever wing methodology in FY-75 followed by complete vehicle and conversion studies in FY 76-77. In-house analyses of airfoil sections and variable geometry appropriate to the tilt rotor will continue. Contracted analyses and tests will be initiated to study rotor/wing/tail interference problems. Contracted analyses to evaluate the cost of noise reduction for tilt rotor aircraft will be extended.

W75-70128 505-10-23
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT FLIGHT DYNAMICS
B. H. Wick 415-985-5066
(768-78-01)

An hierarchy of control systems will be investigated to establish the minimum augmentation requirements and to develop methods of implementation. Emphasis will be given to minimizing the system complexity, minimizing the effects of upsets and disturbances, and on developing techniques for decoupling controls. A coordinated flight and simulation study will be completed to determine the effect of gross weight on the handling qualities and flight control requirements for crane helicopters up to the heavy lift class. Simulations of commercial versions of tilt rotor aircraft will be conducted in a program to develop control systems suitable for the short-haul transport mission. Flight verification will be accomplished using the Tilt Rotor Research Aircraft.

W75-70129 505-10-23
Langley Research Center, Langley Station, Va.
ROTORCRAFT FLIGHT DYNAMICS
R. E. Bower 804-827-3285
(768-82-02; 505-07-41; 768-83-04)

Using broad capability helicopter in-flight simulators as primary tools, required research will be conducted to develop improved certification criteria (primarily in the areas of handling qualities and overall flight characteristics) for the various classes of VTOL vehicles as well as for helicopters and other rotoct. The scope of the research includes consideration of manual IFR flight conditions, as well as consideration of advanced vehicles having automatic and active control capability with satisfactory provision for pilots to monitor and take over flight control manually with particular emphasis on flight in the terminal area. Representative types of problems to be investigated include defining the requirements and flight/operational characteristics of advanced flight control systems including active controls, inherent and augmented stability, cockpit displays, pilot controls, vehicle/pilot interfaces with ground based and onboard navigation systems for manual flight in IFR conditions, and vehicle/pilot interfaces with automatic flight systems. The VALT CH-47 will be instrumented to provide a highly flexible and efficient replacement for the CH-46 in-flight simulator during FY-1975. The SH-3A will be used for cockpit display - pilot workload studies.

W75-70130 505-10-24
Langley Research Center, Langley Station, Va.
ROTORCRAFT CIVIL HELICOPTER TECHNOLOGY
R. E. Bower 804-827-3285
(505-10-21; 505-10-23; 505-10-26)

The objectives are: (1) to identify in critical disciplinary areas the projected requirements and associated criteria for achieving successful and acceptable civil operations, and to evaluate existing vehicles in meeting these requirements, (2) to assess the extent to which existing advanced technology can be applied to meet projected requirements, and to identify areas requiring additional research, (3) to conduct vehicle and systems design application studies utilizing existing advanced technology, and (4) to carry out key experimental evaluations which are deemed critical to industry acceptance and use of promising advanced technology features. Studies will be carried out both through analytical, design, and systems studies and through experimental evaluation of selected systems in simulated operational environments. The program will utilize principally contractual effort, plus some in-house effort in flight research experiments.

W75-70131 505-10-26
Langley Research Center, Langley Station, Va.
ROTOR ACOUSTICS AND AEROELASTICITY
R. E. Bower 804-827-3285
(505-10-21; 505-10-25)

The objective of this plan is to develop technology related to the aeroelastic and noise characteristics of rotors, and to use this technology in developing and validating adequate design prediction methods. Technical areas of interest include methods of predicting aeroelastic stability characteristics of rotors in hover and forward flight, vibration characteristics of helicopters and means for reducing or alleviating excessive vibrations, unsteady rotor aerodynamics, tip air mass injection for control of rotor noise, and design prediction methods for noise from main and tail rotors. Work will continue on the establishment of a generalized rotor aeroelastic model (GRAM) to be used for experimental correlation of advanced aeroelastic stability analyses being developed in-house and under contract. The GRAM will also be used for testing advanced rotor configurations, such as the variable geometry rotor, being proposed for RSRA. An analytical effort will be begun to develop a mathematical model for predicting the vibration characteristics of a complete helicopter configuration. An in-house research project will address the problem of active vibration isolation systems which will have application to RSRA. Structural system identification techniques will be used in an attempt to predict blade rotating properties from non-rotating vibration tests. A program to compute compressible, unsteady, rotor dynamic loads will be formulated for use in aeroelastic stability calculations. Rotor noise tests using the rotor test tower will be conducted to validate available noise prediction theories. In-house research on impulsive rotor noise will be conducted along with contractural tests for evaluation of tip air mass injection as a means for controlling rotor noise.

W75-70132 505-10-31
Ames Research Center, Moffett Field, Calif.
VTOL AERODYNAMIC PERFORMANCE
B. H. Wick 415-965-5036
(505-03-12)

This RTOP covers research on the aerodynamics, performance, stability and control of promising jet-lift VTOL commercial and military transport configurations, including a better understanding of the interaction of aerodynamic and propulsion system characteristics in predicting these characteristics will be improved. Wind tunnel investigations of a large scale model of a lift-fan research aircraft both in and out of ground effect will begin. Large scale wind tunnel investigations of aircraft components will continue, as will wind tunnel research on the noise generated by lift-fan jet-lift VTOL aircraft at forward speed. Analytical studies to improve prediction methods will begin. Studies of advanced augmentors at both large and small scale will continue. Theoretical and experimental studies of cruise performance of lift/cruise fan powered VTOL aircraft will continue.

W75-70133 405-10-31
Langley Research Center, Langley Station, Va.
VTOL AERODYNAMIC PERFORMANCE
R. E. Bower 804-827-3285
(505-11-41)

This research is a continuing three-part effort in VTOL aerodynamics involving applied fluid mechanics phenomena, combat aircraft, and transport aircraft. The basic research objective is to provide the technology required for improved performance, stability, and control of promising VTOL configurations applicable to civil and military transports as well as military fighter and attack aircraft. Limited fundamental studies will be continued in-house and by contract to develop, through theory and experiment, engineering design methods for optimizing the aerodynamics of VTOL aircraft. University grants will augment the in-house analytical work. Major emphasis will be placed on investigations of promising lift-fan transport configurations in the V/STOL tunnel and investigations of combat aircraft configurations in both the V/STOL and full-scale tunnels. This will include
exploratory wind-tunnel research of VTOL fighter-type configurations suitable for application by the Navy on ships without catapults or arresting gear. These concepts include the ejector-augmented-lift principle, deflected thrust, lift-engines plus lift/cruise engines, and a ‘tail sitter’ configuration.

**W75-70134**
Ames Research Center, Moffett Field, Calif.

**VTOL FLIGHT DYNAMICS**
B. H. Wick 415-965-5567
(505-10-33; 505-10-34)

Design and handling qualities criteria will be developed for satisfactory manual control of jet or fan lift VTOL aircraft. Two areas are of primary concern: control of the aircraft for precise decelerating approaches to hover, and precision control in hover. Flight and simulation studies have indicated that thrust vector management to control speed and position relative to the flight path is the primary problem to be solved to obtain satisfactory manual control during the IFR approach. Analysis and simulation, centered on a lift-fan transport aircraft will be conducted to evaluate various techniques of automating control of the magnitude and direction of the thrust, and to develop improved concepts. Control systems for precise control of hovering aircraft will be considered for both commercial and military applications. Candidate systems for specific VTOL aircraft will be developed through analysis and simulation. In flight verification and extension of results will be accomplished with the X-14B variable stability aircraft.

**W75-70135**
Ames Research Center, Moffett Field, Calif.

**HANDLING QUALITIES REQUIREMENTS FOR SHIP-BASED VTOL**
B. H. Wick 415-965-5066
(505-10-12; 505-10-26; 760-62-02)

Solutions will be sought to the special problems involved in manual control of the takeoff, approach, and landing of VTOL aircraft operating from the Navy Ships under severe weather conditions. The approach to these problems will be primarily experimental, using both piloted simulations and VTOL research aircraft. An integrated approach will be taken in the simulations, whereby, the ship systems, the aircraft systems, and the guidance systems are studied in combination with one another. Parallel flight investigations will follow using existing VTOL aircraft. The unique aspect of the ship landing problem which will be emphasized, as distinguished from VTOL terminal area research under RTOP 505-10-21, is the nonstationary landing and take-off surface.

**W75-70136**
Ames Research Center, Moffett Field, Calif.

**SIMULATION MODELS OF ADVANCED TRANSPORTS**
B. H. Wick 415-965-5567
(505-10-23)

Simulation models of all important aircraft concepts in the CTOL, RTOL, STOL and V/STOL commercial transport classes are required to support the study of terminal area efficiency factors. To permit valid comparisons, the models of all competing concepts must be designed to the same level and technique and, where possible, for the same mission. Computer storage for each element of the terminal area study must be minimized to avoid exceeding the computer capacity. Aircraft models therefore must be as simple as possible consistent with the aim of providing representative pilot handling qualities.

**W75-70137**
Ames Research Center, Moffett Field, Calif.

**POWERED-LIFT (STOL/RTOL) AERODYNAMIC PERFORMANCE**
B. H. Wick 415-965-5036
(505-06-23)

This RTOP covers Ames efforts in R/STOL aerodynamics and noise. The goal is to provide aerodynamically efficient, quiet, and mechanically simple powered lift systems having RTOL and STOL performance. Studies show that the augmentor wing can meet noise goals and that augmentor nozzles may also be used for cruise propulsion. The experimental investigation at large scale of several types of augmentors and complementary theoretical and small scale experimental studies for improving augmentor performance and acoustics will be continued. The study of quiet augmenter jet lflap thrust reversers will be included. Acoustics and performance of USB concepts will be studied in the 40- by 80-Foot Wind Tunnel. Supporting investigations of wind tunnel wall effects for STOL aircraft, ground effects, and noise characteristics of STOL aircraft will be conducted under this RTOP.

**W75-70138**
Ames Research Center, Moffett Field, Calif.

**STOL/RTOL FLIGHT DYNAMICS**
B. H. Wick 415-965-5567
(766-71-02)

Generalized analytical studies, ground-based simulation, and flight research will provide data for revision and extension of existing handling qualities and certification criteria for STOL aircraft. The data will apply to the following critical areas: flight path control, altitude control, landing flare in the presence of ground effect; roll and yaw control for cross-wind landing; and the control of a powered-lift STOL following loss of an engine. The effectiveness of a hinged plate spoiler system in improving flight path control and landing dispersion will be studied on a DHC-6 aircraft. Tentative airworthiness criteria based on studies of representative powered-lift aircraft, together with techniques for determining compliance, will be developed. Cooperative FAA/NASA piloted simulation studies on the Flight Simulator for Advanced Aircraft. These results will contribute to generalized criteria for all concepts. The program will be coordinated with the Flight Experiment Program for the augmentor wing jet STOL research aircraft. A simulation experiment will be conducted to develop means and procedures for minimizing landing field length for short haul RTOL aircraft.

**W75-70139**
Langley Research Center, Langley Station, Va.

**MEDIUM AND LONG HAUL CRUISE AERODYNAMIC TECHNOLOGY - AERODYNAMIC DRAG REDUCTION RESEARCH**
D. M. Bushnell 804-827-3151

The objective is to provide the technology basis for more fuel efficient energy conserving aircraft through exploitation of advanced airfoil designs, such as the supercritical airfoil, and by development, optimization and flight demonstration of skin friction reduction concepts, thus conserving our nation's energy resources and enhancing our nation's competitiveness in the international aircraft market. Experimental, theoretical, and system studies will be concentrated on transport configuration applications of such concepts as laminar flow control, gaseous slot injection, compliant wall, surface roughness drag, low drag airfoils, wing vortex diffusers, and other innovative techniques. The most promising of these concepts will be carried into flight test phases where the tests will typically be conducted on wing panel sections.

**W75-70140**
Ames Research Center, Moffett Field, Calif.

**SUBSONIC/SONIC AIRCRAFT AERODYNAMIC PERFORMANCE**
H. M. Drake 415-965-5990
(505-06-31; 791-93-62)

The objective of this investigation is to determine by FY-76, the aerodynamic performance, stability and control characteristics, and airport and community noise characteristics of the R.T. Jones oblique wing transport aircraft configuration at subsonic, transonic and low supersonic speeds, so that adequate aerodynamic prediction methods for this class of vehicle can be provided. This information will be used for mission studies to assess the potential of antisymmetric configurations for advanced transport aerodynamics. Concurrent with the analytical and experimental investigation of nacelle-airframe interference effects on engine type and nacelle size, shape and location will be made using a scale wind tunnel oblique wing transport model.
The technical objective of this work is to provide the analytic methodology and a background of aerodynamic data throughout the speed range (up to about $M = 4.5$) for defining and optimizing the aerodynamic performance of high-speed aircraft configurations. The approach to be used will employ both theoretical and experimental investigations of generalized aircraft configurations to develop techniques for increasing aerodynamic efficiency; to determine means of managing the aerodynamic center variation with Mach number to attain low static margins without encountering regions of static instability; and, to develop new aerodynamic control concepts to provide maximum aerodynamic control effective with high angle of attack. Attempts will be made to formulate original theories and to adapt existing theories to practical usage in computing programs. Limited wind-tunnel tests will be made to verify, to establish limits of, and where appropriate, provide empirical corrections to theoretical results. Interactive computer graphics will be developed for efficient use of both manpower and computer power.
rocket as well as air-breathing systems with special consideration being given to inlet-airframe integration.

W75-70148  505-11-23
Langley Research Center, Langley Station, Va.
MILITARY A/C VECTORED THRUST MANEUVERABILITY
R. E. Bower  804-827-3285
The objective is to expand VIFF studies of the Harrier aircraft to maximum speed and thrust. Flight trails of the Phase 2 Joint NASA/U.K. VIFF flight research program will be completed in the U.K. using a modified Harrier aircraft supplied by the U.K. These trails will be in two parts: (1) air-to-air, and (2) air-to-ground. Both research and services (USMC and RAF) pilots will take part in the trials. During FY-1976, radar data from these trials will be analyzed by McDonnell Douglas utilizing techniques developed for analyzing Harrier simulator and Phase 1 data.

W75-70149  505-11-24
Flight Research Center, Edwards, Calif.
F-15 STALL/SPIN-RPV FLIGHT TESTS
G. P. Layton  805-258-3311
This program involves the design and construction of three 3/8-scale remote piloted F-15 fighter aircraft configurations to be air-launched, flown through high angle-of-attack maneuvers and recovered by horizontal landing on Edwards Dry Lake or by parachute recovery. These vehicles are to be flown to gather needed flight data at angle-of-attack values at, near, and beyond the aircraft stall and departure. The overall objectives are to develop a remote controlled test technique that is suited to stall/spin type research; to obtain high angle-of-attack data specifically for a 3/8-scale F-15 configuration up to and including post-stall, pre-spin conditions; and to assess advanced control systems in pre-stall, post-stall, and pre-spin flight.

W75-70150  505-11-31
Langley Research Center, Langley Station, Va.
HYPERSONIC AIRCRAFT AERODYNAMIC TECHNOLOGY
R. E. Bower  804-827-3285
(505-04-31; 501-22-06)
The purpose of this work is to provide the technology for the design of efficient, practical hypersonic airbreathing aircraft. A number of aircraft systems are being studied. These include hypersonic transports, military strike and reconnaissance vehicles, hypersonic research airplanes, and the airbreathing launch vehicle. The airbreathing launch vehicle which is potentially capable of providing a truly low cost space logistics system can fill an expected need in the NASA/DOD program in the post 1980 time period. The hypersonic transport, with its long-range capability and cruise sonic boom levels that may be acceptable over populated areas, has the potential of providing a major step in air transportation in the latter part of the century. Airbreathing vehicle systems must fully exploit synergistic interactions between aerodynamics, propulsion, structures, trajectory selection, etc., to achieve maximum overall efficiency and operational flexibility. Detailed work on configuration concepts, reliable prediction techniques, full-scale Reynolds number effects, engine-airframe integration, etc., will be vigorously pursued to provide the technological base necessary. The technology for all three systems needs to be demonstrated in flight before commitment to mission hardware is made. The high speed research aircraft (HSRA) will be used as a focal point in the technology development.

W75-70151  505-11-41
Langley Research Center, Langley Station, Va.
DOD ASSISTANCE - SPECIFIC MILITARY DEVELOPMENT PROGRAM
R. E. Bower  804-827-3285
The objective is to determine, at specific request of DOD, the aerodynamic characteristics of models and model components at subsonic, transonic, and supersonic speeds. Current emphasis is focused on the USAF B-1, USAF YF-16, USAF YF-17, USN XFSV-12A and several missile concepts. Anticipated emphasis will be focused on DOD requested (program of interest to NASA) generalized research programs on methods to improve aircraft maneuverability. Results will be obtained by means of wind tunnel investigations conducted over appropriate ranges of aerodynamic variables to determine forces, moments, and loads, as well as by the use of the many available analytical programs. Analysis of the results will be performed and selected results will be documented.

W75-70152  505-11-41
Ames Research Center, Moffett Field, Calif.
DOD ASSISTANCE
L. Roberts  415-965-5850
(136-63-02: 760-74-01: 764-74-01)
This technical assistance, consultative services, and facility support will be provided to the DOD in support of military aircraft and missile development programs. Included are research efforts to aid in assuring satisfactory aerodynamic and handling qualities of piloted aircraft and to define and develop techniques for improvement of marginal or unsatisfactory characteristics of new airplane designs. Wind tunnels and flight simulators will be employed as required. Specific weapon systems programs for which support is planned during FY-1975 include the B-1, Advanced Harrier, Advanced Navy Fighter, AFTI, and YF-16 CCV.

W75-70153  505-11-41
Lewis Research Center, Cleveland, Ohio.
OUTSIDE AGENCY SUPPORT AERONAUTICS TESTING
D. N. Bowditch  216-433-6123
The objective is to support requests from the Department of Defense, Department of Transportation and other Federal agencies outside of NASA for Aerodynamic testing in the facilities of the Lewis Research Center.

W75-70154  791-40-03
Ames Research Center, Moffett Field, Calif.
ANALYSIS OF FUTURE CIVIL AIR TRANSPORTATION SYSTEMS AND CONCEPTS
L. J. Williams  415-965-5887
The objective of this RTOP is to provide systems analyses of future civil air transportation systems and concepts in order to identify promising aeronautical systems, determine optimum characteristics, and define technology requirements and costs associated with such systems. Studies of general aviation aircraft, CTOL, STOL and VTOL transports, advanced subsonic/transonic transport aircraft, and advanced supersonic transports will be conducted. Total system studies will be carried out considering all of the interactions between aircraft, airports, airways, community impact, and economics (both within the aviation industry and on a national basis). In addition, studies of a short term nature will be conducted in support of the aeronautical program planning activities of ARC and OAST to perform the necessary studies in support of the more general total systems studies.

W75-70155  791-40-04
Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF METHODOLOGY TO AID IN DEFINING TECHNOLOGY NEEDS FOR FUTURE MILITARY AVIATION SYSTEMS AND CONCEPTS
L. Roberts  415-965-5881
The objective of this RTOP is to develop a methodology to aid in defining the benefits of new aeronautical technology and to assign the value of NASA's research in support of the DOD for preliminary design studies and evaluations. The approach will be continued incorporation of advanced technologies into in-house aircraft synthesis programs and exercising these programs by analysis of aircraft systems intended to meet mission requirements obtained from or developed in cooperation with appropriate DOD planning personnel. Historically, NASA has supported the DOD by generating advances in technology and by providing analytical and test assistance during the development of specific designs. NASA does not become involved in assessment of technology advances as they affect military requirements. This is a prime responsibility of the military planners and industry designers.

W75-70156  791-40-05
Flight Research Center, Edwards, Calif.
HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY (HIMAT) - STUDY PROGRAM
This RTOP covers a contractual and in-house study program to provide improved technology for the design of highly maneuverable aircraft. Present design constraints will be relaxed to permit complete freedom in the application of state-of-the-art systems such as integrated computerized controls, composite structures, supercritical airfoil technology, vectored thrust and the like in order to achieve the maximum benefits from synergistic effects. In an initial procurement, 9 contractors were asked to bring forth their ideas, possible innovations, and general approach towards the improvement of the design technology for highly maneuverable aircraft. In a second phase, three contractors will be given $330,000 each to study and develop a conceptual design of a full-scale, manned, highly maneuverable aircraft. Emphasis will be on achieving superior performance through discipline interactions and through promising but untested concepts where the technical and financial risk is unusually high. In a third phase, two contractors will be asked to complete the design and construct a scaled version which will be tested in free flight at FRC using remotely-piloted research vehicle (RPRV) techniques.

W75-70157
Ames Research Center, Moffett Field, Calif.
CIVIL AIR TRANSPORTATION SYSTEM STUDIES
H. M. Drake 415-965-5881
The objective of this research is to develop and use an overall system synthesis capability which can identify the best aircraft characteristics for given air transportation system. Mathematical models of the air vehicle elements will be used and verified by comparison with operational situations. Quick response studies of civil air transports will be conducted to identify critical research areas, assess energy consumption and provide information for cost benefit studies. Specific studies of aircraft optimized for cargo, reduced energy consumption, and reduced noise and wake-vortex hazard will be initiated. These in-house studies will provide guidance for possible future contract studies.

W75-70158
Ames Research Center, Moffett Field, Calif.
STUDY OF POTENTIAL UTILITY OF RPV'S (REMOTE PILOTED VEHICLES) FOR CIVIL APPLICATIONS
H. M. Drake 415-965-5881
Studies will be conducted to identify and describe the potential civil market for RPV's, to assess the associated benefits and costs of using these vehicles, and to identify likely candidate vehicle concepts and the technology required to satisfy civil markets. In addition, the study will include an assessment of the impact of safety, reliability and environmental requirements on the future use of civil remotely piloted vehicles. Study to be completed by mid-FY-1976.

W75-70159
Flight Research Center, Edwards, Calif.
ANALYSIS OF REMOTE-PILOTED (RP) VERSUS PILOTED (P) RESEARCH AIRCRAFT TO CONDUCT AERONAUTICAL FLIGHT RESEARCH
J. Weil 805-258-3311
This RTOP covers an evaluation of current rotorcraft maintenance cost experience of both civil and military operations and the establishment of statistical techniques for projecting maintenance cost of advanced rotorcraft, in particular the tilt rotor concept. Commercial and military operations will be surveyed to provide a data base for current experience. Projections of likely technological developments on subsystem design will be made in conjunction with rotorcraft manufacturers. Multiple regression techniques will be used to develop the importance of parameters such as vibration level, mission cycle vs. flight hours, etc. as well as the effects of major technical design differences if pertinent, in determining good maintenance cost estimating relationships.

W75-70161
Ames Research Center, Moffett Field, Calif.
TECHNOLOGY ASSESSMENT OF FUTURE INTEGRATED TRANSPORTATION SYSTEMS
H. Hornby 415-965-5894
The objectives of this RTOP are to enhance NASA's contribution to our nation's ability to provide adequately for its future transportation needs and to determine the possible impact of the more promising future integrated transportation systems and corresponding urban structures on aviation and air transportation R and T planning. The approach will be based on a technology assessment encompassing energy requirements, environmental and societal constraints and barriers, and political and economic considerations and on studies of component systems, air ground, and water vehicles for integrated transportation system applications, including short and long haul. The roles of more promising vehicle and system concepts in the integrated transportation system will be identified. This work will also support and extend the development of a comprehensive OAST paper on transportation mode energy consumption.

W75-70162
Ames Research Center, Moffett Field, Calif.
TECHNOLOGY ASSESSMENT OF PORTABLE ENERGY RDT AND P
H. Hornby 415-965-5895
The objectives of this RTOP are to determine the impact of promising future portable energy options on aviation and air transportation R and T planning and to enhance NASA's contributions to our nation's ability to provide adequately for its future portable energy and mobility needs. These objectives will be established consistent with environmental standards and constraints, politico-economic considerations, and the sustenance and amelioration of our quality of life. The approach is to: (1) perform systems analysis at the Ames Research Center on the economics of aircraft fuel futures in support and extension of the evolving OAST transportation energy paper; and (2) improve the base aviation and air transportation R and T alternative fuels decisions by extending the technology assessment of portable energy RDT and P into Phase 2 activities. Phase 2 shall include the selection and initiation of follow-on studies of critical issues, constraints, and barriers (identified during the Phase 1 workshop and subsequent analyses of results) which require further definition upon future objectives of the NASA aeronautics program.

Aeronautics Systems Technology Programs
W75-70163
Langley Research Center, Langley Station, Va. 510-51-01
The objective is to obtain longtime flight service performance of filamentary composite materials in the center wing box of C-130 aircraft. The objective will be achieved through a systematic program as follows: (1) conduct advanced development study to provide design allowables, manufacturing and process methods, and required analysis methods; (2) perform detailed design; (3) fabricate three composite-reinforced aluminum-alloy wing boxes; (4) perform ground test on one full-scale box; (5) install wing boxes in two C-130 aircraft, and deliver aircraft to Air Force; and (6) perform periodic monitoring to establish performance of wing boxes. The results of this flight service program will provide meaningful data on the performance of composite materials in a primary structure in the flight environment. Results will also be obtained on design, manufacturing, and processing methods, non-destructive evaluation and field inspection procedures heretofore unavailable on large scale composite-reinforced primary aircraft structures. The program will provide confidence needed before commitments are made to future applications in aircraft structures.

W75-70164
Langley Research Center, Langley Station, Va.
COMPOSITE PRIMARY AIRCRAFT STRUCTURES FLIGHT PROGRAM
G. W. Brooks 804-827-2042
(766-74-01; 501-22-03)

The objectives and approach are to establish a confidence level and economic base for filamentary composite primary structures that will warrant a production commitment by airframe manufacturers to incorporate these structures in future commercial transport aircraft. This objective will be accomplished by demonstrating weight savings of about 25% with composite materials, by accumulating operation and maintenance experience in an airline environment, and by developing the design and manufacturing technology required to lower the acquisition cost of composite primary structure as well as to achieve life-cycle costs comparable to current metal aircraft structure. The flight components will be replacement parts on existing commercially operated aircraft.

W75-70165
Lewis Research Center, Cleveland, Ohio.
MATERIALS FOR ADVANCED TURBINE ENGINES (MATE)
N. T. Saunders 216-433-6676
(505-01-12)

This program involves the application of at least five new materials and manufacturing processes for aircraft turbine engines. It will cover the advanced development, rig, and engine testing necessary to demonstrate the potential of new materials technology for use in future engines. The purpose of this program is to accelerate the application of new materials technologies to aircraft engine use in order to achieve improved engine performance benefits. The program will be conducted primarily through contracts with domestic engine manufacturers and their vendors. New materials and processes that have shown exploratory feasibility in exploratory development programs will be selected for further development and evaluation under this program. Cost/benefit and risk analyses will be conducted to help guide the selection of the best candidate materials. The selected materials will then be scaled-up, manufactured into appropriate engine hardware, extensively evaluated to provide preliminary design data, and tested in both engine-simulation rigs and experimental engines to demonstrate their potential for future engine use.

W75-70166
Langley Research Center, Langley Station, Va.
INTEGRATED PROGRAMS FOR AEROSPACE-VEHICLE DESIGN (IPAD)
G. W. Brooks 804-827-2042
(505-02-51; 743-32-01)

This RTOP is to develop by 1980 a system of Integrated Programs for Aerospace-Vehicle Design (IPAD) for use by aerospace industry as a tool to reduce cycle time by 50 percent and costs by 25 percent for design of large, complex vehicle systems. IPAD is intended to provide the most effective combination of man and computer to accomplish the total design task. Specific targets are: (1) by early FY-75, complete definition of most promising concepts for IPAD and issue RFP; (2) award development contract by mid-FY-75; (3) have initial incremental release for first level IPAD ready by early FY-78; (4) by FY-80, make a general release to aerospace industry of first level IPAD system.

W75-70167
Lewis Research Center, Cleveland, Ohio.
ADVANCED MULTISTAGE AXIAL FLOW COMPRESSOR
M. J. Hartmann 216-433-6650

Compressors for advanced military and commercial aircraft must be lightweight and efficient and capable of operating over a wide range of conditions. Hardware, maintenance, and operational costs and fuel consumption must all be reduced below present levels. Besides achieving high component performance levels the compressor must be selected to be compatible with expected advancements in the related technology areas of materials, structures, acoustics, fans, combustors, turbines, controls, bearings and seals. To meet these requirements high pressure stages must be properly matched in a multistage compressor operating at high rotational speeds. The compressor is the pacing item in advanced engine development programs. From program risk and schedule considerations, it is necessary to select a compressor design that has demonstrated suitable performance or to minimize modifications to such compressors. To provide an advanced compressor utilizing high levels of stage pressure ratio, the performance of a multistage compressor designed for 20:1 overall pressure ratio will be determined. A preliminary design and definition study will investigate compressors with as few as six stages which to achieve 20:1 overall pressure ratio requires an average stage pressure ratio of 1.65 as compared to 1.3 or less utilized in multistage compressors. The compressor indicated in the preliminary study as providing the greatest benefit to advanced transport aircraft of the mid 1980's will be built and tested at the contractor's site.

W75-70168
Flight Research Center, Edwards, Calif.
DIGITAL FLY-BY-WIRE FLIGHT EXPERIMENT
C. R. Jarvis 805-258-3311
(766-75-02)

The overall objective of this effort with LaRC is to provide the technology necessary for the implementation of advanced reliable digital fly-by-wire systems in future aircraft. Negotiations are also currently underway with JSC to include as an additional objective, flight-test verification of key space shuttle flight control system software, hardware, and redundancy management concepts. The program is to be carried out in accordance with the schedules and resources identified by the digital fly-by-wire project plan which is currently being revised. The Phase 1 flight-test program to establish digital fly-by-wire systems feasibility has been completed. In Phase 2, a multichannel digital system is to be developed and flight tested in the FBC aircraft. This will be a three-channel system utilizing redundancy management developed for space shuttle application. Provisions will be made to evaluate, in flight, advanced control laws being developed by LaRC in accordance with the project plan schedule.

W75-70169
Langley Research Center, Langley Station, Va.
DIGITAL FLY-BY-WIRE FLIGHT CONTROL SYSTEMS RESEARCH AND DEVELOPMENT
G. B. Graves 804-827-3745
(501-23-31; 501-23-32)

The objective is to provide a design base for reliable, cost-effective digital fly-by-wire flight control systems for commercial and military aircraft applications. A cooperative program of theoretical and experimental research and demonstra-
tion in DFBW flight control will be carried out by the Flight Research Center and the Langley Research Center. As presently conceived this program has two phases. Phase 1 of which is an initial demonstration and exploration program using Apollo hardware. This program is currently underway at FRC and responsibility for this program lies largely with FRC. Experimentation in control law software will take place during Phase 2. The phase 2 program, in addition to experimentation in advanced control laws will involve development of active control systems and sensor systems that will benefit the flight control task with a view of providing improved systems to be incorporated into the last portions of the Phase 2 program.

W75-70170
Ames Research Center, Moffett Field, Calif.

512-52-01

GENERAL AVIATION - ADVANCED AVIONICS SYSTEMS TECHNOLOGY
Leonard Roberts 415-965-5427

The overall objective of this program is to provide the critical information required for the design of a reliable low-cost avionics system applicable to general aviation aircraft which would enhance the safety and utility of this mode of transportation. Sufficient data would be accumulated upon which industry could base the design of a reasonably-priced system having the capability required by general aviation in and beyond the 1980's. It should also be emphasized that this program is directed at establishing the technology for a total avionics systems design (i.e., navigation, guidance, control, powerplant management, displays, etc.) as opposed to singling out a particular subsystem, or function, upon which the research effort would be concentrated. The proposed program will include analysis system concept studies and piloted simulation and component research and development. Throughout the program, active coordination will be maintained with this program is the strong and direct participation of the general aviation industry and its representatives.

W75-70171
Ames Research Center, Moffett Field, Calif.

512-53-02

ACTIVE CONTROL AIRCRAFT FLIGHT EXPERIMENT
Bradford H. Wick 415-965-6383

The objective is to apply Active Control Technology (ACT) to STOL, VTOL, and Oblique Wing aircraft to assess potential benefits, identify technology requirements, provide a test bed for verification and application of technology, and provide a data base on which design criteria for these aircraft can be developed. Provide a proven methodology to apply advanced control concepts to these aircraft, with attention to aircraft and control system modeling, simulation, testing hardware development and flight verification of systems. Develop a data base for both non-powered and powered lift aircraft which will include economic justification, technical feasibility, ride quality control, gust load alleviation, aircraft handling qualities modes of failure, maintainability, redundancy requirements, ATC coupled systems and interactions of these concepts. The methodology will be applied to develop new aircraft configurations and design the approach will to be integrate the relevant computer programs used in aerodynamics, structure, propulsion, control and economics into a single interdisciplinary active control systems design program that can be used at any stage in the aircraft design cycle. The design program will be evaluated by simulation and flight test using a DHC-6 with modified control surfaces. A conceptual design of an optimally ACT-configured short-haul non-powered lift transport will be developed and evaluated. In addition design methodology for total active control systems for powered lift STOL, VTOL, and Oblique Wing aircraft will be developed. This design methodology will be evaluated by simulation.

W75-70172
Flight Research Center, Edwards, Calif.

512-53-03

ACTIVE CONTROLS TECHNOLOGY DEVELOPMENT
D. A. Deets 805-258-3311

A coordinated program is planned in conjunction with LaRC and ARC to supplement, validate, and demonstrate the design techniques required to incorporate active control into the design of future civil aircraft. The specific FRC the objectives include:

1) design and test simple aerelastic wind-tunnel models and RPRV flight test models to demonstrate flutter suppression concepts as they are developed; (2) conduct studies to determine the most effective means for demonstrating and transferring active controls technology to industry; and (3) conduct flight demonstration tests of a special ACA research vehicle. Theoretical and wind tunnel work will be performed under research grants. Studies and fabrication of demonstrator will be done by contractor.

W75-70173
Langley Research Center, Langley Station, Va.

513-50-50

TRAVELER ACCEPTANCE - LOW-DENSITY SHORT-HAUL SYSTEMS
R. E. Bower 804-827-3285

The objective is to identify, study in detail, and model those factors influencing traveler acceptance and use of aircraft as the preferred model of travel by the public in the low- to medium-density short-haul market. Appropriate information will be compiled through literature search, traveler questionnaires, and measurements aboard low- to medium-density, short-haul airline systems. Limited information will also be obtained concerning competing modes of transportation which could influence choice of travel. The data will be analyzed and mathematically modeled. Some existing types of aircraft used in low-density, short-haul service will be evaluated using this model. The majority of effort will be carried out under grant.

W75-70174
Langley Research Center, Langley Station, Va.

513-50-51

VLF WIDE AREA NAVIGATION FOR LOW-DENSITY SHORT-HAUL TRANSPORTATION
G. B. Graves 804-827-3745
(505-07-12)

The objective of this work is to investigate VLF navigation techniques and to develop promising approaches for en-route and terminal area navigation. Systems such as Omega can provide large geographic coverage with a limited number of ground stations, and are relatively unaffected by altitude or terrain characteristics. Characteristics such as these are highly desirable for short-haul, low-density transportation systems, where direct terminal-to-terminal routes at relatively low altitudes are required. The application of VLF navigation to civil aviation will also enhance air safety by reducing pilot navigating within an area of approximately 1000 VOR stations. Work will be conducted in two areas. The first area consists of the development and evaluation of Omega avionics, including both differential and composite Omega configurations.

W75-70175
Ames Research Center, Moffett Field, Calif.

513-50-52

MARKET SURVEY OF MEDIUM DENSITY SHORT-HAUL AIR TRANSPORTATION
Susan Norman 415-965-5887

This study will concentrate on preliminary parametric aircraft synthesis studies and aircraft/airline interface studies. Medium density short-haul air transportation refers to service conducted by local service or commuter carriers using 30 to 70 passenger aircraft. An airline/aircraft interface analysis including trunk, local service and commuter type operations will be performed. A parametric analysis of various aircraft configurations will be included and a system analysis indicating the aircraft impact on actual airline operation will be studied. At least three passenger sizes will be included as well as a number of aircraft configuration concepts such as families of aircraft sizes. In addition, the economics of both the operating and initial investment costs will be examined. This is expected to be a critical decision factor since current operational requirements indicate that such service is sensitive to initial aircraft purchase costs and operating costs. A realistic outlook concerning actual airline operation will be encouraged throughout the study and the actual participation by an airline will be considered.

W75-70176
Ames Research Center, Moffett Field, Calif.

513-51-01
NOISE REDUCTION FLIGHT PROCEDURES EXPERIMENTS
Bradford H. Wick 415-965-5427
(768-83-03; 768-83-02)

The objective is to develop navigation, guidance, and control avionics for use in STOL flight experiments and for use in STOL validation flights for the new common-use civil/military Microwave Landing System (MLS). Performance and design requirements for a flexible avionics system which will operate in various manual and automatic modes will be defined to satisfy the objectives of STOL flight experiments and of STOL MLS validation flights. In particular, requirements will be based on the use of the developmental scanning beam system, MODILS, and the MLS provided by the FAA for use in the STOL flight experiments. The flexible avionics system referred to as STOLAND will be designed and developed and then installed in appropriate STOL aircraft and tested in flight. With the exception of MODILS/MLS, the flight tests will be conducted using standard instrumentation, tracking, data processing, and navigation aids. The detailed design and development of STOLAND, which will be performed by the contractor, will be supported by relatively complete fixed base and moving base simulations of the aircraft and avionics system at Ames Research Center.

W75-70177 513-52-01
Langley Research Center, Langley Station, Va.
TERMINAL CONFIGURED VEHICLE PROGRAM
G. B. Graves 804-827-3745
(768-83-04)

The TVC Program is an advanced technology activity focused on Conventional Take-off and Landing (CTOL) Aircraft that will be operating in reduced weather minima in the future high-density terminal areas equipped with new landing systems, navigational aids, and increased surveillance and automation under development by DOT/FAA. The broad objectives of the program are to provide improvements in the airborne systems (avionics and air vehicle) and operational flight procedures for reducing approach and landing accidents, restricting weather minima, increasing air traffic controller productivity and airport and airway capacity, saving fuel by more efficient terminal area operations, and reducing noise by operational procedures. This involves research analyses, simulations, and flight studies. A modified Boeing 737 airplane, (Research Support Flight System, RSFS), equipped with highly flexible display and control equipment being made available by DOT/FAA, will be used to study operations in simulated future terminal area environments. Active coordination will be maintained with DOT/FAA and DOD. Particular emphasis will be given to compatibility with the microwave landing system (MLS) under development by DOT/FAA and with future air traffic control systems.

W75-70178 513-52-09
Wallops Station, Wallops Island, Va.
WALLOPS SUPPORT OF MLS FEASIBILITY DEMONSTRATION
G. E. Godwin 804-824-3411
(768-81-09)

The Microwave Landing System (MLS) is a civil/military aircraft approach and landing system which is being developed in a joint DOD/DOT/NASA program. Needs of the military and civil aviation, at domestic and foreign airports until at least the year 2000, are to be met by MLS. Development is being accomplished under a three step, five year plan. The steps are described as follows: Step 1 - technique analysis and control definition. Step 2 - development of feasibility demonstration models and feasibility demonstration, and Step 3 - development and evaluation of preproduction engineering prototypes. NASA, Wallops Flight Center has been requested to serve as one of the test sites for the Step 2 - feasibility demonstration of the MLS by the FAA, prime government agency responsible for the development of the MLS. The FAA NAFEC at Atlantic City, NJ will serve as the other feasibility demonstration site. This RTOP will cover the Wallops Flight Center support of the feasibility demonstration portion of the MLS development.

W75-70179 513-53-01
Ames Research Center, Moffett Field, Calif.
TECHNOLOGY FOR ADVANCED INTEGRATED AVIONICS FOR TERMINAL AREA FLIGHT EXPERIMENTS IN STOL AIRCRAFT
Bradford H. Wick 415-965-5428
(768-83-03; 768-83-02)

Experiments will be conducted on navigation, guidance, control, and flight management systems for STOL aircraft using advanced airborne avionics and a Microwave Landing System. The results will be used to evaluate system concepts and define design criteria and operational procedures for STOL aircraft. This program is part of the Joint DOT/NASA Operating Systems Experiments Program. Investigations will be conducted encompassing analysis, simulation, flight experiments, and supporting studies. These investigations will emphasize the terminal area navigation, guidance, control and flight management problems which must be solved to take maximum advantage of STOL capabilities for making steep ascents and descents, tight turns, and slow speed approaches and landings. The flight experiments will be conducted using a flexible research avionics system, referred to as STOLAND, in conjunction with appropriate STOL aircraft. This complete research system comprises STOL aircraft, avionics system, instrumentation, and the following navigation aids: VOR/DME, Tacan, and a microwave landing guidance system to be provided by the FAA.

W75-70181 513-53-03
Ames Research Center, Moffett Field, Calif.
STOL OPERATING SYSTEMS EXPERIMENTS USING MODILS AND THE CIVIL MILITARY MICROWAVE LANDING SYSTEM (MLS)
Bradford H. Wick 415-965-5428
(768-83-01)

Experiments will be conducted on navigation, guidance, control, and flight management systems for STOL aircraft using advanced airborne avionics and a Microwave Landing System. The results will be used to evaluate system concepts and define design criteria and operational procedures for STOL aircraft. This program is part of the Joint DOT/NASA Operating Systems Experiments Program. Investigations will be conducted encompassing analysis, simulation, flight experiments, and supporting studies. These investigations will emphasize the terminal area navigation, guidance, control and flight management problems which must be solved to take maximum advantage of STOL capabilities for making steep ascents and descents, tight turns, and slow speed approaches and landings. The flight experiments will be conducted using a flexible research avionics system, referred to as STOLAND, in conjunction with appropriate STOL aircraft. This complete research system comprises STOL aircraft, avionics system, instrumentation, and the following navigation aids: VOR/DME, Tacan, and a microwave landing guidance system to be provided by the FAA.

W75-70182 513-53-04
Langley Research Center, Langley Station, Va.
V/STOL - AIR TRAFFIC CONTROL INTEGRATION STUDIES
G. B. Graves 804-827-3745
This research is concerned with the problems of integrating V/STOL aircraft and their air traffic control system into the total air traffic control environment of the terminal area. The objectives are to determine: (1) aircraft design and equipment requirements; (2) operating procedures and airspace volume; (3) ATC equipment and handling procedures; and (4) requirements for compatibility and integration of the V/STOL system with the total ATC complex. Real-time simulations are being conducted of a VTOL aircraft operating in the New York metropolitan area and performing precision approaches at high-density airports. These simulations will be improved to include new terminal area routings and approach concepts based on the low-speed and maneuver capabilities of V/STOL configurations. Increased reality will be obtained by linking the Langley simulator with the FAA’s ATC simulator at Atlantic City, followed by the eventual linking of a V/STOL aircraft operating at the Wallops Radar Flight and being provided simulated total terminal-area traffic environment by linking to the Atlantic City ATC simulator.

W75-70183

Ames Research Center, Moffett Field, Calif.

INVESTIGATION OF THE USE OF STRAPDOWN INERTIAL SENSOR UNITS FOR THE INTEGRATION OF FLIGHT CONTROL, GUIDANCE AND NAVIGATION FUNCTIONS

Bradford H. Wick 415-965-5426

(768-83-01)

In-flight investigation of specific current system technologies all given for a lowcost, highly reliable inertial guidance and navigation concept which can be used as an integrated sensor package, and for use in improving guidance and navigation. This system will make use of digital computer technology with the system elements regrouped for maximum performance and minimum complexity. It will be a multiple redundant system which fully utilizes an aircraft digital computer for navigation, guidance and flight control. A candidate system is being developed by ARC-CSCL which will replace the standard set of inertial sensors with a multiple redundant strapdown inertial reference unit (SIRU). There are four tasks in this program. Task 1 is the establishment of requirements, development of technology, and identification of deficiencies for rectification. Task 2 is the identification and projection of performance and system requirements through computer analysis for the ARC-CSCL advanced inertial sensor systems. Task 3 comprises the investigation of this system through a comprehensive simulation/laboratory, and flight test program to confirm and refine the SIRU performance. Task 4 is the development of aided inertial Kalman filters for an advanced technology low cost redundant strapdown system through computer and motion simulation studies and flight tests.

W75-70184

Ames Research Center, Moffett Field, Calif.

TERMINAL AREA EFFECTIVENESS PROGRAM - OPTIMIZATION OF FLIGHT PROCEDURES OF SHORT HAUL TRANSPORT AIRCRAFT

Leonard Roberts 415-965-5569

(768-83-01)

The overall objective of the program is to provide guidance to NASA’s aeronautical research and technology efforts by developing techniques and facilities to improve the effectiveness of future short haul aircraft and aircraft system. The criteria for effectiveness will include such factors as fuel usage, noise and pollution impact, terminal area capacity, airspace and ground space usage, pilot and passenger acceptance, operating economics, etc. Mathematical models required for effective studies will be developed for: future short haul transport aircraft, their noise and energy usage characteristics, and for the air traffic environment as well as for other elements of the short haul system. These models will be used in fast and real time simulations to develop optimum flight procedures. System studies will be conducted to determine the capacity of future terminal areas as a function of implementation alternatives. A Methodology will be developed for integrating the effectiveness measures in order to obtain a total assessment of terminal area traffic and environment as well as for other elements of the short haul system. Flight experiments will be conducted to evaluate future short haul operations and systems in a high traffic density area.
flight program for the Augmentor Wing Aircraft. This flight program and the in-flight simulation will encompass basic STOL handling qualities, stability and control augmentation systems, flight director laws, and control integration, with the results having application to handling qualities design criteria. Operational characteristics to be considered include flight path control authority, operating margins, maneuver capability, stability limitations and field length factors.

W75-70188
Ames Research Center, Moffett Field, Calif.

WAKE VORTEX MINIMIZATION FLIGHT RESEARCH
B. H. Wick 415-965-5567
(505-08-02: 505-06-02)

A vigorous intercenter program is in progress to define aerodynamic techniques and devices to alleviate the trailing wake vortices as a constraint in airspace or airport operations. A flight research program will investigate, verify, and demonstrate the effectiveness of promising aerodynamic devices or concepts developed in ground facilities. For these purposes, Ames Research Center will obtain and analyze flight data, using both conventional aircraft response instrumentation and hot-wire anemometry techniques. Flight Research Center has the responsibility for installation of the alleviation devices and for operational planning and conduct of the flight tests.

W75-70189
Flight Research Center, Edwards, Calif.

WAKE VORTEX MINIMIZATION FLIGHT EXPERIMENTS
M. R. Barber 805-258-3311
(505-06-22)

This RTOP covers FRC activities related to full-scale flight-test evaluations of various aerodynamic wake vortex alleviation devices. These devices have been, and/or, are being developed in ground facility tests under the related RTOP (505-06-22). The approach taken will be that of testing the devices on actual transport aircraft (e.g., 747's, 727's, L1011's etc.). Comparisons of the vortex characteristics with and without the devices will be made by probing the aircrafts wake with a specially instrumented probe aircraft.

W75-70190
Langley Research Center, Langley Station, Va.

WAKE VORTEX MINIMIZATION FLIGHT RESEARCH
R. E. Bower 804-827-3285
(505-06-22)

The objective is to develop and demonstrate wake vortex minimization device(s) acceptable for routine aircraft operations. Laboratory and flight tests conducted over the past 18 months have established the feasibility of modifying the trailing vortex system of an aircraft by aerodynamic means. Laboratory testing will continue to develop the alleviation system that will allow safe and economic operation of aircraft with separation distances of 2 nautical miles. Flight evaluations will be conducted as required to demonstrate the effectiveness and operational suitability of the alleviation system(s).

W75-70191
Langley Research Center, Langley Station, Va.

ROTOR SYSTEMS FOR ROTOR SYSTEMS RESEARCH AIRCRAFT
R. E. Bower 804-827-3285

In order to insure timely rotorcraft technology development and demonstration and to provide maximum efficiency of utilization of the Rotor Systems Research Aircraft (RSRA), research rotor systems will be selected, designed, fabricated, and flight tested. A technology program for hardware development and flight experiments will be defined for testing of current and advanced technology rotor systems through a broader flight envelope to define and document technological advancements for rotors and rotorcraft. Through a series of advanced systems design study contracts, definitive program plans will be developed in order to establish both technical and budgetary data necessary for initiating the initial major rotorcraft design and fabrication. Parallel effort will be continued to provide the design verification information required for both the variable geometry rotor and the composite structure rotor. Predesign studies leading to definition of effective manufacturing techniques for the aero/ acoustic rotor will be carried out.

W75-70192
Ames Research Center, Moffett Field, Calif.

OBLIQUE WINGED AIRCRAFT SYSTEM STUDIES
H. M. Drake 415-965-5881

The objective of these studies is to provide configuration definition and detailed analysis in selected technical areas of oblique winged transport aircraft. Previous contract system studies identified promising high transonic speed, oblique winged aircraft at the conceptual design level. An ongoing study of FY-1974 will also identify a similar subsonic aircraft. Studies this year will provide technical and economic depth to the understanding of both the high transonic and the subsonic speed concepts. Particularly, contracts will be initiated to perform an economic assessment of potential benefits from $M = 1.2$ flight, to evaluate the oblique wing concepts studied from an airline operator's viewpoint, and to perform refined technology studies for both the high transonic and subsonic speed vehicles. Additionally, the ongoing study will be extended to provide better definition of the M = 1.2 design. The economic assessment of the M = 1.2 flight will be a contracted study extending over a 4 month period ending in January 1975. The airline evaluation of oblique winged aircraft will be a competitive contract extending over a 6 month period ending in June 1975. Technical refinement of the subsonic concept will be an extension to the current contract, to be completed in a 6 month period ending in May 1975. Extension of the ongoing contract will be a 65KS study through December 1974. Refinement of other key technical areas will be a competitive contract of 50KS ending in April 1975.

W75-70193
Flight Research Center, Edwards, Calif.

YF-12 FLIGHT OPERATIONS
Gene J. Matranga 805-258-3311
(766-72-02)

The YF-12 type airplanes are the only airplanes in the free world which are capable of sustained Mach 3 flight. Major areas of research include the examination of the hot, flexible structure; dynamic inlet behavior; airframe propulsion interaction; and general problems related to high-speed and high-altitude flight. In the structures area, thermocouples and strain gages have been installed in airplane 935. Ground calibrations will allow for the measurement of hot loads in flight. Flight results will be compared with NASTRAN predicted information. Dynamic inlet information obtained in flight will be compared with results from a 1/3 scale inlet model and a full-scale inlet operated in the wind tunnel. Airframe propulsion interaction flight information will be related to data predicted using a 1/12 scale airframe model. The airplanes will be used in support of numerous Supersonic Cruise Aircraft Research projects.

W75-70194
Ames Research Center, Moffett Field, Calif.

YF-12 DISCIPLINARY RESEARCH
H. M. Drake 415-965-5880
(766-72-01: 766-72-02)

The unique performance capabilities of the YF-12 airplane provides an opportunity to obtain heretofore unavailable flight data. These data are invaluable for the assessment of theoretical and empirical prediction methods. Comprehensive wind tunnel tests will be made in the areas of: (1) the engine-air inlet and internal flow system; (2) the effects on the aircraft aerodynamics produced by the various modes of operation of the propulsion system; and (3) aerelastic effects on the aircraft stability characteristics. Flight tests will be conducted by the NASA Flight Research Center for correlation with the wind tunnel results, and with predictions based on theory. Current prediction techniques will be improved and resulting technology provided to industry for use in design of future supersonic cruise aircraft.

W75-70195
Lewis Research Center, Cleveland, Ohio.
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

YF-12 PROPULSION RESEARCH
M. O. Dustin 216-433-6136
(505-05-11)

The objectives are: (1) to evaluate the capability of currently available computer simulation techniques to determine the dynamic behavior of a high Mach number mixed compression inlet to downstream and upstream disturbances; (2) to determine the steady state performance of a high Mach number, mixed compression inlet and compare the performance with a similar inlet in flight; and (3) to study existing aircraft control systems and investigate alternate techniques that minimize the propulsion system-airframe interaction.

W75-70196 516-51-02
Flight Research Center, Edwards, Calif.

YF-12 DISCIPLINARY RESEARCH
J. D. Watts 805-258-3311

A closely coordinated flight and ground test program utilizing the YF-12 airplane is being carried out in parallel with an extensive wind tunnel and analytical program. The over-all objective is to thoroughly evaluate the state-of-the-art of flight loads measurement, loads predictions including aeroelasticity and thermal effects and structural analysis for flexible hot-structure aircraft. The major effort in the program are: flight measurement of wing and fuselage loads and deflections, laboratory determination of temperature effects on loads and deflection measurements, 1/12 scale rigid YF-12 pressure model tests, an 8000 degree-of-freedom NASTRAN structural model of the aircraft, and a FLEXSTAB panelized aerodynamic model of the aircraft. Data from all these sources will be correlated in the final analysis. Propulsion predictability of steady-state supersonic inlet performance, inlet flow dynamics, and interaction of engine, inlet, and aircraft control systems is the major problem to be evaluated with the YF-12 airplane. The effort involves simulations, wind tunnel tests of a 1/12 scale airplane model, a 1/3 scale inlet model, and a full-scale inlet, and flight tests of the YF-12 propulsion system. Other research includes: boundary layer experiments, base drag measurements, and aerothermal tests performed in the Mach 3 flight environment for correlation with theoretical and wind tunnel predictions.

W75-70197 516-51-02
Langley Research Center, Langley Station, Va.

YF-12 DISCIPLINARY RESEARCH
M. L. Spearman 804-827-3134
(766-72-02: 766-72-02: 766-72-02)

Objectives are to evaluate analytical techniques for predicting boundary layer transition, heat transfer, and skin friction; to provide the basis for improved design prediction techniques; to define and provide solutions for unknown problems in flight, and to evaluate the application of experimental wind tunnel results to flight conditions. Approach will be to conduct pertinent ground-based experiments and wind-tunnel tests on a boundary layer test component (hollow cylinder 10 ft. long and 1.5 ft. in diameter) that will be flight tested on the YF-12 aircraft. Analyze and correlate these data with those from flight tests on the same component.

W75-70198 516-52-01
Langley Research Center, Langley Station, Va.

ADVANCED ACOUSTIC-COMPOSITE NACELLE PROGRAM
A. L. Braslaw 804-827-3838

The objectives are to demonstrate the noise reduction potential as well as the savings in cost, fuel, and weight which can be achieved utilizing acoustic-composite materials for quiet nacelle construction; to demonstrate on a modern wide-body transport in airline operation the long-term durability and maintainability of the advanced acoustic-composite nacelle; and establish confidence in the technology such that its application will be implemented by the aircraft and airline industries. Conceptual design studies of cost and weight-effective means of integrating into nacelle design various promising acoustic-composite material concepts for reducing noise will be conducted. These studies will include tradeoff evaluations in which the sensitivity to noise reduction of such factors as direct operating cost, takeoff gross weight, and fuel consumption are determined. Complementary in-house research will also be accomplished. The experimental flight program will be carried out in four major elements: preliminary design, detail design and fabrication, ground and limited flight tests, and in-service evaluation.

W75-70199 517-51-01
Flight Research Center, Edwards, Calif.

TRANSONIC AIRCRAFT TECHNOLOGY (TACT)

The objectives of this effort are: (1) to demonstrate the SuperCritical Wing improved transonic drag rise and lift levels for buffet onset shown in wind-tunnel investigations; and (2) establish the desired level of confidence in prediction of SuperCritical Wing characteristics for future applications. This is a joint NASA/USAF program being conducted in accordance with a Memorandum of Understanding dated 16 June, 1971. The Supercritical Wing and associated parts were provided by Convair Division of General Dynamics under Air Force Contract AF 33615-71C-1912. The left-hand wing was structurally proof tested at the AFFDL Wright-Patterson AFB. NASA FRC will supply and install the basic instrumentation as well as perform the airplane modification and wing installation. NASA FRC will also be responsible for the flight test and total program management beginning at the end of the envelope expansion phase of the flight test.

W75-70200 517-51-02
Ames Research Center, Moffett Field, Calif.

F-111 TACT RESEARCH AIRCRAFT
H. M. Drake 415-965-5987
(501-26-04)

The overall objective of the Transonic Aircraft Technology (TACT) program is to provide a proof-of-concept research flight demonstration of recent advances in supercritical wing technology leading to the development of design criteria for future military and civil aircraft. Specifically, the effort at the Ames Research Center will be to provide thorough wind tunnel investigations as the basis for a prediction of aerodynamic performance, stability, control, buffeting characteristics, and structural loads of the TACT airplane. Correlation of the predicted characteristics based on the wind tunnel results with full-scale flight test data is a further major objective. Current projections are that all wind tunnel test data required for the correlation of wind tunnel and flight test results will be obtained by end of FY-76.

W75-70201 517-51-03
Langley Research Center, Langley Station, Va.

TRANSONIC AIRCRAFT TECHNOLOGY (TACT)
T. G. Ayers 804-827-2631
(766-76-01: 766-76-02)

The overall objective of the Transonic Aircraft Technology (TACT) program is to provide proof-of-concept of supercritical airfoil technology in the transonic and low supersonic flight regimes and to provide design criteria for the design of future military and civil aircraft. The effort at the Langley Research Center will be to analyze and document wind tunnel test results of the nozzle thrust-minus-drag and fuselage afterbody drag coefficients for use in correcting static aerodynamic data to full scale airplane values. Various engine power settings are planned for the Langley effort and will provide technical assistance for the correlation and analysis of the wind tunnel and flight aerodynamic data.

W75-70202 723-01-01
Flight Research Center, Edwards, Calif.

HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY (HIMAT) - FLIGHT RESEARCH PROGRAM
G. Layton 805-258-3311
(505-06-44)

This RTOP covers the flight test phase of a program to provide improved technology for the design of highly maneuverable aircraft. Present design restraints will be relaxed to permit complete freedom in the application of state-of-the-art system such as integrated, computerized controls, composite structures, propulsion augmentation of lift and control and the like in order to achieve...
maximum benefits from synergistic effects. Flight tests of the complete airplane must be conducted to prove most of these concepts. The high technological risk involved in applying such concepts precludes their application to prototype aircraft because of the enormous cost of these aircraft. This program will use large-scale free-flying models controlled by remote-piloting techniques to acquire actual flight test data at a minimum cost. The facility for these tests exists at FRC and is currently being extended to handle supersonic vehicles.

W75-70203
Langley Research Center, Langley Station, Va.
HIGHLY MANEUVERSABLE AIRCRAFT TECHNOLOGY (HIMAT)
R. E. Bower 804-827-3285

The objectives are: (1) to support the HIMAT project through directed research and actual evaluation of HIMAT configurations, (2) to systematically study advanced, novel and innovative concepts of aircraft and systems that will improve the combat effectiveness of future air combat aircraft and also provide guidance to advanced design and test teams, (3) to evaluate the effects of handling qualities on combat effectiveness and to apply nonlinear programming theory to design of stability augmentation systems for control of maneuvering aircraft, (4) to support DDG with research leading to improvement in current combat aircraft, evaluation of new prototype designs and modifications, training simulation requirements, weapons systems, and guidance and display systems. Advanced Manned Simulators and analytical tools will be used to carry out the above objectives. Studies have been conducted which varied parameters pertinent to close-in air combat on an existing combat type aircraft. Reports on this work are being prepared. Similar studies are currently scheduled on an advanced baseline configuration, incorporating design features of the lightweight fighter prototypes. Results of the studies will be utilized by NASA and company design teams to aid in—

W75-70204
Lewis Research Center, Cleveland, Ohio.
QUICK, CLEAN SHORT-HAUL EXPERIMENTAL ENGINE (QCSEE)
Raymond J. Rulis 216-433-6851

The objective of this program is to design, build and test experimental engines to consolidate and demonstrate the technology needed for very quiet, clean and efficient propulsion systems for economically viable and environmentally acceptable powered lift short-haul aircraft. Two experimental propulsion systems, engines and nacelles, one for under-the-wing and one for over-the-wing installation, will be designed, built, tested and delivered to the Lewis Research Center. Acoustic and aerodynamic performance testing in wing/flare system installations will be conducted to verify system characteristics and achievement of program goals.

W75-70205
Lewis Research Center, Cleveland, Ohio.
JTBD RETROFIT DEMONSTRATION
Robert W. Schroeder 216-433-6654

Develop modifications for the JTBD engine that can be produced as retrofit kits, develop nacelles with acoustic treatment for the modified engines, and demonstrate DC-9 airplane performance and reduced noise levels by flight demonstration and 727 performance and noise levels by ground tests. Modifications of the JTBD engine include replacement of its two-stage fan with a larger diameter single-stage fan employing inlet guide vanes and wide spacing between vanes and rotor. Core engine pressure and flow is maintained by installation of two booster stages in front of the compressor. The fan turbine and exit strut assembly are being revised. These changes are designed to increase engine thrust and lower the core jet velocity for the same cycle temperature. The lower jet velocity results in decreased jet noise. New engine nacelles include acoustic treatment in the fan ducts and may include other acoustic devices for optimum performance and acoustic suppression. Demonstration of aerodynamic and acoustic performance of the modified engines and new nacelles is accomplished through engine component and engine ground tests, flight tests of a modified DC-9 airplane, and ground tests of a 727 nacelle and center duct installation.

W75-70206
Langley Research Center, Langley Station, Va.
SCAR STRUCTURAL CONCEPT STUDIES

This RTOP will assess relative merits of various structural arrangements, concepts, and materials for advanced supersonic aircraft configurations, and determine the best structural approaches. Under contract, structural concepts will be developed for a prescribed arrow-wing aerodynamic configuration. These concepts will be evaluated through design studies making use of the best available design tools and criteria, and materials technology. Concepts that merit further evaluation by component testing will be identified, and in-house work will include planning for fabrication and test of such a component. Future design studies will be performed in-house using analysis tools both purchased and in-house developed to study arrow-wing and other advanced configurations. Specific targets are: (1) by FY-75, identify best structural approach for arrow-wing configuration aircraft; (2) by FY-75, develop computerized structural model to represent aeroelastic behavior of arrow-wing configurations; and (3) by FY-76, identify structural component for test.

W75-70207
Ames Research Center, Moffett Field, Calif.
FUEL TANK SEALANTS
Dean R. Chapman 415-985-5065

The objective of this RTOP is to develop fuel tank sealants which offer long service life under conditions encountered in advanced supersonic aircraft. The specific objectives are to: synthesize, characterize and vulcanize sealant elastomers; study mechanism(s) by which they deteriorate on exposure to heat both in the presence and absence of fuels; select optimum sealant and determine its thermophysical and dynamic properties; and evaluate it by performing appropriate environmental and flight testing. Novel elastomers will be synthesized as candidate fuel tank sealants designed to meet flight requirements of Mach 2.7-3.0 and higher. The mechanism and kinetics of thermal degradation of these sealants will be investigated. Gum sealants will be selected, compounded and tested under simulated fuel tank conditions to establish their long term service life. The optimum sealant will then be applied to a fuel tank in an advanced aircraft and flight-tested.

W75-70208
Langley Research Center, Langley Station, Va.
SCAR COMPUTER- AIDED STRUCTURAL DESIGN METHODS
G. W. Brooks 804-827-2042 (743-32-01)

This RTOP will develop computer-aided design methods with multidisciplinary capabilities for supersonic cruise vehicles with particular attention to aerelastic, flutter, thermal stress, and fatigue and fracture considerations. Implement design methodology into operational modules (software) tailored for iterative design. Modules will be suitable for incorporation into integrated design systems or may be used as stand-alone design programs. Provide results useful for assessment of the modules from design studies of candidate airframe designs for supersonic cruise aircraft configurations. Under contract, develop improved techniques for sizing structural members under aerelastic constraints and thermal stress. Under contract, develop computerized analysis for damaged composite structural elements. Specific targets are: by FY-76, have improved unsteady aerodynamic and flutter calculations and sizing algorithms in hand for use in computer-aided design.

W75-70209
Langley Research Center, Langley Station, Va.
SCAR - LOADS AND AEREOELASTICITY TECHNOLOGY
G. W. Brooks 804-827-2042

31
The objective of this plan is to develop technology in the area of loads and aeroelasticity to a sufficient state of readiness to provide an adequate base for confident initiation of development of advanced supersonic aircraft. Technical areas of interest include loads due to steady and unsteady motions of the aircraft and its component parts, high frequency acoustic pressures and landing, takeoff and taxiing. Promising new approaches and the needed aerodynamic, dynamic and acoustic analyses will be vigorously pursued and focused on the needs of supersonic cruise aircraft through a combination of in-house and contract research. The development of advanced flutter analysis theories will provide improved inputs to the flutter design module now being developed particularly in the transonic and low supersonic speed regimes. Loads analyses techniques to include aeroelastic and nonlinear transonic effects will be developed. Both existing and new wind tunnel experimental results will be used to verify and improve analysis techniques. Acoustic pressure inputs from the engine exhaust will be quantified and the response of various structures will be analyzed. A program to predict aircraft landing, taxi and takeoff motion will be formulated and the benefits of an active landing gear for the ride quality and loads will be determined. Related work is being done at Langley. Ames and Flight. The DOD/SST technical follow-on program has related tasks which have been considered in developing this program.

W75-70210 743-01-13
Langley Research Center, Langley Station, Va.

SCAR - ATMOSPHERIC TURBULENCE
G. W. Brooks 804-827-2042
The objective is to obtain detailed definition of power spectra of turbulence and wave motion characteristics present in the atmosphere in various meteorological conditions. Special emphasis will be placed on the determination of the spectral shape at wavelengths of 30,000 ft or greater and altitudes of 30,000 to 65,000 ft. Meteorological conditions will include jet stream, mountain waves, gravity waves, and near thunderstorms as well as earth boundary turbulence measurements, the latter primarily for instrumentation verification. Consistency of spectra and directional characteristics of wave phenomena will be investigated. All measurements will be made with the same type airplane (B-57), the same instrumentation and same data processing procedure. Instrumentation includes low inertia flow vanes, an inertial platform for measuring airspeed, and load angles, platform-mounted accelerometers integrated for aircraft velocities, and rate gyros for angular rates. A total of 60-90 flights over a two-year period should yield sufficient data to accomplish the objectives.

W75-70211 743-01-22
Langley Research Center, Langley Station, Va.

SCAR - MATERIALS APPLICATION
G. W. Brooks 804-827-2042
(505-01-31)
The objective of this program is to advance composite and titanium materials and structural component technology to achieve longterm structural integrity and low weight in supersonic cruise aircraft structures. The technology development program will consist of development of advanced high temperature resistant polymers for use as matrix materials in advanced resin/fiber composites for AST structures. High temperature resistant polyphenylquinoxalines and polyimides with improved processability, elevated temperature strength retention and significantly reduced thermoplasticity at elevated temperatures in fiber composites will be developed. Studies currently underway are directed toward improving the thermo-oxidative stability, processing characteristics and high temperature creep resistance of polyphenylquinoxalines will be continued. Studies to improve the autoclave processing characteristics and upper continuous use temperature of addition-type polyimides will be continued. The work proposed in this RTOP differs from the work at Langley Research Center in the following two respects: (1) polyphenylquinoxaline polymers will not be studied by Langley, and (2) the polyimides being studied by Langley are of the conventional condensation type in contrast to the addition-type polyimides which are being studied at Lewis under this RTOP.

W75-70214 743-02-22
Flight Research Center, Edwards, Calif.

AST/STRATOSPHERIC EMISSION IMPACT (MINI-SNIFFER)
Robert D. Reed 805-258-3311
The objective of this RTOP is to develop a small remote piloted sampling vehicle (Mini-Sniffer) capable of encountering and sensing both natural and man-made atmospheric contaminants and fine turbulence in the altitude ranges from 50,000 to 100,000 feet. Since the vehicle will fly at low expected speed it will provide precise positioning and maneuvering in areas of atmospheric pollution concentration in these altitudes as well as defining the basic fine atmospheric turbulence characteristics at these altitudes. The Mini-Sniffer is the only stratospheric sampling platform that can gather both fine turbulence data in aircraft wakes as well as ambient atmospheric data (gust velocities less than 0.1 foot per second and wave lengths less than 200 feet) in horizontal and vertical surveys. The design target is to develop an inexpensive vehicle and an operational technique requiring only a one- or two-man crew to operate in addition to radar and payload support personnel.

W75-70215 743-02-22
Ames Research Center, Moffett Field, Calif.

AST - STRATOSPHERIC EMISSION IMPACT
D. R. Chapman 415-955-5065
The overall objective is to develop an understanding of the interaction of supersonic jet exhausts with the upper atmosphere to provide data which can be used to assess jet wake impact on the natural atmospheric composition. Detailed objectives are to determine composition of the jet wake and the perturbations (chemical, hydrodynamic) in the stratosphere caused by the passage of supersonic aircraft in a specified air corridor, and develop and apply advanced instrumentation to measure these trace constituents in the stratosphere. The Stratospheric Jet Wake Program will continue its studies in two parts: near-wake...
assessments into FY-78, and far-wake evaluations through FY-79. Integral with these activities is an advanced instruments development program. The near-wake studies involve the use of available instruments on a U-2 aircraft flown into the visibly-marked wake of a supersonic aircraft in the stratosphere to measure exhaust gases. These data are being used to improve and verify mathematical models of engine exhaust wake chemistry. Hydrodynamic models of the wake are being verified by photographic methods which provide wake dimensions with time. Far-wake studies require new types of instruments being developed in the advanced instruments development program. These devices will provide sensitive measurements of very dilute exhaust gases and atmospheric constituents with which the exhaust may react. Improved wake visualization methods are also necessary so aircraft can be directed into and near aging exhaust plumes.

W75-70216 743-02-22
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
STRATOSPHERIC EMISSION IMPACT
R. R. McDonal 213-354-6186
(505-03-31; 506-21-63)
This work addresses itself to the task of establishing an inventory of trace gases existing in the stratosphere at altitudes between 10 and 25 km. Concentration levels of molecular species which are of particular interest will be determined. Measurements of engine emissions into the higher levels of the atmosphere will be determined to accuracies of a few percent. These gases include H2O, CO2, CO, O3, CH4, NO, N2O, NO2 and HNO3, which have already been observed; as well as others as, for example H2CO and HC, for which, so far, only upper limits of their abundance can be given. Measurements of the absorption of infrared solar radiation by the molecular transitions of these trace species in the 1.2 to 8 micron region will be made from airplanes flying at stratospheric altitudes. A high efficiency interferometer spectrometer will observe the rising or setting sun through long stratospheric paths at high spectral resolution during two flight periods in the third and fourth quarter of FY-75. Analysis of the spectra obtained will result in determinations of mixing ratios in the ten to the minus 8 to ten to the minus 10 range and their variations with altitude.

W75-70217 743-02-22
Lewis Research Center, Cleveland, Ohio.
SCAR STRATOSPHERIC EMISSION IMPACT
A. R. Rudey 216-433-6160
An objective is to analyze and describe the possible instrumental effects of aircraft exhaust emissions from fleets of supersonic aircraft on the natural stratosphere. An additional objective is to support the Stratospheric Jet/Wake Experiment currently being planned. Ground tests are needed to identify the engine exhaust pollutant character and level and the chemical processes that they may undergo with the natural environment over a period of time. Flight tests are needed to validate the ground tests and the developed analytical models of the upper atmosphere characteristics.

W75-70218 743-02-22
Langley Research Center, Langley Station, Va.
STRATOSPHERIC EMISSION IMPACT
J. E. L. S. Love 804-827-2893
(506-20-14)
The objective of this research is to develop laser flight instrumentation to measure trace constituents in stratospheric jet wakes and the effect of these constituents on the ambient stratosphere. This RTOP continues a program initiated in FY-73 (501-24-20). A feasibility study under that program identified tunable laser instruments which are capable of measuring jet wake constituents with greater sensitivity than currently available in-house techniques. Under an FY-74 program (743-34-22) a Phase A contractual design and cost study of a flight instrument for two ended diode laser absorption measurements was initiated. The approach of this program will be to contract for the development of a flight instrument using the results of the Phase A study as an input for design and cost. Under the guideline funding flight instrument development will be accomplished by a series of phased contracts. Phase B will be for procurements of detectors, lasers, and preliminary electronics testing; Phase C for instrument packaging; and Phase D for flight tests. In-house studies of advanced instrumentation including heterodyne radiometry will continue with emphasis on using the high spectral resolution available to measure wake or ambient constituent concentrations through absorption of solar radiation.

W75-70219 743-03-11
Ames Research Center, Moffett Field, Calif.
SCAR PROPULSION TECHNOLOGY
B. H. Wick 415-985-5036
(505-03-10; 505-03-12)
This RTOP covers research to reduce the noise level of supersonic aircraft. The noise comes from two sources, turbulent jet mixing from the engine exhaust, and compressor noise. Much research in these areas has been conducted in the past, however nearly all was done at zero forward speed. Recent work has indicated that the jet turbulent mixing noise reduction expected at forward speed does not occur with mixer suppressor nozzles. From the standpoint of compressor noise, distortion at the compressor face arising from aircraft attitude and flow around the airframe can increase noise. It can probably be avoided by proper engine placement and/or careful inlet design. Solution of these problems requires research at forward speed in a ground based facility, that is, in a wind tunnel. Studies in FY-1974 have served to develop techniques for measuring noise in wind tunnel and the results have been encouraging and have provided much useful data. However, the problem of relating near field measurements to far field measurements needs additional work. It is planned to test several 6' diameter nozzles in the Ames 40- by 80-Foot Wind Tunnel, in both the near and far field. This test will provide scale effect data and relative velocity effects on advanced mixer suppressor nozzles, as well as a basis for the development of techniques to extend near field jet noise measurements to the far field.

W75-70220 743-03-11
Lewis Research Center, Cleveland, Ohio.
SCAR NOISE REDUCTION TECHNOLOGY
U. H. Von Glahn 216-433-6658
Objective is to develop the technology required to quiet both conventional and advanced supersonic transport engines to levels acceptable to the community. Areas of particular concern include noise suppression of high velocity jets and choked inlet suppression of turbomachinery noise. Particular emphasis will be focused on the external flow effects on various jet noise suppressor types and on the acoustic characteristics associated with engine cycles of interest for this application. Moving frame acoustic tests will be initiated using scale-model nozzles developed for advanced duct-burning turbofan engines.

W75-70221 743-03-21
Lewis Research Center, Cleveland, Ohio.
SCAR POLLUTION REDUCTION TECHNOLOGY
R. A. Rudey 216-433-6160
(505-03-32; 505-04-31; 743-33-22)
The objective is to minimize the amounts of pollutants being discharged by aircraft engines into the upper atmosphere, by improving combustor and/or augmentor designs. Achieving low levels of exhaust emissions from high altitude aircraft by improving combustion design principles is needed in order to minimize any potential interaction of combustion products with the ambient atmosphere. Reductions in combustor exhaust emissions will be sought in two efforts. The first will be directed toward modification to combustor hardware presently being developed in the Clean Combustor Program with emphasis placed on reducing oxides of nitrogen (NO sub x) at supersonic cruise conditions. The second approach is to evaluate new and unique techniques to minimize NO sub x to the lowest values possible in combustion systems eventually applicable to aircraft jet engines. The first effort is aimed at the near term emission reductions that may be practical, whereas the second effort is geared toward developing technology for future supersonic aircraft engines. The evaluation of potential augmentor emission reductions is needed to assess the impact...
that well designed augmentors, used during cruise, would have to total engine emission levels.

W75-70222 743-03-21
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

AST POLLUTION REDUCTION
R. R. McDonald  213-354-6186
(505-03-31; 506-21-63)

The objective of this task is to obtain an inventory of the trace gases occurring in the stratosphere between 10 and 25 km over a wide range of latitudes. This inventory will consist of the unambiguous identification and accurate determination of concentration levels of those trace species already known to be present and judged to be of importance in the assessment of effects of travel in the stratosphere by high altitude aircraft. Among these gases are those occurring naturally, such as H2O, CO2, CO, O3, CH4, and N2O, as well as others which have been observed, as NO, NO2, HNO3 and HCl. Measurements of the absorption of infrared solar radiation caused by the molecular transitions of these species in the 1.2 to 8 micron region will be made from airplanes flying at stratospheric altitudes with a high resolution (0.25 cm-1), high throughput interferometer spectrometer, the High Speed Interferometer. Analysis of the spectra obtained will result in determinations of mixing ratios in the 10 to the minus 8th power to 10 to the minus 10th power range, and their variation with altitude.

W75-70223 743-03-31
Lewis Research Center, Cleveland, Ohio.

SCAR INLET STABILITY SYSTEM
M. O. Dustin  216-433-6136
The objective is to demonstrate an improved inlet stability system for supersonic, mixed-compression inlets. The system will allow the inlet to operate at a higher pressure recovery with fewer inlets unstarts than for the present inlet system. The development of a shock stability bleed system using mechanical relief valves will be accomplished in wind tunnel tests using a full-scale YF-12 inlet. If successful, the stability system will be evaluated in flight on the YF-12 aircraft.

W75-70224 743-03-41
Lewis Research Center, Cleveland, Ohio.

SCAR ENGINE STUDY
R. J. Weber  216-433-6273
Advances in propulsion system technology will be required to permit the development of a quiet, clean, economical commercial supersonic transport. Contracts for the study of such airplanes will be let by Langley Research Center and other supporting work will be performed by LaRC, LeRC, ARC, FRC, and DOT. As part of this effort, LeRC will let contracts to study various types of propulsion systems that might be applied in the advanced aircraft. The studies will determine the desirable characteristics of the engines, assess the benefits of advanced technology, and identify the needs for future research. They also will be used to define the content of an experimental engine program.

W75-70225 743-03-51
Lewis Research Center, Cleveland, Ohio.

SCAR - TECHNOLOGY-UNIQUE COMPONENTS
M. J. Hartmann  216-433-6650
Advanced aircraft that must perform efficiently over a wide range of subsonic and supersonic flight speeds may employ variable bypass engines which require a number of unique components. These components include fans, flow diveters, and sound suppression systems which must provide a high level of performance over a very wide range of flow conditions. The large complex sections must be fabricated with lightweight structural materials capable of operating at the high temperatures encountered at high flight speeds and in the hot section of the engine. Advanced composite materials provide the most promising materials for these structures. To provide the necessary high levels of performance and advanced materials for these unique components of variable bypass engines, the following major thrusts are included: (1) advanced Boron/Aluminum composite materials for lightweight fan blades with improved impact resistance will be evaluated; (2) structural and fabrication properties of an applicable high temperature composite material (Silicon Carbide in metal matrix) will be evaluated for use in the hot sections of the engine; and (3) performance characteristics of potential flow diverter and fan systems will be evaluated.

W75-70226 743-04-01
Langley Research Center, Langley Station, Va.

SUPERSONIC TECHNOLOGY: SYSTEMS-INTEGRATION STUDIES
R. E. Bower  804-827-3285
The work performed under this RTOP will address the impact of advanced technologies applied to supersonic cruise aircraft by studying their effects on the overall characteristics and mission capabilities of promising aircraft concepts. Integration studies will typically evaluate advances in aerodynamics/configurations, propulsion, structures, materials, and avionics. These studies will not only indicate the most favorable design trade-offs, but will also point out the directions for productive future research and technology activities. Throughout the studies, major considerations will be the meeting or exceeding of current noise and pollution levels and improving the energy utilization. The work will be carried out in two ways. In one, the ASTO will direct and in-house study team which makes use of nonpersonal services contract manpower. The emphasis will be on providing early assessments of new approaches on the characteristics of the total aircraft, and defining reference configurations for future comparison purposes. In the other approach, industry expertise will be utilized by awarding contracts in areas of particular company capability or initiative, and where practical design and construction methodology needs to be applied.

W75-70227 743-04-11
Ames Research Center, Moffett Field, Calif.

ADVANCED SUPERSONIC TECHNOLOGY–OPTIMUM DESIGN/CCV
H. M. Drake  415-965-5881
(791-93-06; 505-26-07)
This RTOP is to provide information in areas where experience has shown that design knowledge for advanced supersonic cruise aircraft is incomplete. Specifically: (1) determine the liquid hydrogen fueled configuration which minimizes the mission energy consumption; and (2) define a refined liquid hydrogen fueled configuration which incorporates advanced technology in engine design and installation insulation materials and acoustic, aerodynamics, stability and structures. Using the results of the LH2 fueled aircraft study of FY-73, a study will be made to assess the impact of several design considerations on the aircraft configuration and its fuel consumption. This will be an add-on to contract NAS5-7732 of FY-73 and will be a 75K$ 6 month study ending in December 1974. A second study will be performed to further refine the LH2 supersonic cruise aircraft concept. This design study will explore the advantages of the applications of such concepts as LH2 fueled variable cycle engines, advanced high temperature composite materials and different aerodynamic configurations resulting from the high volume requirements of liquid hydrogen. This will be a competitive contract study of 125K$ extending over a 6 month period, ending in June 1975.

W75-70228 743-04-12
Langley Research Center, Langley Station, Va.

SCAR - AERODYNAMIC PERFORMANCE TECHNOLOGY
R. E. Bower  804-827-3285
(743-35-21; 743-35-11; 743-35-21)
The objective of this program is to develop advanced supersonic cruise vehicle concepts and to provide a source of experimental data which can be used in the optimization of these concepts. The goal is to provide fully integrated configurations which provide at least a 30 percent improvement in supersonic cruise efficiency while meeting the requirements of other disciplinary areas such as structures, flight controls and propulsion. The approach of the effort will be conducted in two ways. In one approach, in-house developed concepts will be analyzed and tested extensively at subsonic, transonic, and supersonic speeds. Iterations will be made on the concepts and
wind tunnel models to establish trade information and to establish
cause and effect relationships. In the other approach, cooperative
NASA/Industry programs will be established to develop data
bases and trade information on promising airframe industry
supersonic cruise vehicle concepts.

W75-70229 743-04-21
Ames Research Center, Moffett Field, Calif.

AERODYNAMICS AND PERFORMANCE (THEORY)
B. H. Wick 415-965-5033

The research performed under this RTOP is to develop and
evaluate aerodynamic theories for use in predicting the high-lift
characteristics of advanced supersonic technology aircraft,
including wing-body interference, propulsive flow effects,
airframe acoustic shielding effects, and ground effects. The overall
objective is to provide the theoretical technology for design of
advanced supersonic technology aircraft, having acceptable
aerodynamic and acoustic characteristics during landing, take off,
and subsonic flight operations.

W75-70230 743-04-21
Langley Research Center, Langley Station, Va.

SCAR - AERODYNAMIC PERFORMANCE TECHNOLOGY
THEORY
R. E. Bower 804-827-3285
(501-06-01: 743-35-21)

The objective of this program is to develop and validate
methods for use in predicting overall aerodynamic characteristics
and detailed load distributions, for design and off-design
conditions, of advanced supersonic aircraft configurations. The
approach of theoretical methods will be developed through
contract and in-house studies and then evaluated with in-house
tests of representative models of advanced supersonic aircraft.
The studies will involve improvements to existing linearized-theory
area rule methods and to the inclusion of local Mach number
effects to allow prediction of detailed surface loadings and flow
fields of complete configurations. The off-design and critical design
load problems will be approached by including leading edge
separation and reattachment in finite-element lifting surface
theories.

W75-70231 743-04-31
Langley Research Center, Langley Station, Va.

SONIC BOOM
R. E. Bower 804-827-3285
This RTOP is in support of the objectives of the System
Technology Program Supersonic Cruise Aircraft Research. An
in-house program, based on analytic studies and wind-tunnel
experimentation, will be employed to develop improved methods
for prediction and to provide definition of configuration require-
ments for minimization. This in-house research will be sup-
plemented and augmented by a University Grant program and
by Airframe Industry Contracts. Studies of sonic boom acceptabil-
ity, with particular emphasis on low intensity non-N wave
signatures will be conducted under NASA contracts

W75-70232 743-05-01
Ames Research Center, Moffett Field, Calif.

STABILITY AND CONTROL PREDICTION OF FLEXIBLE
AIRCRAFT
H. M. Drake 415-965-5880
(765-72-02)

The aeroelastic deflections experienced by large supersonic
aircraft both in steady state and maneuvering (perturbed) flight
have a major impact upon performance, stability, control, and
the internal loads arising from such deflections. A major
objective of this research is to develop improved analytical methods
and to incorporate such improvements in the FLEXSTAB system
of computer programs for calculating stability and control of
flexible aircraft. Both longitudinal and lateral-directional motions
are included. Modifications are planned that will provide improved
lateral-directional results, more complete loads information, effects
of active controls, and improved representation of non-linear
aerodynamics. As modifications are made, the FLEXSTAB program
will be validated by comparing computed results with experimental
measurements from both flight and wind tunnel tests.

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

W75-70233 743-05-04
Langley Research Center, Langley Station, Va.

AERODYNAMICS AND PERFORMANCE (THEORY)
B. H. Wick 415-965-5033

In order that dynamically scaled aeroelastic wind tunnel
models may be used to study and validate active control
applications for the minimization of aircraft aeroelastic response,
the state-of-the-art of modeling technology, including model design
and construction and testing techniques, will be advanced as
required for active control applications. In addition to basic
technique development considerable emphasis will be placed on
validating model procedures by correlating wind tunnel results
with analytical and flight data. In order that future supersonic
cruise aircraft can take full advantage of the potential benefits
of active control for the minimization of aeroelastic response
technology, research will be conducted to develop new active
control concepts and approaches that are particularly applicable
to SCAR class aircraft.

W75-70234 743-05-11
Ames Research Center, Moffett Field, Calif.

AERODYNAMIC PERFORMANCE TECHNOLOGY
THEORY
R. E. Bower 804-827-3285
(501-06-01: 743-35-21)

The research performed under this RTOP is to develop and
validate model procedures by correlating wind tunnel results
with analytical and flight test procedures for compliance
demonstration.

W75-70235 743-05-12
Ames Research Center, Moffett Field, Calif.

AST CONTROL SYSTEM MECHANIZATION TECHNIQUES
Bradford H. Wick 415-965-5428
(743-36-11: 501-23-33)

The objective is to investigate redundant surface actuation
systems concepts for an active control configured supersonic
transport aircraft. Explore system failure modes, ability of the
crew to react to these failures, and the resultant effect on
control system design requirements. The approach of piloted
motion simulator studies will be conducted to investigate the
acceptability of various redundancy concepts needed for active
controls in terms of control stability and responses in normal
operation, and the ability of the pilot to detect and react to
failure in the systems. These studies will use math models and
hardware mechanisms (mini-rigs) of the candidate control
systems, developed on the basis of contracted efforts by Boeing
extending current Phase I and Phase II SST technology follow-on
efforts sponsored by DOT, and study of alternate concepts by
another contractor, and data from in-house studies at LaRC and
ARC. Emphasis will be placed on actuator systems and structural
support compliances scaled to the size of the SST class of
airplane. This effort is complementary to RTOP 743-36-11 and
will be carried out jointly with that RTOP.

W75-70236 743-05-22
Flight Research Center, Edwards, Calif.
Significant airplane flight path disturbances, attributable to the propulsion system, have been observed on the XB-70 and YF-12 airplanes at high speed. This RTOP is developing wind-tunnel and analytical techniques for predicting airflow/propulsion system interactions of advanced supersonic aircraft and determining the feasibility and benefits of a cooperative autopilot/SAS/propulsion control system. This goal is being pursued by conducting simulator and analytical studies to determine the possible benefits to be derived through the use of such an integrated control system on the YF-12. Contracts are being let for the design, construction, and installation of such a system on the YF-12. Flight tests are planned to verify the benefits that can be obtained by such a system in an operational environment.

W75-70237  744-01-01
Ames Research Center, Moffett Field, Calif.

V/STOL TILT ROTOR RESEARCH AIRCRAFT PROGRAM
W. L. Cook 415-965-5486

Technical approach is to develop and conduct flight research on two Tilt Rotor Aircraft to prove the Tilt Rotor V/STOL concept for potential military and civil missions. A program of direct supporting technology is also a part of this RTOP. The Project Plan for Development of V/STOL Tilt Rotor Aircraft, Revision 2, dated January 1974, addresses the technical objectives, approach, justification, the operating plan, environmental impact statement, milestone schedules and the review and reporting for the subject project.

W75-70238  745-01-01
Langley Research Center, Langley Station, Va.

ROTOR SYSTEMS RESEARCH AIRCRAFT
R. E. Bower 804-827-3285
(505-10-21; 505-10-22; 505-10-23; 15-10-24; 505-10-26)

The Rotor Systems Research Aircraft (RSRA) objective is to develop and bring into operation two versatile flight research aircraft to provide economical rotorcraft research capability in the real and dynamic environment of flight. These research aircraft will provide research capabilities that cannot be duplicated in groundbase facilities and that have previously been restricted because of the expense of specialized vehicles. The versatility of the Rotor Systems Research Aircraft will provide: (1) economical flight research of a wide variety of promising new rotor concepts, and (2) real-world verification of rotorcraft supporting technology offering potential solutions to existing or anticipated problem areas. This is a joint program with the Army, in accordance with the Memorandum of Understanding between NASA and the Army, dated November 1, 1971. The program will be managed through a joint Project Office in accordance with the NASA/Army Rotor Systems Research Aircraft Project Plan which was jointly approved by NASA and the Army on February 23, 1973, and updated February 7, 1974, by the NASA/Army RSRA Project Office.

W75-70239  769-01-02
Langley Research Center, Langley Station, Va.

AMST EXPERIMENTS PROGRAM PARTICIPATION
R. E. Bower 804-827-3285

The objective is to obtain, through participation in the U.S. Air Force Advanced Medium STOL Transport (AMST) prototype aircraft program, upper-surface blowing and externally blown flap propulsion-lift flight research data. The Langley Research Center will participate in the AMST flight research program by supplying principal investigators to plan and help execute specific experiments in various discipline areas. A Langley representative will serve on the inter-Center Quiet Propulsive-Lift Technology (QPLT) Flight Experiments Working Group where the NASA experiments will be planned, evaluated, and integrated into the AMST flight experiments program.

W75-70240  769-01-03
Lewis Research Center, Cleveland, Ohio.

AMST EXPERIMENTS PROGRAM PARTICIPATION
Michael F. Valerino 216-433-6280

This RTOP provides for Lewis Research Center participation in the joint Air Force/NASA AMST Program which includes definition of flight research experiments in the areas of propulsion system performance and noise to be conducted using the Boeing YC-14 and Douglas YC-15 prototype aircraft. LeRC will define, develop, and implement NASA propulsion-related flight experiments to be conducted during the Air Force-led portion of the AMST flight test program and during the subsequent NASA-led flight research program.

W75-70241  769-02-01
Lewis Research Center, Cleveland, Ohio.

QSRA PROPULSION SUPPORT
Michael F. Valerino 216-433-6280

This support has included the study of engines potentially suitable for the research aircraft in achieving its powered lift, noise, and near terminal performance goals such that the most attractive concept can be selected. Based upon the results of these and the aircraft studies, the hybrid upper surface blowing system has been selected for incorporation into the Buffalo aircraft. These selections then resulted in the selection of the Lycoming 502 series turbofan engine as that most suited for the intended application. The continuing engine support will then include further determination of modifications required to the engine to accommodate the needs of the research aircraft, exploring alternate approaches to the engines (refurbishment of YF102's, new engine procurement, leasing) and then those following activities required to insure delivery of four (4) engines plus a spare to the aircraft hardware contractor in a time frame consistent with his needs. The effort also includes participating in all other propulsion aspects of the aircraft program. In addition, assistance will be provided to the QPAT Office in its staff support role to the OAST Transport Technology Programs Office in carrying out the vertical cut responsibilities for the Short-Haul Transport Technology Program. This includes participation in a Short-Haul Transport Technology Program Plan.

W75-70242  769-02-02
Ames Research Center, Moffett Field, Calif.

QUIET SHORT-HAUL STOL RESEARCH AIRCRAFT (QSRA)
W. L. Cook 415-965-5486

This RTOP covers the design, fabrication and test of a quiet propulsive-lift research aircraft which will permit flight research beyond the flight regimes of the AMST and the existing augmented jet flap Buffalo aircraft. The approach stresses low-cost modification of an existing aircraft. Key design simplification guidelines are use of fixed landing gear, 160 knot maximum speed, +2g -0.5g limit load, and design life of 500 flight hours. The flight research will advance technology for future development of reliable, quiet, and economical propulsive lift transports. The test program will provide specific information on flight characteristics, and powered lift performance, as well as information on design, noise, operational features and propulsive-lift system economics, all needed variously by designers, regulatory agencies and operators. The research aircraft will be capable of useable approach lift coefficients greater than 4.6 and 90 EPNdB noise footprints smaller than one square mile. Preceding the RFP for the aircraft, eight month design studies by two contractors are developing information for configuration selection. The completed Task 1 required each contractor to consider as a baseline the modification of a Buffalo aircraft with an augmented jet flap (AJF), and another aircraft/propulsive-lift combination of their choice. Candidate existing aircraft included the Buffalo, F-27, Jetstar and S-3. Each contractor chose the upper surface blown hybrid (USBH) concept to study in addition to the AJF. Each contract has recommended that the continuing Task 2 design studies be based on the USBH propulsive lift concept, modification of the existing C-8A Buffalo aircraft, and use of off-the-shelf Lycoming engines.

Space and Nuclear Research and Technology Base
W75-70243  506-16-11
Ames Research Center, Moffett Field, Calif.

SURFACE PHYSICS
Dean R. Chapman  415-965-5065

Studies will be initiated to expand the understanding of surface and interfacial properties and surface-environment interactions to determine their effects on material behavior. These studies range from describing the changes in surface properties that result when atomic and molecular beams interact with solid surfaces to the study of the growth characteristics of thin films and to the nature of composite interfaces. In addition, a study will be initiated to correlate grain boundary segregation and embrittlement of structural materials. This study will use an in-situ Auger analysis system and will have the capability of fracturing and examining a variety of metal alloys in aggressive environments. Other experimental studies will involve in-situ high resolution electron microscopy of thin film nucleation and growth phenomena in ultra-high vacuum under well controlled experimental conditions. The LEED/Auger work function/thermal desorption studies of the interaction of metal vapors and gaseous species with metal and graphite surfaces will continue and the Auger-microprobe capability will be improved.

W75-70244  506-16-12
Ames Research Center, Moffett Field, Calif.

PHYSICS AND CHEMISTRY OF SOLIDS
Dean R. Chapman  415-965-5065

The objective is to exploit the unique capability of the Illiac 4 computer to calculate the reliable wave functions for ground and excited states of atoms, diatomic molecules, linear polyatomic molecules, and ultimately solid state matter. These wave functions will in turn be the basis for precision calculation of many basic properties of matter such as bond energies, radiation transition probabilities, dipole moments, Auger transitions, chemical rate coefficients, and ultimately solid state properties such as electronic band gaps and conductivities. Computer codes for calculating wave functions using the parallel processing feature of the Illiac 4 will be developed. These codes will be compared with the best available numerically computed wave functions, to assure that the coding is reliable, then they will be used to calculate larger expansions of these wave functions, which will be more precise than heretofore, and also wave functions for species which have not yet been computed. The lowest state of each symmetry type will be computed, and optical transition probabilities between these states will be evaluated. The work will concentrate on molecules such as HF, CO, CN, NO, CH, N2, O2, C2, etc., which are of current interest with regard to planetary entry, heat shield ablation, upper atmosphere pollution, or gas lasers. Eventually the theory will be extended to include excited states of these species.

W75-70245  506-16-12
Lewis Research Center, Cleveland, Ohio.

PHYSICS AND CHEMISTRY OF SOLIDS
R. A. Lad  216-433-6601

The objectives are to: (1) to increase the base of understanding of the relationships between the electronic, atomic, molecular and microscopic structures of solids and their useful mechanical, structural, and chemical properties, and (2) to provide information that will lead to advanced materials development, in areas of particular importance to Lewis' programs. Data cover: (1) metal matrix composites - strength of fiber-matrix behavior; internal friction studies - measurement of stress distribution in B fibers, effect of thermal fatigue and corrosion on integrity of the composite, calculation of fiber-matrix bond strength, preparation of B on surface modified substrates, and effect of coatings on fiber on bond strength and ductility; (2) hot corrosion of turbine alloys gravimetric studies of bare, preoxidized and coated alloys, study of chemical conversion to predict chemical species, and high pressure mass spectrometry of gas phase species; and (3) battery separators - mechanism studies related to control of ionic conduction and morphology of zinc growth during charging.

W75-70246  506-16-13
Langley Research Center, Langley Station, Va.

INTERDISCIPLINARY LABORATORIES FOR MATERIALS RESEARCH
R. A. Lad  216-433-6601

The objectives are to: obtain new understanding of the relationships between electronic, atomic, molecular and microscopic structures of solids and their useful mechanical, structural, electronic and chemical properties; to employ the expertise obtained to the development of new materials and advanced devices.
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

existing in universities to obtain knowledge in these areas and to aid in determining the best directions to follow in improving existing materials and obtaining new materials of direct interest to NASA programs. Interdisciplinary research involving several departments is conducted at 3 universities in areas recommended by a committee composed of representatives from Headquarters, LeRC, LaRC and ARC. Research areas under study are as follows: at NASA Lewis Polytechnic Institute - (1) mechanical and structural properties of metals, composites, and polymers, (2) surfaces and interfaces of crystalline solids; and (3) relaxation and transport properties of amorphous solids; Rice University - (1) stress corrosion and hydrogen in metals, (2) optical and magnetic memories, and (3) polymers and high temperature materials; and at the University of Washington - (1) solid electrolytes; (2) ceramic fibers; and (3) ceramic processing. The results are disseminated in summary reports, journal publications and topical conferences.

W75-70249  506-16-15
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

NON-METALLIC SUPERCONDUCTORS  R. R. McDonald 213-354-6186

The primary objective is to determine the feasibility of synthesizing a high temperature superconductor. The approach involves a coordinated experimental and theoretical effort. The experimental effort will be directed towards investigation of high temperature excitonic superconductivity of quasi one dimensional organic metals (e.g., TCNQ-polarizable cation radicals). Emphasis will be placed upon evaluating the competition of cation and anion radicals to the band metallic state and the excitonic interaction. Single crystal structures will be stressed in the quasi one dimensional organic metals program. Resistivity, superconductivity, X-ray, and chemical measurements, as well as chemical synthesis, will be involved in the experimental effort. Prof. A. Hermann of Tulane University, under a subcontract, will measure the Hall effect in quasi one dimensional systems and, in addition, evaluate the narrow gap semiconductor-metal structure. Pb-PbTe, as a possible excitonic superconductor (Bardeen model). The potential of an excitonic superconductor formed by the intercalation of a one dimensional polymeric metal (polysulfur nitride) into an excitonic layered semiconductor (Ginzburg model) will be evaluated in collaboration with Prof. M. Labes of Temple University whose work is supported by non-NASA funds. Work will be continued on the one dimensional excitonic model under subcontract to Prof. W. Little, Stanford University. He will evaluate the platinum cyanine dye complexes as possible superconductors by utilizing X-ray diffuse scattering, normal reflectivity measurements and theoretical calculations involving the use of computer assisted molecular modeling to estimate Tc for the excitonic mechanism. An additional theoretical effort by J. Zmuidzinas at JPL will involve a coordinate investigation of high temperature superconductivity via the Dielectric function approach. This approach allows a generalized study of high temperature superconductivity independent of assumptions concerning particular mechanisms or models.

W75-70250  506-16-16
Lewis Research Center, Cleveland, Ohio

RELATIONSHIP OF ATOMIC STRUCTURES WITH MATERIAL PROPERTIES  W. D. Klopp 216-433-6676

The objective of this program is to elucidate the relationships between atomic and microstructural properties of refractory, iron-, and nickel-base alloys in order to relate these to useful engineering materials properties to help guide the development of these materials for advanced applications. The approach consists of: (1) determination of the relationship and mechanism of grain-size effects and the threshold stress for diffusion creep in creep of nickel and binary-nickel alloys, including solid-solution-strengthened, precipitate-strengthened, and dispersion-strengthened alloys, and (2) investigation of the correlation between electronic properties (such as locations and widths of solute d-bands) and low temperature solution softening in dilute body-centered-cubic alloys (including Mo, Nb, and Fe-base alloys).

W75-70251  506-16-17
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

VISCOELASTIC PROPERTIES OF POLYMERS  R. R. McDonald 213-354-6185

This is a program of fundamental research on the mechanical behavior of polymers. It is intended to determine the molecular parameters which control rheological behavior. This has been successful in simple amorphous rubbery systems which are not chemically reacting. The goal now is to extend this work to longer times, where degradation may set in, and then to shorter times, where the material is glass-hard. At the same time a modified theory must be developed to describe crystalline and polyphase systems. The general approach involves the synthesis of both new and modified polymeric and prototype chemical structures, the characterization of these materials and the determination of chemical structure, morphology and property relationships. Applications for the mechanical properties work might range from improved solid propellants, expulsion bladder and valve seat materials for liquid propulsion systems, sealants for high-speed aircraft, new types of reinforced plastics, and high reliability belts and tapes for spacecraft magnetic recorders.

W75-70252  506-16-21
Langley Research Center, Langley Station, Va.

ADVANCED MATERIALS FOR SPACE  G. W. Brooks 804-827-2042

The objectives of this research are: (1) to develop improved materials and materials combinations for advanced space applications, (2) to apply the numerical methods which have been developed in other disciplines, and thereby to achieve better understanding and more effective application of materials, (3) to develop in-house capability for determining thermal, physical, and mechanical properties of materials. Concepts for improved structural or protective materials will be developed and evaluated. Basic processes, such as diffusion and chemical reactions which occur during materials processing or in service, will be studied, and based on a better understanding of these mechanisms, modifications in composition or process will be made to improve performance. New or more accurate methods will be developed to measure key materials characteristics as required.

W75-70253  506-16-21
Lewis Research Center, Cleveland, Ohio

ADVANCED MATERIALS AND MANUFACTURING PROCESSES  W. D. Klopp 216-433-6676

The objectives of this program are to characterize the suitability of present materials and to develop improved materials and manufacturing processes for advanced space systems, such as power-generation systems, communications systems, propulsion systems, and re-entry vehicles. The approach consists of: (1) development of new iron-base alloys with high fracture toughness over a wide range of temperatures (-423 to 1000 F), (2) determination of space environmental effects on properties of columbium-base and nickel-base alloys, (3) improvement of the long time, high power transmission properties of laser window materials, (4) determination of the feasibility of developing chemical vapor deposition techniques for depositing high strength alloys, and (5) completion of the evaluation and characterization of ceramic fiber systems for advanced reusable surface insulation heat shield concepts.

W75-70254  506-16-22
Lewis Research Center, Cleveland, Ohio

MATERIAL FOR LUBRICATION AND WEAR IN MECHANICAL COMPONENTS  R. L Johnson 216-433-4000

The objectives are to: (1) obtain greater understanding of the structure of materials to eliminate empirical approaches in the selection of materials for lubricants, seals, bearings and other mechanical components; (2) extend the technology of application methods to improve materials including designs for optimized solid and fluid mechanics in mechanical components for the
real and anticipated extreme environments of aerospace devices; also, the utilization of aerospace materials and tribological concepts for the general benefit of mankind; and (3) pursue solutions to real and anticipated extreme environments of aerospace devices.

**THERMAL CONTROL-HEAT PIPE MATERIALS**

J. F. Morris 216-433-4000

The objective is to establish materials and designs for efficient, durable heat pipes and to understand corrosion mechanisms in operating ranges from cryogenic to high temperatures. The general approach includes evaluating NASA-contractor heat pipes as well as determining materials and designs for effective new heat pipes. The resulting technology must provide heat pipes with efficient performance, long lifetimes, suitable fabricating and processing techniques, and economy for thermal control in all operating ranges. A major heat pipe problem is internal corrosion, which affects both efficiency and durability through dimensional changes, gas evolution, and deposit accumulations. These mechanisms and those of environmental interactions with heat pipes must be understood and counteracted. Performance and life testing in appropriate environments reveal such effects through thermal sensing of vapor, gas interfacial movements and through careful before-and-after examinations. Specific problem areas under investigation are gas generation in stainless steel and aluminum heat pipes, deposits in ammonia, aluminum heat pipes, and corrosion in liquid metal refractory alloy heat pipes. Another approach to eliminate some refractory alloy difficulties is the development of alkali metal, superalloy heat pipes for high temperature terrestrial and space applications.

**W75-70256**

Ames Research Center, Moffett Field, Calif.

**THERMAL CONTROL-HEAT PIPE TECHNOLOGY**

John V. Foster 415-985-5083

The objectives are: (1) to develop basic control mechanisms by which heat pipes may achieve variable conductance, feedback control, or thermal diode performance, (2) to improve liquid transport capacity and reliability, and (3) to participate in flight tests of advanced heat pipe technology to establish flight level confidence. The Ames Research Center shall act as the lead OAST Center and provide guidance to OA, OSS, and OMSF in this capacity as a means of extrapolating basic understanding into practical missions. Development of basic control techniques will be continued with increased emphasis on cryogenic thermal diodes and vapor controlled variable conductance heat pipes. Investigation of feedback control will also be continued, but the development of gas-controlled variable conductance heat pipes will be concluded. Liquid transport capacity and reliability will be increased through the development of higher performance non-arterial heat pipes and a deeper understanding of gas occlusions in arteries, development of gas-inoculant and flexible arteries, and continued research into electrolydynamics and pumping. Emphasis will be increased in the cryogenic region where liquid transport capacity is currently limited. The Ames heat pipe experiment (AHPE) on OAO-C and the advanced thermal control flight experiment (ATFE) on ATS-F will be supported. A new experiment to flight test a cryogenic diode and a vapor controlled variable conductance heat pipe will be developed for the ATS-F spacecraft.

**W75-70257**

Goddard Space Flight Center, Greenbelt, Md.

**THERMAL CONTROL-HEAT PIPE MATERIALS**

Stanford Ollendorf 301-982-5228

The objectives of this task are to improve both the capability and reliability of spacecraft temperature control in the following manner: develop more reliable heat pipes and vapor chambers in the ambient and cryogenic temperature range. The approaches considered are to: (1) develop reliable high performance heat pipes for ambient temperature; and use this technology to develop isothermal vapor chambers and extend the temperature range to the cryogenic region, and (2) investigate the problems associated in integrating a cryogenic heat pipe and IR type detectors.

**W75-70258**

Langley Research Center, Langley Station, Va.

**THERMAL CONTROL-SECOND SURFACE MIRRORS**

G. W. Brooks 804-827-2042

The experimental program is in progress to define, study, and solve the problems associated with utilization of second-surface mirror coatings for passive thermal control of spacecraft. The development of the technology necessary to economically utilize second-surface mirror coatings on large spacecraft surfaces will be emphasized. Experimental aromatic-heterocyclic polymers will be evaluated to provide improved radiation stability for the second-surface mirror coatings. The approach shall include: (1) understanding the principles of second-surface mirrors, determining the materials to be employed, and developing complete coating systems and procedures for their application to spacecraft, and (2) the continued use of the Space Environmental Effect System facility to evaluate the radiation stability of thermal control coatings.

**W75-70259**

Marshall Space Flight Center, Huntsville, Ala.

**THERMAL CONTROL SURFACES AND THERMAL ENERGY STORAGE DEVICES**

D. R. Wilkes 205-453-3090

Control surfaces are required on all spacecraft in both active and passive thermal control systems. Presently, thermal control surfaces are available that should meet the thermal requirements of missions that are now planned. Use of these thermal control surfaces require that three specific conditions be met: (1) the optical and thermal properties of thermal control surfaces and the changes in these properties due to natural and induced environments must be well defined, (2) the thermal control surfaces must be protected from prelaunch handling and launch contamination, and (3) the thermal control surfaces must not contaminate other optical systems of the vehicle by outgassing optically damaging materials. Tasks covered in this RTOP are directed toward meeting these conditions. Thermal energy storage devices such as phase change materials have been used successfully as thermal capacitors. Another task of the RTOP is to improve knowledge of present phase change materials' properties and to investigate other systems to use as thermal energy storage devices with additional efficiency, weight and cost savings, and wider range of use.

**W75-70260**

Marshall Space Flight Center, Huntsville, Ala.

**SPACECRAFT INDUCED ENVIRONMENT AND SURFACE EFFECTS (OPTICAL CONTAMINATION)**

H. M. Weathers 205-453-3040

The objectives of this research are: (1) to re-evaluate the effects of length of exposure, temperature cycling, and radiation level on material outgassing rates, (2) to determine the interaction between (effects of) the surface of deposition and (upon the) deposited material itself, (3) to develop methods of predicting particle sites, production rates and velocity distribution as a function of the source and process of particle production, (4) to develop comprehensive optical effects models, and (5) to develop methods and techniques for optical contamination control. The approach being pursued is that of conducting, primarily in-house, a number of related, complementing studies in which factors such as outgassing rates for sample materials are determined as functions of exposure environment parameters, in which accommodation coefficients are determined, in which surface phenomena are investigated. As data are obtained they are used to test models which have been hypothesized to explain phenomena observed in space. Additionally they are used to develop techniques and establish criteria for optical contamination control.

**W75-70261**

Langley Research Center, Langley Station, Va.

**SPACE DEBRIS STUDIES**
The broad objective of this RTOP is to provide spacecraft designers on a continual basis sufficient knowledge of the meteoroid environment, man-made earth orbital debris, and the effects of these on space operation to insure proper mission spacecraft and schemes to protect spacecraft against these hazards of its potential hazard to space operations. The hazard man-made meteoroid environment in the asteroid belt and in the space debris is a natural extension of Langley work.

E. S. Love 804-827-2983

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E. S. Love 804-827-2983
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

W75-70267 506-16-44
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE THERMAL PROTECTION SYSTEMS
Dean R. Chapman 415-965-5085
The performance, including reusability, of candidate heat shield materials and configurations will be evaluated and failure modes and material modifications identified that would increase the performance potential. Immediate objectives for FY-75 include completion of materials evaluation leading to materials selections and continued reusable surface insulation (RSI) and reinforced carbon/carbon (RCC) exposure to arc plasma flows leading to material characterization. This is the determination of the residual thermophysical and mechanical properties after 100 simulated firings and is required for final TPS design. These material evaluation tests will be done in the Ames Aero and 20 MW Pilot TPS Test Facilities. Details of the shuttle TPS designs result in elements that require evaluation in the appropriate environments. These evaluations are referred to as design development tests—an example being tile-to-tile gap joint design. Tests to support this activity will be performed in the Ames Aero 60 MW pilot TPS test facility and 60 MW interaction heating shuttle panel test facility.

W75-70268 506-17-11
Lewis Research Center, Cleveland, Ohio.
LARGE LASER MIRROR FOR SPACE
D. L. Nored 216-433-4818
(506-21-40; 506-25-51; 506-18-21)
The objective of this program is to complete by FY-77 exploratory investigation of the feasibility of concepts suitable for erectable large space-based mirrors for high power laser transmission. This program will investigate preliminary conceptual feasibility of large structures to support and point large (approximately 30 meter diameter) mirror systems in space for the purpose of transmitting high power laser beams. Workable concepts for the packaging and deployment of such structures will be investigated (such structures to maintain the spacing of various elements of a transmission system to within a fraction of a wavelength). A detailed analysis will be performed to catalog significant parameters, define operational criteria, and select or conceive new structural concepts. A conceptual design will be performed to the extent necessary to instill an acceptable level of confidence of feasibility.

W75-70269 508-17-11
Langley Research Center, Langley Station, Va.
LARGE ERECTABLE SPACE STRUCTURES
G. W. Brooks 804-827-2042
The objective is to develop technology necessary to make feasible consideration of exceedingly light space structures which could be erected in space. The approach involves (1) investigating applications of graphite composites as ultra lightweight material to meet thermal distortion and stiffness requirements for space structures, (2) evaluating mechanical properties of impregnated graphite cloth as low cost material for large panel construction, and (3) performing in-house studies of effects of curvature to stabilize large sandwich panels and conduct crippling tests on ultra-light sandwich structure. Efforts were continued to define larger, a large geometry erectable space structures experiment for shuttle. Under contract, a survey of existing and possible future national needs for large space structures will be made. In-house and contractual studies will be performed on various structural concepts for supporting flexible paddles and for providing hard, thermally inert supporting structure. Preliminary industry systems studies will be initiated to determine critical controls and thermal requirements for the experiment. Dynamic response problems unique to large area structures will be identified and investigations initiated.

W75-70270 506-17-12
Lewis Research Center, Cleveland, Ohio.
COMPOSITE TANK TECHNOLOGY
R. H. Kemp 216-433-4000
Composite pressure vessels and propellant containment tanks offer a variety of attractive advantages in space vehicle applications. Due to the high structural efficiency of the constituent materials, a composite vessel is significantly lighter than an all-metal vessel. Even relatively small weight savings can be significant for upper stage vehicles such as the shuttle orbiter ($30K/lb) and tug ($160K/lb). The catastrophic shrapnel-type failure of a metal vessel can be prevented by using composite vessel technology. This can provide a reliability advantage which is not directly relatable to cost savings but is considered a major factor in selection of candidate system configurations. In addition, composite vessels have an inherent design flexibility in providing optimum combinations of thermal, structural, and weight characteristics. The principal objective of this program is to develop structurally efficient, reliable, low cost composite vessels from a variety of composite materials including S-glass, Kevlar 49, and graphite fibers in epoxy resin matrices. In this context, a pressure vessel is considered to be a complete structural system. Due to the porous nature of high performance composite vessels, liners are required. Both structural (load-bearing) and non-structural (thin-metal or polymeric) liners are therefore a part of this program. Candidate liner materials for load-bearing and non-load bearing lined vessels are aluminum Inconel, cryoformed stainless steels, titanium, and polymers such as Saran. The latter liner types have an excellent potential for providing a minimum weight composite vessel design for storage of gaseous nitrogen or helium at essentially room temperature.

W75-70271 506-17-14
Lewis Research Center, Cleveland, Ohio.
COMPOSITE MATERIALS APPLICATION TO STRUCTURES
R. H. Kemp 216-433-4000
Composite materials offer a high potential for reducing the weight of many structural components. However, before full advantage can be taken of the unusual properties of composite materials in such applications, considerable material property and design information is needed. It is proposed that studies be continued that will: (1) develop (in-house) analytical design techniques for predicting structural characteristics of given composite configurations, (2) develop (in-house) analytical design techniques for optimizing composites structures for minimum weight, cost or maximum efficiency, (3) develop (in-house) testing facilities for measuring the mechanical properties of fiber composites under complex loadings, environments, and high velocity impact, (4) determine (by contract) the effects of fatigue on the load-carrying ability of composite structures, (5) develop (by contract) improved finite element capability consistent with NASAs requirements to permit improved stress analysis of fiber composite components, (6) develop (by contract) improved composite analysis capabilities for high velocity impact, flaw growth and arrest, and (7) develop (by contract) composite systems with improved impact resistance and the methodology for assuring structural integrity. The studies outlined above have been reviewed and coordinated with cognizant Langley Research Center personnel and do not duplicate work at that center.

W75-70272 506-17-15
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ADVANCED CONCEPTS FOR SPACECRAFT ANTENNA STRUCTURES
R. R. McDonald 213-354-6186
(506-20-22)
Outer planet and planetary orbit missions in the 1975-1985 period will require substantially increased communication capabilities. The JPL studies indicate that optimum telecommunication design for these missions is realized with antennas having much higher gain than those now used on Mariner type spacecraft. Although, however, the assumed gain vs. weight used in these studies has not been verified, nor is the technology sufficiently well developed. The principal objective of this effort is to fulfill the need to develop and make available the knowledge required by flight project to be able to utilize new large antennas. A number of feasible antenna configurations have been considered from 100 feet in diameter to 10 feet, up to X-band. The technical approach is to demonstrate feasibility on small scale development models of entire antennas or components and to design and fabricate larger models as close to flight hardware as possible. A 14-foot diameter furlable conical
The overall objective is to reduce cost and increase effectiveness of structural evaluation and reliability demonstration services for spaceflight hardware. This objective will be approached through a study of means to improve the cost effectiveness of both test and analysis services. During FY-75, contributions to the above objective will be met by concentrated activity in the following areas: (1) continued study of cost optimized test levels, (2) development of more cost effective test specifications for NDE techniques, and (3) development of automated signal processing and analysis methods to put inspection on a more quantitative basis and eventually reduce the time and costs of inspection. The program will be conducted through in-house and contractual programs for improvement of NDE techniques. The work will be first aimed at idealized materials and parts and then directed at specific requirements of advanced space vehicles.

W75-70277
Goddard Space Flight Center, Greenbelt, Md.
SPACE VEHICLE DYNAMICS
J. F. Young 301-982-4984
(506-17-31)

The objective of this research is to provide improved prediction methods and data on the dynamic loads resulting from aerodynamic noise, and exhaust plume interactions with the flow field and the resulting effects on dynamic loads. The research on dynamic loads will include basic experimental studies of surface pressure fluctuations due to attached and separated boundary layers and shocks waves at transonic supersonic, and hypersonic speeds. Empirical formulae that predict the temporal and spatial characteristics of the nonsteady loads will be derived from these data.

W75-70280
Goddard Space Flight Center, Greenbelt, Md.
SPACE VEHICLE DYNAMICS
J. F. Young 301-982-4984
(506-17-31)
components. (3) study of low cost conversion of existing large
enveloped volumes as suitable dual use acoustic test chambers,
(4) demonstration of how the use of common subsystem module
hardware can result in a substantial cost reduction in the
environmental test/analysis process, and (5) development of
spacecraft past performance data from which cost versus risk
tradeoffs can be made on future pre-shuttle programs.

W75-70281  506-17-31
Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE DYNAMICS
R. W. Schock  205-453-4387
(502-22-11)
The general objective is to derive and develop space vehicle
structural dynamics technology to effect reduction of spacecraft
and payload program costs. Implied in this objective is the
requirement to verify and qualify the payload with a minimum
test program. Methods for accomplishing space vehicle dynamics
cost reductions are discussed in the following approach. Candidate
solutions for reducing program costs associated with space vehicle
dynamics will be evaluated under this RTOP. These candidate
solutions are the development of new and/or improved qualification
test philosophies and techniques which will provide more
exact simulations of operational environments, reduce test costs,
and provide quantifiable factors of safety such that redesign
and retest costs can be minimized. More accurate methods of
predicting dynamic loads and the response of the structure,
subsystem, or payload will be developed. This will be done by a
well planned effort to measure the shuttle payload bay dynamic
environment and improved methods for combining parameter
variations which affect loads and response. Improved methods
for analytically calculating high fidelity mathematical models of
the payload are also planned.

W75-70282  506-17-32
Langley Research Center, Langley Station, Va.
SHUTTLE DYNAMICS AND AEROELASTICITY
G. W. Brooks  804-827-2042
(506-17-31)
Objectives are to develop critical technology to determine
loads, dynamics, acoustic and aerelastic response of the space
shuttle system, to investigate dynamic behavior using advanced
techniques, and conduct key tests and develop critical advanced
hardware. In-house studies of shuttle loads will be continued; results
of measured and predicted pressure distributions in the
jet plume model will be compared; transient and steady state
loads in decelerator system for booster recovery will be
investigated, and tests will be conducted in the LaRC 16-Foot
Transonic Dynamics Tunnel. In-house studies of vibrations of 1/8-scale
shuttle system model will be compared and vibration
transit tests on shuttle models will be conducted in the LaRC High Intensity Noise
Facility to define ambient and elevated temperature response.
Use of advanced inspection techniques such as infrared scans to
detect failures will be investigated. In-house investigations of
potential aerelastic problems associated with space shuttle
vehicles will be continued, and critical flutter tests in the LaRC
Transonic Dynamics Tunnel will be conducted. New methods
for testing aerelastic models will be investigated.

W75-70283  506-17-32
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE DYNAMICS AND AEROELASTICITY
H. M. Drake  415-965-5880
Wind tunnel test support and analysis will be provided to
investigate transonic buffet (including aerelastic effects),
aerodynamic noise inputs and response, and flutter of a space
shuttle vehicle. Rocket exhaust plumes will be simulated by
cold jets so that static and dynamic loads can be measured in
a realistic launch environment. The dynamic response of
representative skin panels will be determined in wind tunnel
tests which simulate the actual launch environment. The flutter
of representative skin panels will be evaluated and a computer
program for predicting the flutter of space shuttle type panels
including boundary layer effects will be validated. Aerelastic
effects on the stability and control of the space shuttle will be
determined using the FLEXSTAB computing program. Additional
models will be tested as needed to investigate panel response,
buffeting and flutter, and pressure fluctuations will be measured
in regions of high intensity noise to evaluate aerodynamic noise
inputs.

W75-70284  506-17-33
Goddard Space Flight Center, Greenbelt, Md.
STOP (STRUCTURAL-THERMAL-OPTICAL-PROGRAM)
H. P. Lee  301-982-5275
The objective is to advance analytical capabilities in combined
disciplines by developing methods in respective areas and unified
computer programs. The resulting capabilities are suitable for
use in both design and evaluation. The degradation in performance
of a spaceborne telescope or a RF antenna is chiefly due to
thermal loads caused by the varying orbital conditions. The
approach is to develop a general purpose finite element heat
transfer computer program compatible with the structural version
of NASTRAN which, by its intrinsic characteristics, is suitable
to computer automation and extremely versatile in regard to
variations in configuration, properties, etc. The unified thermal-
structural model simplifies the discipline interface and permits a
virtually unlimited problem size. The structural analysis uses the
computer temperature information as the input of thermal
loads and its deformation results are then used in an associated
ray trace computer program to analyze optical or RF performance.
Analytical capabilities to assess sensitivity of temperature and
displacement variances of thermal and structural analyses due to
uncertainties inherent in input values of the system parameters
are also pursued in this RTOP.

W75-70285  506-18-11
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ADVANCED IMAGING SYSTEMS TECHNOLOGY
R. V. Powell  213-354-6586
(186-68-52: 185-50-73)
The long-term objective is the development of an imaging
system enabling technology to meet the anticipated requirements of
future planetary imaging missions. The general approach
includes the study of future missions as a source for the postulation
of future imaging requirements, the study of current and projected
imaging technology as a means of establishing a state-of-the-art
baseline, and the implementation of specific technology development
tasks to provide the desired enabling technology. The current
objective is the development of solid state imaging sensor
technology for both Mariner and Pioneer class spacecraft, based
upon charge-coupled device (CCD) technology. These devices
have the potential advantages of small size, reliability, scan
versatility, geometric fidelity, magnetic cleanliness, and very
high sensitivity. Furthermore, they are expected to lead to an
integral solid-state camera (excluding optics) with major cost
savings to future missions. A near-term target is to provide, by
FY-77, a CCD imaging sensor with 10 to 100 times the sensitivity
of the Mariner vidicon for outer planet flybys. The approach
includes a three phase contractual program coupled to an in-house
analysis and test program.

W75-70286  506-18-12
Langley Research Center, Langley Station, Va.
HIGH RESOLUTION ENVIRONMENTAL SENSORS
G. B. Graves  804-827-3745
The objective is to develop advanced sensors and sensor
systems technology for remote and in situ sensing of the earth,
aircraft, and spacecraft environments. Technology areas to be
investigated are: (1) hydrographic LIrAR techniques for
the measurement of chlorophyll A concentration, salinity, and turbidity
of bodies of water; (2) continuously tunable infrared diode lasers

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for high resolution absorption and emission spectroscopy of low concentration atmospheric constituents; (3) atmospheric LIDAR techniques for determination of slant range and runway visibility at airports; (4) diode lasers with visible emission and operation at 283 K sensor and optical data processing applications; (5) ultrasonic sensors for particulate detection in turbulent fluids; (6) ultraviolet absorption sensors for smoke stack effluent monitoring; and (7) satellite mass spectrometer calibration techniques.

The objective of this program is to provide effective coordination of NASA sponsored research and development efforts on electronic devices and systems with similar work supported by DOD and other government agencies. Through associate membership on the advisory group on electron devices and associated working groups, NASA program managers receive expert advice on the feasibility, currency and soundness of planned R and D procurement activities, long range R and F requirements, complementary work in other government agencies, and forecasts of new technical developments.

The primary objective is to develop high resolution sensor technology which can be applied to NASA's research and applications programs in remote sensing of earth and planetary environments. Specifically, the aspects of using lasers for the measurements of ocean depth, fertility, and oil spills in the ocean will be studied. Its application in remote detection of phytoplankton and oil in the water from low flying aircrafts has been demonstrated. Extended effort will be focused on laser bathymetry. Underlying principles of this lidar technique can be undoubtedly extended into the remote probing of planetary environments from a manned or unmanned spacecraft.

The objectives are to develop approaches for assessing and assuring predictable long operating life of microcircuits and other electronic devices used in aerospace applications. Evaluation test programs are being conducted to define relationships of applied voltages and temperature to accelerated life test failure rates. The results will be used to develop effective and economical accelerated life test methods that will provide more accurate and quicker assessments of microcircuit and semiconductor device long life stability and characteristics. An all tantalum wet slug capacitor that does not degrade with shelf life and nominal use stresses is being developed and qualified. The capacitor effort also consists of developing more explicit application and derating criteria for tantalum capacitors to improve their long life characteristics. A program to identify the acceptable designs and materials for solid encapsulated microcircuits for use in long term space applications is being continued. The program also includes developing the necessary lot controls, qualification criteria, screening, and inspection methods necessary to assure reliable solid encapsulated devices.

The goal of this effort is to develop a microelectronics technology which will provide the reliability that is necessary to achieve the mission objectives of the wide range of future space missions, including those involving unusually long flight times. The approach will be to thoroughly investigate those technologies which NASA will be utilizing on future missions and to identify the life limiting mechanisms inherent in the basic processes involved. Generalized device models will be developed which will incorporate models of specific failure mechanisms. These models will be used to predict the probability of device failure and their specific behavior under varying environmental stresses. This understanding will promote constructive feedback to the fundamentals of processing which will then further enhance device
reliability. The near-term objectives will focus specifically on standard CMOS Technology and appropriate hybrid packaging techniques which will take full advantage of the CMOS potential. Specific investigations of failure processes will center around: oxide stability, charge migration, metallization, and silicon defects. The work is being conducted in close cooperation with the MSFC to satisfy the specific NASA objective, Long Life Reliable Circuit PRODUCTION.

The objective is to develop and flight demonstrate an engineering model Extended Life Attitude Reference (ELACS) with a 0.1 deg pointing accuracy and a lifetime potential greater than eight years; (6) by mid FY-79, develop and demonstrate an engineering model Star Tracker for Economical Long Life Attitude Reference (STELLAR) with a cost saving greater than 50 percent (1,200k reduced to less than 500k) of a typical Mars orbiter program; and (7) By FY-79, mechanize and test a breadboard Extended Life Attitude Control System (ELACS) with a 0.1 deg pointing accuracy and a lifetime potential of more than 10 years with functional redundancy.
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Pointing (VIP) System will provide computer generated error signals for three-axis stabilization and pointing of the astronomical telescope. In addition, system outputs will drive a video display for use in star field identification and manual pointing control. The star field sensed by a video camera co-aligned with the optics of the astronomical telescope will provide the basis for a three-axis attitude reference system. The relative positions of two or more bright stars in the field will be combined with the outputs of a triad of rate integrating gyros (RIG’s) in an onboard digital computer to generate pointing and stabilization error signals. The output of the video sensor will also drive a CRT display at the operator’s console to facilitate guide star acquisition and/or manual positioning of the experiment. The VIP System will be developed in several stages with each stage culminating in a flight evaluation on the Ames Infrared Balloon-Borne Telescope (AIROscope). Analysis and simulation will be used to develop the multiple star processing capability. The final AIROscope flight evaluation will utilize an advanced CCD sensor to be developed by JPL.

W75-70302 506-19-31
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ARTIFICIAL INTELLIGENCE FOR INTEGRATED ROBOT SYSTEMS
R. V. Powell 213-354-6586

The long-range objective is to establish a technology base in robotics and semiautonomous control of unmanned machines or vehicles to support lunar and planetary surface explorations. The results will also be applicable to other remote systems, automated fabrication facilities, and other systems and activities of importance to NASA and the nation as a whole. At JPL, a robot roving vehicle is being assembled to demonstrate semiautonomous operations, provide practical tests of machine intelligence concepts, define research requirements, and develop design guidelines for system applications. During FY 1975, a four-wheeled vehicle, a manipulator, a laser rangefinder, stereo TV, and navigational and proximity sensors will be integrated with each other and with a computer system; and tethered operations will begin in an indoor laboratory. In FY 1976, this ‘breadboard’ system will be extensively tested to evaluate controlling software, system operational procedures, and strategies for coordinating sensors and effectors to accomplish such tasks as moving from one location to another and picking up a rock or tool without operator assistance. In FY 1977, semiautonomous operations of an untethered vehicle in increasingly complex outdoor settings will be demonstrated. In FY 1978 and subsequent years, new concepts in manipulators, sensors, and control strategies will be incorporated and evaluated; studies will be made to determine the balance between autonomous control and interactive (man-machine) control for the efficient conduct of remote operations; and data and engineering criteria will be provided to guide the design of lunar and planetary rovers and other remotely controlled machines.

W75-70303 506-19-32
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ARTIFICIAL INTELLIGENCE FOR INTEGRATED ROBOT SYSTEMS
R. V. Powell 213-354-6586

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W75-70304 506-20-11
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ADVANCED DIGITAL DATA SYSTEMS FOR DEEP SPACE
R. V. Powell 213-354-6586

The goal is development of advanced technology for integrated spacecraft data systems, including the functions of control, automation, data acquisition and processing and data storage. Work is focused on achieving a unified digital data system (UDS) approach for post Mariner Jupiter Saturn (MJS) 77 missions. Specific targets include achieving a UDS design by mid FY-75 and a breadboard test and evaluation in FY-76. The effort
encompasses the consolidation of hardware, the application of mini-processors, simplification of software, and incorporation of fault tolerance. The justification for a new UDS design is based on a cost savings goal of approximately $1300K per mission for the six missions set listed in 15.B of this plan. The $1300K per mission saving represents $500K saving in-flight software costs, $400K saving in support equipment and support software costs, and $400K saving in hardware costs due to the common processor and standardized S/C interfaces. Work is also focused on the development and application of high performance data compression algorithms and the development of compression techniques which are applicable to high rate imaging radar data. By late FY-75 the preliminary design and analysis of a new image data compressor designated RM2 will be completed. The capability to extend the performance of the compressor to include feature recognition will be investigated, and by late FY-76 a report will be published on the results. A definition of the imaging radar data handling problem will be reported by mid-FY-75. The architecture for a static memory using bubble technology will be completed by late FY-75 with a BB targeted for late FY-76. This is in cooperation with the Langley effort and for application to the UDS.

W75-70305
Goddard Space Flight Center, Greenbelt, Md.

AUTOMATED DATA HANDLING TECHNIQUES AND COMPONENTS (HIGH CAPACITY DATA SYS.)
David H. Schaefer 301-982-5184
(175-31-42)

In a continuation of FY-74 RTOP 502-23-32, the focus of this RTOP is to develop methods of onboard analysis of data generated in earth resource and other image sensing missions. The primary task is the hardware development of 'parallel' image processing systems. Such systems process all points of an image simultaneously. Priority is being given to the development of a digital type of parallel image processor known as 'a TSE computer'. Such computers are two dimensional analogs of conventional digital computers. These computers will process from sixteen thousand to one million points simultaneously. It is the aim of the RTOP to develop TSE systems that have an effective bit rate of 10 bits per second. Real time image processing systems that utilize coherent optical phenomena are also being developed. In addition to the above image processing tasks, a small effort will be devoted to developing components to increase the utility of the 'mu-scope' microprocessor that has been developed in previous years under this RTOP.

W75-70306
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

MICROMINIATURE TRANSPONDER DEVELOPMENT
R. V. Powell 213-354-6586
(186-68-53; 506-20-22)

The objectives of this RTOP and OSS RTOP 186-68-53 are to jointly develop microwave radio transponder techniques, components, and subsystem technology required for NASA planetary missions in the period 1977 to 1982. Particular emphasis will be placed on substantially reducing the cost of transponders, while improving performance capability, reliability, and lifetime and reducing size, weight, volume, and power consumption. By the end of FY-74 the technology readiness of the S/X-band multimission transponder in a discrete component-printed circuit board miniature version appropriate for flight missions beginning in 1977 will have been demonstrated. This version has the following advantages over the Viking Orbiter design: an order of magnitude improvement in differential phase and group delay stability; and reductions of 35 percent in per unit cost; 80 percent in power consumption; 72 percent in volume; and 64 percent in weight. Key future targets are: (1) in FY-75, demonstrate an order of magnitude improvement in transponder turn-around time delay stability (through the use of quartz surface wave filters); and (2) by the end of FY-76 demonstrate the technology readiness of the transponder in a micromin version (beam-leaded parts on ceramic substrates) for flight missions beginning in 1979 which has the following advantages relative to the discrete component version: a doubling of mission life potential (adequate for 10-year missions without additional redundancy); and reductions of 56 percent in weight and volume.

W75-70307
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

MICROWAVE COMPONENTS AND TECHNIQUES
R. V. Powell 213-354-6586
(506-20-21; 645-25-02; 186-68-53; 506-17-13)

Microwave components and techniques necessary to provide the data transfer and tracking capability for NASA planetary missions from 1977 to 1982 are developed. Specific targets are: Antenna: (1) in FY-75 complete RF test of 5m unfurlable conical antenna, demonstrate ability to determine far-field gain from near-field measurements; (2) in FY-75 complete systems test of the functional design of pointing system; (3) in FY-76 complete functional specification for 60 db antenna; (4) in FY-77 complete development of S/X-band tracking feed with error less than 1/15 of S-band beamwidth; and (5) in FY-78 demonstrate 60 db X-band unfurlable antenna with S/X feed. Propagation: (1) in FY-75 use MVM occultation data to verify weak-turbulence model; (2) in FY-77 complete strong-turbulence solar corona model; and (3) in FY-79 verify strong-turbulence model with solar occultation data. Coding and Corona Communication: (1) in FY-75 assess effects of weak turbulence on coded communication; (2) in FY-75 complete software for noncoherent coded telemetry system development; (3) in FY-75 assess soft decision decoding of block codes; (4) in FY-76 perform design trades for noncoherent solar corona link; (5) in FY-77 select design of solar corona telemetry/command link and perform demonstration; (6) in FY-77 design solar corona telemetry experiment for MUJ-79; and (7) in FY-80 demonstrate reduced telemetry/command blockout due to solar corona using MUJ-79. Microwave Radio Techniques and Components: (1) in FY-76 demonstrate RF digital phase detector; (2) in FY-78 demonstrate breadboard electronic antenna beam steering systems; and (3) in FY-78 demonstrate micromin transponder with digitized baseband and low frequency portions and with monolithic UHF multiplier and amplifiers.

W75-70308
Lewis Research Center, Cleveland, Ohio.

MICROWAVE AMPLIFIER TECHNOLOGY
R. E. Alexovich 216-433-6889
(643-40-10; 643-60-01)

Objectives are to advance the state-of-the-art of microwave power amplification for space and terrestrial applications above one GHz. To achieve this objective, research and technology development programs will be undertaken on microwave amplifiers, high current density electron emitters and high power microwave passive components. Studies and investigations of space-earth propagation and interference will be undertaken to guide high power communication component and subsystem investigation. Specific techniques, such as multi-stage de-emphasized beam collection and beam refocusing for linear and crossed-field amplifiers, are among promising techniques being investigated in addition to circuit and electron gun optimization studies.

W75-70309
Goddard Space Flight Center, Greenbelt, Md.

MICROWAVE NEAR EARTH DATA TRANSFER AND TRACKING
F. J. Logan 301-982-4901
(643-40-10; 643-60-01)

The objective is to achieve technology advances in data transfer and tracking systems in order to satisfy the demanding communication requirements for future space flight projects, such as space shuttle, Earth Observation Satellite program and TDRS. The capability and performance requirements on the communication links for these advanced projects are characterized by high data rates (up to 200 Mb/s) simultaneous multi-link operation, and reliable long life operation. The attainment of these parameters requires technological advances in spacecraft techniques and hardware. High power efficient solid-state amplifiers at Ku-band will be developed. This will circumvent the limitations associated with vacuum tube TWTs, namely limited life, size and weight, and high voltages. These advances will be utilized in the development of a high data rate spacecraft transmitter package.
capable of direct communication to ground or to a data relay spacecraft. Room temperature parametric amplifiers for spacecraft receivers at S-band, C-band, and Ku-band having noise temperatures of 150 degrees Kelvin or less will be developed employing hybrid microwave integrated circuits to achieve an advanced degree of miniaturization. All solid state components will be utilized both to enhance size and weight reductions and to significantly improve operational reliability.

**W75-70310**
National Aeronautics and Space Administration, Washington, D.C.

**OPTICAL DATA TRANSFER RESEARCH**
C. E. Catoe 202-755-2450

This program of research is directed towards providing NASA with fundamental tools and methods of optical communication at earth orbital and interplanetary distances for missions in the late 1970 to 1985 time period. The future requirements for high data rate communication may possibly be satisfied by optical communication systems using laser technology. This program will advance optical technology by means of two grants for research in laser transmitters, modulators, receivers and optimal communication techniques.

**W75-70311**
Goddard Space Flight Center, Greenbelt, Md.

**OPTICAL DATA TRANSFER SYSTEMS**
J. H. McElroy 301-982-6542

W75-70312
Goddard Space Flight Center, Greenbelt, Md.

**GEOPHYSICAL MEASUREMENT TECHNOLOGY**
M. W. Fitzmaurice 301-982-4948

The technology necessary for the development of precise space-to-space, space-to-ground ranging system and techniques for calibrating spaceborne measuring systems through the atmosphere is provided. NASA flight missions in the late 1970's require satellite-to-satellite range accuracy to 0.03 cm and range-rate information to 0.003 cm/second. A large portion of the component development being conducted under RTOP 502-23-15 has application to these requirements. The major components developed under this RTOP are for higher power CO2 transmitters (20 watts), tunable waveguide lasers to compensate for larger Doppler shifts, spaceborne neodymium laser transmitters, and image converter receivers for the detection of short laser pulses. The precision limits of ground based ranging systems will be improved by the start of the development of a multi-gigahertz image converter receiver system. Spaceborne ranging system concepts will be analyzed and the development activities for a space qualitative pulsed laser initiated. The earth beacon facility at the Goddard Optical Research Facility (GORF) will be upgraded with the installation of a dye laser and the data analysis from the Skylab Experiment completed. Ground stations for laser ranging will be modified to permit pointing at the subarcsecond level using adaptive digital controllers and improved prediction up-dating techniques.

**W75-70313**
Lewis Research Center, Cleveland, Ohio.

**ADVANCED ROCKET COMPONENTS**
D. A. Petrasch 216-433-6860

The general objectives are to provide the technology for improvements in performance and reusability of liquid rocket components and subsystems. Experimental and analytical programs will be conducted to develop (1) low cycle thermal fatigue and heat transfer technology for reusable thrust chambers, (2) improved fabrication techniques for thrust chambers and (3) reduced gravity fluid acquisition and transfer systems. In the area of reusable thrust chamber technology, efforts will be devoted to obtaining fundamental fatigue data, developing the analytical capability to predict thrust chamber life and testing materials or new designs in an inexpensive thrust chamber simulator. Advanced heat transfer techniques will also be applied to ease the severity of the thermal load of high performance thrust chambers. Improved fabrication techniques involving sputtering and electroforming will be evaluated along with new nondestructive testing methods to produce better, more reliable thrust chamber hardware. Low gravity fluid system studies will investigate critical characteristics and components for in-orbit fluid acquisition and transfer.

**W75-70314**
Lewis Research Center, Cleveland, Ohio.

**ADVANCED LIQUID ROCKET SYSTEMS TECHNOLOGY**
John W. Gregory 213-433-6849

Analytical and experimental efforts are being pursued to provide the technology required for advanced, reusable hydrogen-oxygen space propulsion systems, such as the space tug. The primary effort is aimed at developing the technology for small, high pressure, reusable, pump-fed, staged-combustion cycle hydrogen-oxygen rocket engines. The work during FY-72 through FY-76 will be concentrated upon critical component technology for a 20,000 lb. thrust engine operating at about 2000 psia chamber pressure. In FY-76, the components resulting from these programs will be assembled into a Powerhead Breadboard Assembly (PBA). Tests will be made to determine the actual high pressure, staged-combustion cycle engine. Critical component technology programs in the turbomachinery and thrust chamber areas as well as engine system studies will be continued this fiscal year.

**W75-70315**
Lewis Research Center, Cleveland, Ohio.

**REUSABLE CRYOGENIC STORAGE AND TRANSFER**
J. W. Gregory 216-433-6849

The technology required for the effective design and fabrication of reusable cryogenic thermal protection and fluid transfer systems is provided. The work will be conducted on thermal protection systems designed to meet the problems associated with the changing environments experienced during a typical flight cycle by a reusable high energy upper stage. Work on both a purged multilayer insulation system as well as an evacuated multilayer insulation protected by a rigid lightweight vacuum jacket will be continued. Work has started on a unique high performance load bearing composite material providing of providing the high performance of uncompressed MLI while still providing all of the advantages of an evacuated system without the attendant weight penalty usually associated with rigid vacuum shells. The effort on fluid transfer systems will be applied to evaluation of the use of composite materials for the fabrication of engine feed lines, vent lines and pressurization lines. Designs will be evaluated to provide lines that are lightweight, have low axial heat conduction and provide rapid cooldown without excessive use of chilldown propellant, when compared to all metal lines.
THE CHEMISTRY AND ATMOSPHERIC INTERACTIONS OF OXYGEN PROPELLANTS

The objective is to develop a basic understanding of the chemistry of exhaust clouds from rocket vehicles and the interactions of the exhaust clouds with the atmosphere. Although the initial composition of the rocket exhaust is readily approximated by equilibrium calculations, it is of little use in determining the ultimate chemical and physical distribution of these products in the atmosphere, or on the ground. The chemical composition of the exhaust cloud changes continually; rapidly at first as a result of high temperature reactions with atmospheric species and nucleation of condensible species, and then more slowly as a result of both ordinary and photochemical gas and condensed-phase reactions, gaseous diffusion, droplet growth and evaporation, and various other interphase and transport phenomena. Thus, a complete chemical characterization of the resulting exhaust cloud as a function of propellant, atmospheric conditions, and time is needed to properly assess the environmental impact of the exhaust products. The results of the research proposed herein will provide a critical part of the technology base required by NASA to develop and substantiate the environmental impact statements for future NASA rocket launches.

EXHAUST CLOUDS FROM ROCKET VEHICLES

E. S. Love 804-827-2893
(180-72-50)

THE OBJECTIVE IS TO DEVELOP AND DEMONSTRATE TECHNOLOGY FOR PYROTECHNIC SYSTEMS THAT IS NEEDED TO MEET AEROSPACE FLIGHT PROGRAM REQUIREMENTS. EXPERIMENTAL PROGRAMS WILL BE CONDUCTED TO DEVELOP UNDERSTANDING OF CRITICAL PERFORMANCE PARAMETERS AT THE SYSTEM LEVEL, PROVIDING ADVANCED NON-DESTRUCTIVE EVALUATION TECHNIQUES AND PERFORMANCE MONITORING TO DETERMINE THE ADEQUACY OF SYSTEM DESIGNS. SYSTEMS MUST DISPLAY COMPATIBILITY OF INITIATION, COMBUSTION, ENERGY CONVERSION TO MECHANICAL OR CHEMICAL WORK, AND THE ACTUAL ACCOMPLISHMENT OF THE DESIRED MECHANICAL/CHEMICAL FUNCTION. STUDIES WILL BE DIRECTED TOWARD VALIDATION OF AGING TECHNIQUES AND ACTUAL DEMONSTRATION OF HIGHLY STABLE PYROTECHNIC AND EXPLOSIVE MATERIALS, SUBJECTED TO HEAT STERILIZATION CYCLING AND LONG-TERM, DEEP SPACE CONDITIONS. THE EFFECTS OF IGNITION AND COMBUSTION OF PYROTECHNIC MATERIALS WILL BE STUDIED, UTILIZING ADVANCED PERFORMANCE MONITORING SYSTEMS, PRODUCING INFORMATION ON IGNITION, BURN RATE, PRESSURE, AND ENERGY DELIVERED IN SIMULATED FLIGHT REQUIREMENTS. NEW PYROTECHNIC PROPELLANTS WILL BE STUDIED THAT EXHIBIT IMPROVED RESISTANCE TO ELECTROSTATIC AND STRAY VOLTAGES, AS WELL AS PROVIDING LOW BURN RATES TO MORE EFFECTIVELY TAINT PYROTECHNICS TO THE REQUIRED MECHANICAL/CHEMICAL FUNCTIONS.

ADVANCED SOLID PROPULSION AND PYROTECHNIC CONCEPTS

P. J. Meeks 213-354-2546

THE LONG-RANGE OBJECTIVE IS TO DEVELOP AND DEMONSTRATE SOLID ROCKET PROPULSION AND PYROTECHNIC ADVANCED TECHNOLOGY THAT CAN BE APPLIED TO: (1) REDUCE COST, IMPROVE PERFORMANCE, AND IMPROVE RELIABILITY OF EXISTING CONCEPTS, OR (2) PROVIDE NEW CONCEPTS FOR FUTURE NASA MISSIONS, IN WHICH EXISTING PROPULSION AND PYROTECHNICS MECHANISMS CANNOT BE USED TO SATISFY THE MISSION SPECIFIC REQUIREMENTS. A COMPREHENSIVE APPROACH, WHICH EMPLOYING ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS, IN BOTH IN-HOUSE AND SUBCONTRACTED MODES, WILL BE UTILIZED TO SELECT, DEVELOP, AND DEMONSTRATE THE REQUIRED ADVANCED TECHNOLOGY. WORK WILL ALSO BE ACCOMPLISHED TO PROVIDE SOLUTIONS TO SOLID ROCKET MOTOR OPERATIONAL AND DESIGN PROBLEMS. THIS PLAN IS THE MAJOR COMPONENT OF THE OAST LEVEL IV PROGRAM ON 'LOW COST SOLID PROPULSION.' THE TECHNICAL AREAS OF THE VARIOUS EFFORTS THAT ARE INCLUDED IN THIS RTOP ARE: (1) DEVELOP NEW POLYMERS WITH IDEAL CHARACTERISTICS FOR USE IN SOLID PROPELLANTS, (2) OBTAIN A FUNDAMENTAL UNDERSTANDING OF THE MECHANICAL BEHAVIOR OF SOLID PROPELLANTS, (3) STUDY PROCESSES TO DISPOSE OF LARGE QUANTITIES OF WASTE SOLID PROPELLANT AND RECOVER THE PRINCIPAL INGREDIENTS IN AN ECONOMIC AND ECOLOGICALLY
acceptable manner, (4) establish the principles for the scientific formulation of the binders of composite modified double base propellants, (5) eliminate the performance losses of composite aluminized propellants operating near 100 psia chamber pressures, (6) improve the stability of composite propellants under heat sterilization cycling conditions.

W75-70322  506-21-40
Lewis Research Center, Cleveland, Ohio.

LASER PROPULSION TECHNOLOGY
D. L. Nored 216-433-6948
(506-25-51)

The objective is to evaluate the concepts and establish the feasibility of laser propulsion by 1978. The program will investigate propulsion concepts and systems based upon the energy being transmitted by a laser beam, produced either from a space-based or earth-based system. The effort will include: (1) development of laser energy transmission and laser propulsion (performed in cooperation with other NASA centers).

W75-70323  506-21-41

ATOMIC AND METALLIC HYDROGEN AND ACTIVATED SPECIES
Gerald V. Brown 216-433-4000

The objectives are to produce and store hydrogen in each of two different monatomic forms, metallic hydrogen and spin-aligned atomic hydrogen. Each monatomic hydrogen is stoichiometric, and the energy of approximately 50 K eV per gram with respect to the molecular state. Such stored energy would be recoverable by allowing reversion to the molecular state. Other objectives include investigation of superconductivity of metallic hydrogen, to determine other properties of both new allotropes, and to study high energy electronically excited species. Targets for 1975 are to determine if spin-aligned monatomic hydrogen can be stabilized by strong magnetic fields (10 tesla). Targets for 1976 are to determine if metallic hydrogen, produced by megabar pressure, is metastable at normal pressure.

W75-70324  506-21-42
Langley Research Center, Langley Station, Va.

PROPAGATION STUDIES USING EXTENDED WAVELENGTH RANGE OF HIGH ENERGY LASERS
E. S. Love 804-827-1983
(759-11-12; 506-25-04)

The objective is to improve atmospheric transmission of high energy lasers, primarily by extending the wavelength range of electrically excited CO lasers below approximately 5.2 micrometers where transmission can be better than that of CO2 lasers operating in the range of 10.6 micrometers. CO2 lasers (approximately 3.8 micrometers) and HF (approximately 2.8 micrometers) will be studied at a later date when electric excitation techniques are better developed so as to permit closed cycle operation which is required for most laser propulsion and energy transfer missions. The study will begin by extending the wavelength range of low energy/pressure CO lasers and verification by laboratory transmission studies. Later, high energy laser energy will be obtained by pulsed operation at high pressure greater than 1 atmosphere, using photopreionization to obtain wider wavelength range, stability and single mode output; the added benefit is obtainable only if improved transmission through continuous wavelength tuning across pressure broadened laser lines. The length of the high energy/pressure pulse can be varied for future evaluation of long (quasi-steady) and short pulse effects on transmission and laser propulsion (performed in cooperation with other NASA centers).

W75-70325  506-21-43
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

NEW HORIZONS IN PROPULSION
P. J. Meeks 213-354-2546

The objective is to identify and conduct research on new concepts in propulsion which offer significant improvements over systems that now exist or are in development when these new concepts are applied to a variety of future propulsion requirements. The approach is to define the concepts in sufficient detail to allow initial applications analyses and then to evaluate the applications. These concepts are compared with current systems and with each other. Experimental and theoretical investigations are conducted as required for verification of these concepts which are promising. Concepts include the investigation of the annihilation cross sections of matter-antimatter with applied fields, the development of pointing accuracy and collector cooling requirements for beamed laser power, the potential application of nuclear fusion in space, and the evaluation of propulsion utilizing planetary atmospheres.

W75-70326  506-21-44
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GENERATION AND STORAGE OF ACTIVATED SPECIES
P. J. Meeks 213-354-2506

The main objective is to perform experimental and theoretical investigations of methods of producing and increasing the lifetime of excited states of helium and other atomic and molecular species in both the superfluid and solid phases of helium. A second objective is to perform experimental and theoretical investigations of producing and stabilizing monatomic and molecular hydrogen, containing very high concentrations of hydrogen/deuterium, and also producing and stabilizing solids which have undergone electronic collapse.

W75-70327  506-21-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SPACECRAFT LIQUID PROPULSION RESEARCH
Paul J. Meeks 213-354-2546
(506-21-21)

The chemical-physical processes that are the essence of liquid rocket engines are being characterized. These processes include ignition, combustion and decomposition, the fluid dynamics and chemistry of nozzle flows, compatibility of chamber walls with reaction products and plume effects on spacecraft components. The mixing effectiveness of liquid/liquid and gas/liquid propellant injection systems are being evaluated experimentally and the mechanisms that control mixing are being correlated with injector dimensions and operation conditions. An on-line high-speed mass-spectrometer, in combination with a molecular beam probe, is being used to relate engine conditions (compositions) and injector variables, and to bound the relevance of the reactive data and predictions of analytical/computer models. The origin of solids deposited on low temperature surface is sought. Computer programs for the detailed analysis of liquid rocket performance are being developed and evaluated. A combustion model (Distributed Energy Release) in conjunction with a 2-dimensional non-linear combustion instability models (COMB and TRDL) is being used to predict performance and stability margins. Densities and pressure within the exhaust plume (single component gas) of a small rocket nozzle have been experimentally determined in previous FY. These data are being compared with predictions from a computer model developed in FY-74. This model now is being extended to the case of multi component rocket exhaust gases.

W75-70328  506-21-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SOLID PROPELLANT RESEARCH
Paul J. Meeks 213-354-2546
(506-21-32)

The objective is to establish scientific bases for the chemical formulation, ballistic design, and mechanical design of solid propellants for rocket motors. Theoretical and experimental investigations will be performed in solid propellant chemistry and combustion to: (1) obtain a better understanding of propellant mechanical, processing, and ballistic property character-
istics to permit the formulation of techniques for the control thereof, and (2) derive information on the combustion of propellants to enable one to make a realistic prediction of combustion instability in new motor designs and an assessment of instability in existing motors.

W75-70329 506-21-53
Lewis Research Center, Cleveland, Ohio.
CHEMICAL PROPULSION RESEARCH
D. A. Petrash 216-433-6860

The objectives of this work are to expand the basic understanding of injection, mixing, combustion, and other chemical physical processes in chemical propulsion systems in order to provide higher performing, more reliable, and lower cost systems for future missions. These objectives will be attained through: (1) theoretical studies to delineate the important design parameters required to achieve engineering improvements, (2) experimental studies to demonstrate the validity of specific theoretical approaches and design parameters, and (3) exploratory studies to investigate new techniques or theoretical approaches that will provide further engineering improvements in liquid rocket engines. Areas in which this effort will be applied are the following: (1) combustion (2) fluid flow (3) thermodynamic, transport and kinetic data, (4) instrumentation, and (5) mission and system analysis.

W75-70330 506-21-54
Lewis Research Center, Cleveland, Ohio.
SAFETY RESEARCH
Paul M. Ordin 216-433-6941

The objectives are to obtain a better understanding of the hazards and improve the safety of NASA and contractor operations associated with oxidizer and fuel systems and related propellants for flight, research and development facilities and ground service equipment. Specific areas of current interest include: (1) preparation of standards/criteria for the design and operation of propellant systems, (2) investigations of the initiation of system failures induced by propellant properties including the effects of contaminants, (3) investigations of combustion and non-ideal explosions caused by propellant spills and tank ruptures, and (4) analysis and tests of gravity effects on fire extinguishment systems and studies of flow dynamics of multi-phase cryogenic propellants under transient conditions.

W75-70331 506-21-56
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED PROPULSION TECHNOLOGY
R. C. Kahl 713-483-4871

JANNAF Performance Evaluation Methodology and computer programs will be improved by new technology developed as appropriate to allow for the experimental measurement, analytical prediction, correlation, extrapolation, and flight configuration of the performance of liquid/liquid, gas/liquid, gas/gas, solid, and hybrid rocket engines. The developed technology will define the nature and magnitude of the performance losses associated with each kind of rocket engine system and provide or improve models which describe the major physical processes.

W75-70332 506-21-63
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
BASIC CHEMICAL REACTIONS BETWEEN ROCKET EXHAUST AND STRATOSPHERIC CONSTITUENTS
P. J. Meeks 213-354-2546 (502-21-64)

In both an experimental and theoretical approach, the experiments will include laboratory measurements of reaction mechanisms and rate constants utilizing photochemical techniques. Also, the techniques of Auger spectroscopy, photoelectron spectroscopy, electron diffraction and mass spectroscopy will be utilized in determining the nature of the HCl adsorbed on the AI2O3 surface. The theoretical calculations will be based on an electrostatic theory of absorption developed by King and Benson. Calculations will also be performed to determine residence times of AI2O3 particulates in the stratosphere.

W75-70333 506-21-64
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SHUTTLE SOLID ROCKET BOOSTER EXHAUST ENVIRONMENTAL EFFECTS
P. J. Meeks 213-354-2546 (506-21-63)

The assessment activities of the environmental impact of the space shuttle require characterization of the rocket exhaust with emphasis on different substances and small concentrations that were of interest in prior studies directed toward performance assessment and improvements. Aluminum oxide particles generated during the combustion of aluminized propellant in the proposed space shuttle booster rockets can participate significantly in the environmental cycle of the exhaust products. The following possible roles for AI2O3 have been indicated: (1) solar radiation scatterer, (2) water condensation nucleating center, and (3) gas reaction catalyst. The last function, because of its participation in the HOCl-03 and NOx-03 cycles, is of paramount importance. The work proposed is directed toward an extensive characterization of the AI2O3 particulates; namely, size distribution, surface characteristics, elemental and chemical composition. An added objective is the collection of significant amounts of materials to be made available to environmental researchers in the scientific community.

W75-70334 506-21-65
Ames Research Center, Moffett Field, Calif.
ATMOSPHERIC EFFECTS OF SOLID ROCKET CONSTITUENTS
D. R. Chapman 415-965-5065 (176-61-11)

The objectives are to determine the effects of solid rocket exhausts on the stratosphere. The specific goals are: (1) to extend current and future stratospheric models in order to assess the effects on the stratosphere of chlorine and nitrogen compounds and alumina particles exhausted by solid rockets, (2) extend stratospheric measurements to include those needed for input and validation of shuttle impact assessment models; (this includes the development of needed instruments), and (3) measure important reaction rates. One- and two-dimensional stratospheric models now under development at Ames Research Center are being extended to include chlorine and alumina chemistry; the one-dimensional model has already been extended to include chlorine chemistry and preliminary impact assessment studies have been made. Airborne measurement missions are being implemented to study the HCL, AI2O3 and NOx exhausted by large solid rockets at the Western Test Range: the development of the additional instruments needed for these missions has been initiated. Background stratospheric measurement programs will be extended to include the additional species that are important to solid rocket impact assessment. Laboratory scale measurements are being implemented to measure homogeneous and heterogeneous reactions between chlorine, alumina and natural stratospheric constituents.

W75-70335 506-21-68
Langley Research Center, Langley Station, Va.
ROCKET EXHAUST PLUME COMPOSITION AND ATMOSPHERIC INTERACTIONS GROUND LEVEL TO STRATOSPHERE
E. S. Love 804-827-2893 (506-22-10)

Work will be continued on the determination of the rate constants for the seven most important stratospheric chemical reactions based on the presently defined reaction scheme, AEP meeting, 1/21-23/74. These measurements at pressures and temperatures comparable to the stratosphere are needed by ARC for modeling the chemistry of inorganic chlorine compounds in the stratosphere. Calculations will continue to determine the oxides of nitrogen produced by the shuttle in the stratosphere. The solid motor combustion chemistry, two phase nozzle flow and the entire two phase, nonequilibrium plume flow field will be modeled utilizing existing codes to bound the chemical and physical behavior of the rocket motor plume.

W75-70336 506-22-10
Goddard Space Flight Center, Greenbelt, Md.
AUXILIARY ELECTRIC PROPULSION SYSTEMS
R. A. Callens 301-982-4205
Unmanned meteorological, communication, earth observation and other application satellites require, not only long-lived, lightweight spacecraft propulsion systems, but also ones capable of providing north-south stationkeeping, precession control, east-west stationkeeping, or precise attitude control. The objective of this RTOP is to identify and develop the spacecraft propulsion systems needed for these spacecraft. When necessary, they are evaluated in either GSFC's Electric Propulsion Laboratory or its Hydrazine Test Facility. Additionally, when necessary, space flight tests of candidate systems are conducted to further demonstrate their capability for space flight application. Spacecraft propulsion is required on virtually all application satellites for a variety of specialized functions. For example, the Applications Technology Satellite (ATS), a geosynchronous spacecraft, requires a high specific impulse thruster for north-south stationkeeping. Work on a cesium bombardment ion engine, with a 2500-second specific impulse, is underway to satisfy this requirement.

W75-70337  506-22-11
Lewis Research Center, Cleveland, Ohio.

AUXILIARY PROPULSION ION THRUSTER TECHNOLOGY
R. C. Finke 216-433-4000
The overall program is directed at applying the knowledge gained from ion thruster research programs to the design, fabrication, and testing of new thruster components; integration of promising new components into thrusters sized for widest possible applications and evaluating thruster performance. Testing of components (thruster, PPU, PCU) as a system to optimize component performance and cyclic life testing as part of the system to verify durability will be done. The technology developed will result in hardware for flight prototype thruster subsystems of demonstrated efficiency and durability, thus assuring a firm base of technology-ready hardware for application to anticipated auxiliary electric propulsion controlled spacecraft. The major program in this area is to develop a qualified vectoring ion thruster for low-powered, long-life missions (north-south stationkeeping and attitude control of 5-10 year geosynchronous satellites). Endurance tests of thruster systems will be performed in a cyclic mode, duplicating the mission profile. Qualified, low-power-consumption vectoring systems will be demonstrated.

W75-70338  506-22-12
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PULSED PLASMA THRUSTER SYSTEM TECHNOLOGY DEVELOPMENT
A. Briglio, Jr. 213-354-6137
The objective is to demonstrate the availability of the technology of millipound-level pulsed plasma thrusters suitable for high-energy, high-total-impulse missions, such as north-south stationkeeping of long-lived satellites, and where scientific requirements impose very tight stabilization and pointing control or orbit control. Such devices could provide overall system advantages for many planetary and geosynchronous missions, particularly for spinning spacecraft, if the system mass and total efficiency could be made competitive with such devices as ion engines and colloid thrusters. Key to this is the development of reliable large, high-energy-density capacitors. Significant progress has been made to date in this area, with the life testing of mylar capacitors developed for LES-9 at three times their rated energy density, and the initiation of a life test, under USAF sponsorship, of a K-film capacitor meeting the 40-joule/lb objective. However, there continues to be a problem in obtaining reliable and reproducible capacitors for this application. Major objectives during FY-75 are (1) to complete an evaluation of three capacitor types fabricated under rigid quality assurance procedures, to establish the relative merits of mylar and K-film capacitors divorced from extraneous influences of workmanship and fabrication techniques; and (2) to survey possible NASA and commercial applications and perform systems analysis on identified candidate spacecraft missions for application potential of millipound-level pulsed plasma systems. The long-range objective of the joint NASA/USAF program is to qualify a high-energy pulsed plasma thruster for flight application by the end of FY-77.

In FY-75, NASA support is required for the activities described above. After FY-75, it is expected that all effort will be carried out by the USAF.

W75-70339  506-22-20
Lewis Research Center, Cleveland, Ohio.

PRIME PROPULSION ION THRUSTER TECHNOLOGY
R. C. Finke 216-433-4000
The overall program is directed at applying the knowledge gained from ion thruster research programs to the design, fabrication, and testing of new thruster components; integration of promising new components into thrusters sized for widest possible applications and evaluating thruster system performance. Testing of components (thruster, PPU, PCU) as a system to optimize component performance and cyclic life testing as part of the system to verify durability will be done. The technology developed will result in hardware for flight prototype thruster subsystems of demonstrated efficiency and durability, thus assuring a firm base of technology-ready hardware for application to anticipated electric propulsion spacecraft. The major program will develop qualified mercury electron bombardment thruster systems for high efficiency applications; for instance, synchronous orbit control, and 0.3 to 3 a.u. interplanetary missions. Interactions of multi-thruster clusters are also being investigated. Pertinent information from experimental and analytical studies and demonstrated components will be integrated into a specific thruster system design. This design will cover the widest possible range of currently foreseen mission types. Thruster system interactions and integration problems will be investigated to the extent necessary to clearly define interface problem areas. Effect of power conditioner on thruster performance and dynamics will be studied.

W75-70340  506-22-33
Marshall Space Flight Center, Huntsville, Ala.

SEPS ENVIRONMENTAL IMPACT
J. B. Stephens 205-453-2114
(180-17-56: 502-24-17)
The parametric qualities associated with terrestrial perturbations in the lower stratosphere and the troposphere from the release of mercury will be investigated. The study contract for RTOP 502-24-17 on the Environment Impact of Solar Electric Propulsion revealed that a detailed analysis of the effects of a mercury release from a failure mode of the atmosphere required additional definitive investigation to establish reaction rates and diffusion parameters. This work will address two separate problems: (1) the reactions and rates of mercury with ozone to determine the long-term effects of mercury on the ozone layer in the lower stratosphere; and (2) the development of mathematical methods to account for the deposition and diffusion of mercury in the troposphere.

W75-70341  506-22-40
Lewis Research Center, Cleveland, Ohio.

ION THRUSTER RESEARCH
R. C. Finke 216-433-4000
The broad objective is to provide the basic research needed to increase in an orderly and meaningful manner the knowledge of the behavior of electrostatic thrusters and their interaction with the spacecraft to be employed in communication and scientific missions. By conducting pertinent experimental and analytic studies, the overall program is directed at obtaining a more thorough understanding of the basic physical processes: (1) occurring in and external to electrostatic thrusters, (2) interacting with the spacecraft or its intended mission, and (3) resulting from thruster/power conditioner/control system interactions. Major programs are directed at searching for basic understanding of thruster and spacecraft interactions to permit refinement of the designs of a given thruster and spacecraft to enable the combined system to experience no significant degradation in mission performance. Specifically, the basic research goals are to investigate the surface deposition of materials from thruster components, erosion, the electrostatic interactions affecting the thruster/spacecraft interface, problems of ground simulation of thruster/spacecraft interactions in space, thruster/space environment phenomena, theoretical and experi-
mental thruster diagnostics and operation of various sized thrusters using xenon as a propellant.

W75-70342 506-23-12
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
PLANETARY SOLAR POWER RESEARCH AND TECHNOLOGY
A. Briglio, Jr. 213-354-6137
(506-22-32)
A listing of the JPL FY-75 program for planetary solar arrays and solar cell research and technology is given. The relationship between the JPL program and the specific NASA target or objective is provided after each program listing. (1) Continue the 110-W/Kg Solar Array Development Program (Ref: NASA Target-50 W/Lb Technology Ready by FY-77). (2) Continue the development of .01-cm-thick, high-efficiency solar cell (Ref: NASA Target-Pilot Production of 4-mil cells by FY-76). (3) Continue the development of silicon ribbon technology for solar cells (Ref: NASA Target-Ribbon Solar Cells by FY-76). (4) Continue the development of low-cost solar array technology (Ref: NASA Target-Low Cost $40/W Technology by FY-78). (5) Continue the program to test and evaluate solar cells for deep space applications (Ref: NASA Target-Qualify Violet Cells by FY-74). (6) Develop space solar cell standards for evaluating new solar cell designs (Ref: NASA Target-Develop New Standards by FY-75). (7) Continue the silicon research program (this effect is directed to advancing materials and device technology for purposes of increasing radiation resistance and efficiency and to improve cell design; each of these factors is related to the NASA Objectives of array cost reduction and power density improvement). (8) Continue the inversion layer solar cell program (the comments after Item 7 above apply here also). This work will be accomplished through combined in-house and contracted efforts with industry and universities. The needs of solar electric propulsion will receive special consideration.

W75-70343 506-23-15
Goddard Space Flight Center, Greenbelt, Md.
HIGH EFFICIENCY SOLAR CELL DEVELOPMENT AND EVALUATION
L. W. Slifer
Objectives are: (1) development of high efficiency solar cells into production line item; and (2) evaluation of production line cells for space flight use. These will be approached as follows: (1) evaluate pilot line samples of high efficiency cells; (2) transfer technology to production line; (3) evaluate production progress samples; (4) flight qualify production cells; (5) develop large area production cells; (6) develop thin production cells; (7) perform yield and cost analysis; (8) develop detailed production procedures; (9) develop quality assurance requirements; and (10) develop high efficiency solar cell specification.

W75-70344 506-23-17
Lewis Research Center, Cleveland, Ohio.
SOLAR CELL TECHNOLOGY
D. T. Bernatowicz 216-433-4000
In order to reduce cost and improve performance of solar cells and arrays for space applications, research and technology programs will be continued toward the following targets: (1) develop silicon solar cell with efficiency of 14 per cent (AMO) and same cost as conventional cell by end of FY-75 by integrating known technology advances in individual process steps; (2) develop an 18 per cent solar cell by FY-78 through basic research to uncover, understand, and reduce the source of losses in highly-doped cells; and (3) produce solar cell arrays at $90/ watt (30 per cent of present $300/watt) by FY-79 through development of low cost single crystal silicon ribbon, automated cell fabrication and automated FEP-array production.

W75-70345 506-23-22
Goddard Space Flight Center, Greenbelt, Md.
BATTERY QUALITY CONTROL AND TESTS
T. J. Hennigan 301-982-5547
Objectives are: (1) to advance battery material development; (2) to increase the usable energy density of nickel-cadmium cells; and (3) to improve cell and cell component characterization methods and cell fabrication process control; (4) to develop analytical methods for cell component analysis; and (5) maintain a NASA test facility to perform battery life tests and investigate methods of accelerated testing.

W75-70348 506-23-23
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE
A. Briglio, Jr. 213-354-6137
The battery technology to support future planetary missions and terrestrial applications is provided. The objectives, in accord with the NASA Program Objectives, are to attain longlife (10-year), high-energy-density, and highly reliable electrochemical energy storage devices by advancing the technology of its components, operating and storage techniques, and test and evaluation procedures. Additional requirements, such as high-rate discharge and cost reduction are also addressed. A more thorough understanding of battery failure modes will be obtained, and means for eliminating these failure sources in order to permit highly reliable battery operation will be investigated. This is to be accomplished through a continuing research effort, the major activity of which is the investigation of pulse charging effects on battery performance. The specific targets of the RTOP include: (1) achieving doubling of life of Ni-Cd batteries by means of non-gassing construction and improved fabrication techniques; (2) determining the effects of zero gravity on high power outputs of Ni-Cd, Ag-Zn, Ni-H2 and other candidate systems using test vehicles such as Astrobee and the shuttle; and (3) screening and evaluating candidate electrochemical systems for selected probe applications requiring high-rate (up to 15C) performance with a life of up to five years, by the end of FY-1977. The immediate objectives of the research effort are: (1) to determine the effects of pulse charging on degradative changes in alkaline cells, and (2) to establish a better theoretical understanding of the relationship between pulsed current parameters and electrode polarization.

W75-70347 506-23-24
Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL DEVICES
Harvey J. Schwartz 216-433-6910
The object is to attain long-life, high energy densities and high reliability for electrochemical energy storage devices. In order to meet this objective, work will be performed to develop silver-zinc batteries with 4-5 times the energy density of nickel-cadmium batteries for five years life in synchronous orbit and planetary applications by FY 1977. A longer lived (10 year) higher energy silver-hydrogen synchronous orbit battery will be developed by FY 1979. A high energy potassium-sulfur cell using a glass fiber electrolyte will be demonstrated by FY 1979. Solid electrolytes suitable for operation in alkali metal batteries of the 100-150 WH/lb class will be identified by FY 76. Testing of a prototype cell for a 20 lb/KW, 10,000 hour life H2-02 fuel cell system will be completed by FY-77.

W75-70348 506-23-34
Marshall Space Flight Center, Huntsville, Ala.
MULTI-KW DC DISTRIBUTION SYSTEM TECHNOLOGY
J. L. Felch 205-453-4631
(113-60-21; 502-25-73)
As part of the NASA space vehicle technology development program, TRW Systems performed a comprehensive Space Vehicle Electrical Power Processing, Distribution and Control Study under Contract NAS8-26270 for the Marshall Space Flight Center. This study, which was completed in late 1972, disclosed that significant reductions in weight, greater design flexibility, reliability, and lower cost can be realized for large future aerospace vehicles through use of higher dc distribution and transmission voltage (above 100 Vdc) when compared to conventional 28 Vdc or 115 Vac systems. It also showed that maximum benefit can be obtained when high voltage dc distribution is coupled with remotely controlled solid state switchgear and multiplexed computer controlled supervision and checkout of the electrical system. The approach which has been selected for providing technology-readiness consists of the design of a flexible
FOR PLANETARY APPLICATIONS
A. Briglio, Jr. 213-354-6137

The major objective is to develop and demonstrate advanced power processing and distribution and related system configuration and integration technology to meet the requirements of future planetary spacecraft. These requirements, as identified in NASA's 'Objectives' documentation, include longer life, higher performance, higher reliability and lighter weight than can be achieved with existing technology. The intent of this work is to develop designs that not only can meet the technical requirements but which can also be built and incorporated into the spacecraft power system for minimum cost. In developing the necessary capability, techniques and hardware it is required that the specialized requirements of both solar and sun-independent power sources be accommodated. Also, a significant capability for advanced power systems operation is a likely requirement for many future planetary spacecraft. The basic approach being taken is to develop modular or 'building block' designs of the major power processing elements within the spacecraft power system. These designs are standardized to the maximum extent possible and feature active rather than standby redundancy. This minimizes the total number of separate modules required in the system and, hence, the cost to build and test it. High performance circuits and components are used throughout and the basic approach offers a large degree of flexibility for scaling the system to different input voltages and power levels, thus, providing capability for multiple applications. Additionally, standardized design and analysis methods are being developed and applied for all power processing circuits used in planetary spacecraft power system. Finally, test methodology and equipment for multi-redundant power systems are being developed, and initial investigations into providing automated power system management are being conducted.

W75-70354 506-23-41
Lewis Research Center, Cleveland, Ohio.
HYDROGEN-OXYGEN POWER SYSTEMS
D. L. Nored 216-433-6948

The objectives of this activity are to develop technology readiness for a hydrogen-oxygen APU to provide hydraulic and electric power for the space shuttle vehicle, and to evaluate the performance potential and applicability of hydrogen-oxygen dynamic power systems for other space and ground applications. Detail analysis, design, fabrication and test of a 400 hp test APU supplied with high-pressure liquid or gaseous propellants is being conducted under Contract NAS3-15708 by AiResearch. The primary technology area under investigation involves the system dynamic controls in the propellant feed and conditioning subsystem. This effort includes development of a system computer model to permit ready evaluation of system modifications and parametric changes as required for final application. In-house effort will be used to provide conceptual designs (weight and volume) of H2-O2 supply systems. Evaluation tests of a positive displacement liquid hydrogen pump, which would be required for a low-pressure liquid supply system, are being performed.

W75-70352 506-23-37
Jet Propulsion Lab., Calif. Inst. of Techn., Pasadena
LONG-LIFE, HIGH-PERFORMANCE POWER PROCESSING

The objectives are to develop and demonstrate advanced power processing and distribution and related system configuration and integration technology to meet the requirements of future planetary spacecraft. These requirements, as identified in NASA's 'Objectives' documentation, include longer life, higher performance, higher reliability and lighter weight than can be achieved with existing technology. The intent of this work is to develop designs that not only can meet the technical requirements but which can also be built and incorporated into the spacecraft power system for minimum cost. In developing the necessary capability, techniques and hardware it is required that the specialized requirements of both solar and sun-independent power sources be accommodated. Also, a significant capability for advanced power systems operation is a likely requirement for many future planetary spacecraft. The basic approach being taken is to develop modular or 'building block' designs of the major power processing elements within the spacecraft power system. These designs are standardized to the maximum extent possible and feature active rather than standby redundancy. This minimizes the total number of separate modules required in the system and, hence, the cost to build and test it. High performance circuits and components are used throughout and the basic approach offers a large degree of flexibility for scaling the system to different input voltages and power levels, thus, providing capability for multiple applications. Additionally, standardized design and analysis methods are being developed and applied for all power processing circuits used in planetary spacecraft power system. Finally, test methodology and equipment for multi-redundant power systems are being developed, and initial investigations into providing automated power system management are being conducted.

W75-70353 506-23-40
Lewis Research Center, Cleveland, Ohio.
THERMO-MECHANICAL ENERGY CONVERSION
C. S. Corcoran 216-433-8346
(506-16-21)

The objective is to provide a technology base for high-efficiency, long-life thermomechanical space power conversion systems applicable to near-term NASA missions (late 70's). This program will include a demonstration of the Brayton power conversion process in the fractional-to-2 kilowatt power level. NASA missions in the late 70's and early 80's appear to require power levels in the neighborhood of 1 kilowatt. Several of these missions, especially deep space probes, cannot use solar arrays. In addition, certain DOD missions in this time period require compact power systems with long-life and in the range of 1 kilowatt power output. To fulfill these needs especially to provide confidence for mission selection, a proof-of-concept Brayton conversion system will be designed, built, and run to demonstrate failure-free and unattended operation for a continuous period of at least two years.

W75-70352 506-23-37
Jet Propulsion Lab., Calif. Inst. of Techn., Pasadena
LONG-LIFE, HIGH-PERFORMANCE POWER PROCESSING

The objectives are to develop and demonstrate advanced power processing and distribution and related system configuration and integration technology to meet the requirements of future planetary spacecraft. These requirements, as identified in NASA's 'Objectives' documentation, include longer life, higher performance, higher reliability and lighter weight than can be achieved with existing technology. The intent of this work is to develop designs that not only can meet the technical requirements but which can also be built and incorporated into the spacecraft power system for minimum cost. In developing the necessary capability, techniques and hardware it is required that the specialized requirements of both solar and sun-independent power sources be accommodated. Also, a significant capability for advanced power systems operation is a likely requirement for many future planetary spacecraft. The basic approach being taken is to develop modular or 'building block' designs of the major power processing elements within the spacecraft power system. These designs are standardized to the maximum extent possible and feature active rather than standby redundancy. This minimizes the total number of separate modules required in the system and, hence, the cost to build and test it. High performance circuits and components are used throughout and the basic approach offers a large degree of flexibility for scaling the system to different input voltages and power levels, thus, providing capability for multiple applications. Additionally, standardized design and analysis methods are being developed and applied for all power processing circuits used in planetary spacecraft power system. Finally, test methodology and equipment for multi-redundant power systems are being developed, and initial investigations into providing automated power system management are being conducted.

W75-70351 506-23-32
Goddard Space Flight Center, Greenbelt, Md.
POWER PROCESSING FOR EARTH ORBITAL SPACE SCIENCE AND APPLICATIONS SATELLITES
Edward R. Fasciotti 301-982-4885

Objectives are power conditioning investigative techniques and developments to improve power conversion efficiencies, reliability, performance, and develop commonality circuitry in hybrid form. Specific aims are: (1) to investigate input/output transient problem areas and solutions; (2) to establish library of computer design programs for design and analysis of power conditioning systems and subsystems; and (3) to effect improved efficiency, utilization and lower cost through standardization. Means to improve encapsulation techniques for high voltage assemblies, diffusion of gases through solids in a vacuum environment, and development of a high voltage shunt regulator circuitry in hybrid form will also be studied.

W75-70350 506-23-31
Lewis Research Center, Cleveland, Ohio.
HIGH PERFORMANCE POWER ELECTRONIC COMPONENTS
P. A. Thollot 216-433-4000
(506-23-30)

The objectives are to advance the state-of-the-art and establish the technology required to improve electronic power components and subsystems and to investigate interactions between the electrical systems and the environment of spacecraft. This includes the development of improved electronic power components as required for use in low weight, high efficiency power processors and distribution systems. It also includes the interaction effect of high voltage and construction materials with the space environment, including plasma, solar illumination, low temperature, and vacuum. These components are for use in space station-base and shuttle flight programs, satellites for survey, scientific and communication purposes. Contract and in-house studies will be implemented to perform experimental investigations, and hardware fabrication as required to establish the technology of new circuits and power processing and distribution systems.

W75-70349 506-23-30
Lewis Research Center, Cleveland, Ohio.
ADVANCED LOW COST POWER PROCESSING AND DISTRIBUTION TECHNOLOGY
P. A. Thollot 216-433-4000
(506-23-31)

The objectives are to advance the state-of-the-art and establish the technology required to improve aerospace power processing and distribution systems. Terrestrial applications will also be considered in the establishment of this technology. Addressed are, improvements in electrical circuit performance, and the general optimization of power processing and distribution systems including utilization of integral solar array power regulation and conditioning. In addition to general technology, this program has as an objective directed technology for specific applications. Included in this category are: (1) power processing concepts with efficiencies in excess of 90 per cent and power densities of about 2.5 Kg/Kw for ion thrusters, and (2) single and multi-module power conditioning units meeting low cost, reusable space station/base and shuttle requirements. Also included is an effort directed toward developing engineering tools, using modeling and analysis techniques, which will enable designers to rapidly and accurately assess total system interaction and trade-off effects. Contract and in-house studies will be implemented to perform experimental investigations, and hardware fabrication as required to establish the technology of new circuits and power processing and distribution systems.
under contract. Additional pump development and testing of the pump with the complete system may be performed.

W75-70355 506-23-42
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THERMIONIC POWER SYSTEMS FOR PLANETARY APPLICATIONS
A. Briglio, Jr. 213-354-6137

The purpose is to determine the applicability and usability of dynamic power systems on outer planet spacecraft. A number of dynamic conversion systems are potential candidates for utilization in outer planet spacecraft. These include the rankine, the Stirling engine, and the Brayton engine. To date only the Brayton engine has had any significant development support by NASA. Therefore, this system has been selected to perform the initial S/C integration studies. The work will be performed under the following tasks: (1) S/C integration and packaging; (2) effects of engine rotation on the attitude control system; (3) the magnitude of the magnetic field; (4) electrical transient behavior and on-pad operations, and (5) reliability and lifetime. The effort will lead to reduced cost for space nuclear power systems, which is an objective of the NASA thermomechanical energy conversion effort. In FY-75 it is planned to complete preliminary integration studies to determine the suitability of thermomechanical energy conversion systems in outer planet spacecraft, in accord with the NASA Target.

W75-70356 506-23-50
Lewis Research Center, Cleveland, Ohio.
SOLAR ENERGY SYSTEMS TECHNOLOGY
Robert G. Raghsdale

The objective of this program is to develop and demonstrate the component and systems technology for economical utilization of solar energy to the degree necessary that commercial implementation will be achieved by 1980. Solar energy represents a nonpolluting, everlasting energy source that is available in sufficient quantities to provide a large part of the nation's energy needs for electricity, for heating and cooling buildings, and for clean fuels. Tests will be carried out to evaluate and to improve the operating characteristics of solar energy systems, such as solar collectors, energy storage devices, and air conditioning units that can be driven by hot water. These tests will be carried out both under controlled, laboratory conditions, and outdoors in variable weather conditions. Model systems tests will be carried out to study the dynamic behavior of components connected into total systems. Design studies will be conducted to determine ways to reduce system and component costs without reducing performance. Cost/performance trade-off criteria will be established for various applications. This program will provide the technology base necessary to design and carry out major solar energy demonstration programs.

W75-70357 506-23-51
Lewis Research Center, Cleveland, Ohio.
LANGLEY BUILDING SOLAR SYSTEM
Robert G. Raghsdale 216-433-6943

The objective is to provide a solar test bed to demonstrate the technical and operational characteristics of a solar energy collection system being used to heat and cool an office building. This will be accomplished by designing a solar energy collection and storage system which will provide the energy to heat and to drive the absorption air conditioning system for the new Langley Systems Engineering Building. The solar system will operate in parallel with a conventional HVAC system. The conventional HVAC system will supply energy when the solar energy is not sufficient. The solar energy system, collectors, support structure and energy storage facilities will be designed in-house. The detailed design of the system and all component parts with the exception of the collectors, will be designed in-house for a construction contract. The collectors will be detail designed and procured under separate contract. The building/solar system interfaces will be defined in-house and an architectural engineering firm will design the building.

W75-70358
Langley Research Center, Langley Station, Va.
PLASMA-CORE REACTOR RESEARCH
E. S. Love 804-827-2893

The objective is to establish the scientific understanding of 235UF6 and 235U plasma-core nuclear reactors and to study their technological usefulness. Emphasis in this basic research is on the physics of fission fragments - gas interactions to understand the mechanisms of nuclear-induced electromagnetic radiation, the transport of this radiation and its conversion to useful energy. In addition, a major effort of research is directed toward fluid mechanical confinement of fissioning gaseous nuclear fuel and for flow and materials studies of UF6 and uranium vapor handling systems. Fluid mechanics, UF6 handling and part of the optical radiation research will be conducted under contract to LaRC direction. Other supplementary radiation research is conducted under the LaRC Nuclear reactor experiments will be conducted at Los Alamos under a separate NASA Headquarters RTOP.

W75-70359 506-24-13
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
NUCLEAR PUMPED LASERS
T. Vrabolovich 213-354-4530

The primary objective is to develop high pressure, visible and vacuum ultraviolet lasers where the laser pumping is provided by a pulsed nuclear reactor. A secondary objective is to conduct supporting theoretical and experimental research which will lead to an understanding of the kinetic processes responsible for lasing in high pressure plasmas produced by the products of nuclear reactions.

W75-70360 506-24-21
Lewis Research Center, Cleveland, Ohio.
HIGH-EFFICIENCY, LOW-TEMPERATURE THERMIONIC CONVERSION
J. F. Morris 216-433-4000

The objective is to develop for land, sea, and space applications cesium diodes that produce greater current densities and higher output voltages at lower temperatures than those for established thermionic converters. The approach to high efficiency, low temperature thermionic converters combines development of improved electrodes and reduction of plasma losses. This work will utilize NASA's miniature plane guarded cesium diodes (diminiodes) and a computer system to control, collect, and correlate power-output data. Diminoide smallness allows increased coverage and economy in electrode screening while its simple, adaptable design makes possible modifications to reduce plasma maintenance voltages. Evaluations of best candidates from metals, metal oxides and metal-metal-oxide solid solutions will indicate more effective emitters and collectors. Studies to minimize plasma losses will involve tiny distributed shorted diodes and pulsed discharges across the interelectrode gap. Detailed performance mapping for the better converter components will provide design data for scaling up to the thermionic conversion systems. Coordinated contract and grant efforts will also produce higher thermionic conversion efficiencies through improved electrodes and reduced interelectrode losses---

W75-70361 506-24-22
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
LOW-TEMPERATURE THERMIONIC CONVERTER
R. R. McDonald 213-354-6186

The long range objective is to develop a low temperature converter having a conversion efficiency which is more than twice that of high temperature converters. In the high-temperature converters, radiative heat losses from the high temperature emitter are a significant part of the total input energy required to operate the converter. This radiative loss can be drastically reduced by lowering the emitter temperature. Resulting reduction of thermionic emission current can be readily compensated by a reduction of emitter work functions (from 3.0 eV to 2.0 eV). However, the smaller emitter work function creates a need for a collector work function as low as 1.0 eV so as not to lose
the output voltage. Thus a development of a low work function collector, which operates at a temperature as high as 800 K, becomes necessary. The short range objective is to fabricate and test a low temperature converter having a metal-oxide emitter and a low work function collector. The collector will be made of a negative electron affinity (NEA) electrode using appropriate semiconductor material, which will be determined from independent measurements of work functions in a work function test vehicle which has been built during FY-74. The goal of the low temperature converter is an efficiency better than 12 percent at an emitter temperature of 1400 K and an ultimate efficiency of better than 25 percent when means for neutralizing space charge are established. Also, a feasibility study of a thermionic power system for solar energy conversion for domestic use will be made on a limited scale during FY-75.

W75-70362 506-24-31
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THERMIONIC SYSTEMS TECHNOLOGY
R. R. McDonald 213-354-6186
The long-term objective is to achieve high efficiency, low-temperature thermionic power subsystem technology readiness for application to terrestrial and space power. The intermediate objective is to establish the feasibility of low cost design concepts applicable to quantity production of thermionic systems. These objectives are accomplished through system design studies and engineering applications studies, materials studies, well-defined key technology experiments at the component and subsystem levels, and a detailed evaluation of technology from other programs. A typical thermionic power subsystem consists of a heat source, thermionic converters, heat exchanger, pumps, controls, structure, and power processing. A nuclear heat source also requires nuclear shielding and containment. Power systems technology is being studied for such applications as building heating and cooling and process heating, auxiliary (decentralized) powerplants, space power, and mining. Emphasis is placed on achieving low cost, effect in fuel utilization, and maintenance-free operation. This RTOP is coordinated with the research work being conducted under RTOP 502-12-01.

W75-70363 506-24-23
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
NUCLEAR THERMOELECTRIC SYSTEMS TECHNOLOGY FOR SPACE GENERATION
R. Bigio, Jr. 213-354-6137
Continued exploration of the outer planets will require many cases the use of improved and advanced isotope power systems. The broad objectives of this RTOP are as follows: (1) evaluate advanced isotope systems technology developments by the AEC for NASA mission use; (2) perform technology investigations leading to improved mission effectiveness of isotope power systems; (3) develop improved methods for integrating isotope power systems with spacecraft; and (4) advance the technology of thermoelectric conversion. This work will be accomplished by analytical studies and experimental research. Planning and execution of work under this RTOP will be coordinated with the AEC and will be complementary to their programs.

W75-70364 506-25-11
Lewis Research Center, Cleveland, Ohio.
PLASMADYNAMICS
George R. Seikel 216-433-4000
The objective is to gain the ability to generate, confine, and manipulate plasmas of desirable characteristics in ways relevant to the potential of advanced power and propulsion applications of importance to NASA. Investigations are aimed at both understanding the physics of the processes and demonstrating the feasibility of high performance systems. Investigations will also attempt to define possible new system concepts that could lead to new NASA applications and missions. Analytical and experimental studies which include extensive diagnostics will be made. Topics to be investigated include: MHD generators for both open and closed cycle electric power systems, and high temperature plasma heating and containment in open and closed magnetic geometries. Investigations will include studies to define potential system performance, critical technology needs, and alternative applications of technology developed.

W75-70365 506-25-21
Lewis Research Center, Cleveland, Ohio.
MAGNETICS AND CRYOPHYSICS
R. R. McDonald 216-433-4000
Objectives are: (1) to develop compact, lightweight magnets for propulsion and power applications; (2) to devise methods of producing higher fields; (3) to improve superconductors and to apply them in magnets; (4) to devise improved auxiliary systems (refrigerators) for magnets; and (5) to measure effects on high magnetic fields on materials. Targets include: FY-75 - 3 tesla, twisted, multifilament Nb3Sn ribbon superconductor in small coils; demonstrate principle of magnetic cooling by operating a 1-watt refrigerator between 4K and 20K. FY-76 - produce long lengths of twisted, multifilament Nb3Sn by a production line process; analyze room temperature potential of magnetic cooling; demonstrate small magnetic heat pump. FY-77 - demonstrate twisted, multifilament Nb3Sn superconductor in large coils. FY-78 - complete and test 30 tesla cryogenic magnets. To advance magnet technology, new structural and cooling ideas will be applied in new magnets designed for research to 30 teslas and for MHD generators. Improved superconducting materials and components will be developed and applied to make magnets more compact and reliable. Magnetic cooling cycles will be analyzed and devices constructed to try to raise the efficiency of refrigeration for superconducting systems. Existing and newly developed magnets will be used to determine effects of high fields on materials. University grants will support the superconductivity and magnetic cooling efforts.

W75-70366 506-25-31
Lewis Research Center, Cleveland, Ohio.
FUNDAMENTAL PHOTONICS
J. W. Blue 216-433-4000
The objectives are to utilize the newly completed cyclotron at LeRC and other sources of ionizing radiation to produce atoms and molecules at high levels of excitation. High energy photons are emitted in the subsequent de-excitation process, and an object of the work is to investigate the use of these photons in laser systems and other applications where energetic photons are advantageous. Fissioning uranium is the method of producing high levels of excited atoms and molecules for nuclear weapons, most fissioning has been in systems in which the photon energy cannot be utilized directly. The cyclotron is to be used to produce low power levels of uranium fission in which the details of the photonic processes can be determined. The radiation fields connected with fission reactors include beta, gamma, neutrons and fission fragments. These determine the environment in which a window for photons must function. The cyclotron will be used to stimulate this environment and transmission studies will be made of fused silica, alumina. The highly excited atoms and molecules produced by charged particle beams will be studied as to whether or not they can be assembled in a manner to give stimulated emission.

W75-70367 506-25-31
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
FUNDAMENTAL PHOTONICS
R. R. McDonald 213-354-6186
(506-25-52; 506-25-62)
The objective of the laser kinetics task is to conduct the research required to develop various types of high power, efficient, short wavelength lasers. Emphasis is placed on understanding the basic physical phenomena that determine the efficiency, wavelength, size, and power output of laser devices. The objectives of the nuclear pumped laser task are to develop a laser device where the laser pumping is provided by a pulsed nuclear reactor, and to conduct supporting research which will lead to an understanding of the laser kinetics in high pressure plasmas produced by the products of nuclear reactors. The principal objective of the electron impact spectroscopy task is to generate reliable cross sections for electron-molecule (atom) collision processes for use in understanding the behavior of high energy
lasers, plasma devices, and the energy degradation of high energy electrons. In the physics of molecular interactions, both basic and applied research programs are being conducted. In the basic research program, ion cyclotron resonance spectroscopy is being used to examine the properties and properties of excited ions in plasmas and discharges. The fundamental knowledge thus far obtained has led to a new concept for a flowing afterglow ion laser. Prototype lasers are now under construction in the applied research program. The first objective of the nuclear Zeeman maser task is to study the feasibility of constructing a nuclear Zeeman maser system and to investigate its characteristics. The second objective is to conduct preliminary ion narrowing experiments in the solid state nuclear spin system to determine if this technique can be used to narrow the Mossbauer gamma-ray lines to provide adequate amplification for gamma-ray laser action to occur.

W75-70368  506-25-31
Langley Research Center, Langley Station, Va.
FUNDAMENTAL PHOTONICS
E. S. Love  804-827-2893

The fundamental characteristics of a fissioning uranium plasma will be investigated to determine the feasibility of direct conversion of nuclear energy into electromagnetic radiation, laser power or work. The thermodynamic properties of uranium hexafluoride will be investigated and the interaction of fission fragments with a uranium hexafluoride gas will be determined. Radiation induced plasmas will be studied to determine possible population inversion, nonequilibrium emission, and ionization and excitation cross sections. The interaction of intense CO2 laser radiation with the dense plasma focus will be investigated, specifically the efficient conversion of laser radiation to X-rays. Photocatalysts will be investigated with the aim of providing direct photodissociation of water by sunlight. The LARC plasma focus device will be used to produce a fissioning uranium plasma. Research on fission-fragment plasma interactions and on photoelectrochemical phenomena will be performed under grants to various universities.

W75-70369  506-25-32
Ames Research Center, Moffett Field, Calif.
QUANTUM ELECTRONICS
Dean R. Chapman  415-965-5065

The objectives are to conduct experiments and analysis of topics in the physics of quantum electronics that provide basic data on, and understanding of, the interaction of laser radiation with matter in support of a broad image of NASA applications in propulsion, power, lasers and space, and atmospheric physics. The specific approach will include an investigation of the following areas: The interaction of high intensity radiation with solids and plasmas, leading to linear absorption phenomena as well as to nonlinear effects, such as self focusing, will be examined by irradiation with Nd:glass or ruby lasers. Experiments will be performed to obtain inversion on ultraviolet, soft X-ray, and even X-ray transitions pumped by such high intensity sources. Special attention will be given to resonance charge exchange between highly stripped ions in a laser produced plasma and ambient, neutral gas. Theoretical and experimental work will be directed toward ascertaining the relevant cross sections. A comprehensive study of a potential new CW ion-electron combination class of lasers, which will lase in the near IR and visible, will be followed by experimental verification. An examination of laser techniques for the separation of isomeric nuclei, so important to the development of a gamma-ray laser, will be made. Finally, the use of resonance two-photon pumping, to achieve lasers in the UV and SXR region, will be examined.

W75-70370  506-25-51
Lewis Research Center, Cleveland, Ohio.
HIGH-POWER LASER SYSTEMS TECHNOLOGY
D. L. Nored  216-433-6948
(506-21-40; 506-17-11; 506-16-21)

The objective is to evaluate by 1979 the potential of high-power lasers for NASA applications. This program will define and investigate high-power laser systems and their potential use. Both space and ground-based systems for potential NASA, commercial, and/or military applications will be included. A broad technology base will be provided, as necessary, for realistic appraisal of systems and applications, and for future design, development, and use of such systems. Efforts will concentrate on evaluation and technology investigations of flowing gas laser concepts suitable for future high-power laser transmitter systems, efficient power generation systems for such devices, conversion systems for high-power laser energy receivers, optical components unique to large high-power lasers, and on (1) screening and definition of applications and in-depth evaluation of their requirements (a continuing effort); (2) performance of components and system studies (synthesis, definition, design, tradeoffs, and problem-area isolation); (3) experimental investigation of component and subsystem technology needed within critical areas; (4) design and operation of high-power lasers to assist in the component technology investigation program; (5) design, fabrication and ground testing of large high-power laser transmitter systems for demonstration purposes, for evaluation of system-type problems, and for applications; and (6) design, fabrication, and operation of systems and experiments applicable to potential applications.

W75-70371  506-25-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
HIGH ENERGY LASER TECHNOLOGY
R. R. McDonald  213-354-6186
(506-25-62)

The objective is to develop the necessary technology required to construct various types of high power, efficient, short wavelength lasers. Emphasis is placed on the development of scaling laws that govern the efficiency, size, and power output of specific laser devices.

W75-70372  506-25-55
Langley Research Center, Langley Station, Va.
HIGH RESOLUTION LASER ATMOSPHERIC TRANSMISSION RESEARCH
E. S. Love  804-827-2893
(506-21-42)

The objective is to perform high resolution atmospheric transmission spectroscopy with continuously tunable diode lasers radiating in the wavelength range of high energy lasers operating with CO, DF, and HF having potentially better transmission than CO2 lasers. High spectral resolution studies are necessary for optimizing transmission of CO and HF lasers radiating through microwindows at the edges of H2O vapor absorption bands, and for improving DF laser transmission through H2O, CO2, NO2, and other atmospheric gases. Tunable diode lasers will also be applied to high energy/pressure CO and CO2 lasers for study of pressure broadening of laser lines and amplification of low energy tunable laser radiation to high energy radiation of narrow line width and high stability. Laboratory and field transmission studies will be performed under a variety of conditions (humidity, turbulence, altitude, beam direction) and the results compared with theoretical computer studies, strengthened by inputs from high spectra resolution data. Laboratory transmission studies will be performed with chemical DF and HF laser having high frequency stability. Other studies performed under a university grant, are concerned with novel techniques for operating chemical lasers in the visible and near infrared spectral range, with the advantage of reduced laser beam divergence; also investigated will be the influence of Q-switch relaxation effects on non-linear transmission of high energy CO2 lasers.

W75-70373  506-25-61
Ames Research Center, Moffett Field, Calif.
HIGH-POWER LASERS
Dean R. Chapman  415-965-5065

The objectives are to conduct experiments and analysis of topics in the physics of quantum electronics that relate to the development of lasers and ancillary devices suitable for NASA missions and applications in solar physics, space physics, atmospheric physics and space flight technology. This work should provide the necessary research and technology base needed to evaluate the potential of the laser for these needs. The specific approach will include an investigation of the following areas: Firstly, the development of an efficient, supersonically cooled,
electric discharge carbon monoxide (COEDS) laser will be pursued. Secondly, an arc-heated GDL facility will serve as a versatile test bed to examine CW lasing at higher pressures and temperatures than previously attainable by others. Various lasant test bed to examine CW lasing at higher pressures and development of new, laser systems will be pursued. Typical of such efforts are the computer code for predicting the output power of a CO2 gas dynamic laser, and a comprehensive theory of vibrational energy transfer in anharmonic diatomic gases.

W75-70374 506-25-62
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

LASER ENERGY CONVERSION RESEARCH
R. R. McDonald 213-354-6186 (506-25-52)

Work will be carried out to demonstrate the feasibility of efficiently converting laser energy to electrical energy with: (1) a Schottky barrier (SB) photovoltaic converter, and (2) a laser plasma dynamic (LPD) converter. Much emphasis in laser generation development is in the shorter visible and ultraviolet wavelength regions. Consequently, semiconductor materials and barrier formation techniques compatible with such wavelengths must be examined. The materials to be used will be gallium arsenide and ternary III-V compounds for the visible range, and gallium phosphide, zinc selenide, and zinc oxide for the ultraviolet range. The barrier fabrication will be the Schottky barrier technique (thin metal film-semiconductor) because of its demonstrated high collection efficiency at short wavelengths, ease and low cost of fabrication, radiation resistance, and adaptability with most any semiconductor. Multi-layer barrier devices being developed for solar energy conversion will be tested for laser conversion when and if they become available. Experimental evaluation of an existing LPD converter will be performed by irradiating it with a ruby and a Nd-YAG laser. The evaluation is to determine energy conversion capabilities rather than to understand the physics of laser-plasma interactions. These interactions including inverse-Bremsstrahlung absorption of laser energy by a pre-ionized plasma will be further investigated by dynamic scaling techniques and/or heat loads and optimize aerodynamic performance by changing the leeward flow. These data will be used to verify prediction techniques, and successful techniques will be integrated into flow field codes developed for space shuttle windward surface flow field prediction. Aerodynamic data for advanced vehicles, and space tugs will be obtained experimentally in the appropriate Ames facilities.

W75-70377 506-26-20
Langley Research Center, Langley Station, Va.

PLANETARY ENTRY TECHNOLOGY
E. S. Love 804-827-2893

The objective is to study the technology base necessary to assure survival and reliable performance of scientific probes during entry into the atmospheres of Mars, Venus, and the outer planets. The technology readiness target schedule, which assumes a cutoff in technology development three years prior to launch, is 1975 for Venus, 1977 for Saturn and Uranus, and 1981 for Jupiter. This target schedule is the key for the specific task milestones. The objective will be pursued using analytical and experimental methods and will be conducted primarily in-house with contract support as justified. This work will encompass the following topics: (1) studies to define hypervelocity earth and other planetary entry vehicle heating and aerodynamic environments and minimize radiative and convective heating and/or heat loads and optimize aerodynamic performance by choice of trajectory and vehicle shapes; and (2) development of aerothermodynamic technology required for upgrading of existing facilities or design of new facilities considered appropriate to development of planetary entry aerothermodynamic technology.

W75-70378 506-26-21
Ames Research Center, Moffett Field, Calif.

GAS DYNAMICS RESEARCH
Dean R. Chapman 415-965-5065 (502-27-01)

The objective is to add to the understanding of high energy fluid flow processes and the relations between such flow processes and the basic thermodynamic and transport properties of matter, including kinetic rate processes and radiative transfer in gases. Classical semiclassical, above quantum theories will be explored to find the most efficient models for these properties in terms of the engineering needs of present and potential long-lead-time NASA mission requirements, particularly in the area of processes induced in the earth's upper atmosphere by high altitude hypersonic aircraft and space shuttle type vehicles, and also in the area of problems experienced by entry probes into the planetary atmospheres, such as those which effect thermal protection and communication. These models will be tested, where possible, with experimental results. Numerical solutions using Monte Carlo statistical modeling of fluid flow will be developed which utilize the large size, speed, and parallel processing features of modern computers to calculate transport properties of gases and other flow properties.

W75-70379 506-26-22
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
Dean R. Chapman 415-965-5065

The objective is to develop the aerothermodynamic technology required to define the flow field around entry vehicles. Emphasis is on the development of turbulence models from numerical and physical experiments. These models will be used in computer codes that numerically simulate the flow fields. Experiments at hypersonic speeds specifically designed to verify these turbulence models and computer codes are to be performed. Additional experiments will be performed, as required, to define the aerothermodynamic environment for particular classes of entry probes such as the effect of moderate to massive ablation rates on transition to turbulent flow on blunt entry probe shapes. The first verification experiment will be that of an axisymmetric shock-wave-expansion interaction with a hypersonic turbulent boundary layer. The computer code planned is the complete solution of the Navier-Stokes equations including various models for the turbulent transport terms.

W75-70380 506-26-23
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PLANETARY PROBE DESIGN/OUTER PLANETS
R. R. McDonald 213-354-6186

The objectives of this plan are: (1) to calculate and measure the radiative properties of the shock heated gas found in the outer planet atmospheres to establish a method where the effect of laminar-turbulent transition and base flow on heat transfer to an entry probe can be determined; (2) to develop and provide physically sound methods and schemes for computing the flow field, energy fluxes and vaporization rates for outer planet entry probes; (3) to investigate entry probe aerodynamic stability; and, (4) to develop laboratory shock tube facilities for the purpose of studying heat transfer problems. Since the outer planets have atmospheres consisting mainly of hydrogen and helium, most of the work performed in this plan is applicable to entry to Saturn, Uranus, Jupiter or Neptune. Only the speed of entry differs for the several planets since it is proportional to the mass of the planet. In fulfilling these objectives, we will measure radiative intensity, and the radiation relaxation time behind shock waves moving at planetary entry speeds in outer planet atmospheric gases within the electric-arc shock tubes. To obtain better agreement with data, the theoretical models of the ionization scheme will be further developed. Measurements of convective heat transfer to blunt entry probe models will be made at high Reynolds number in the free-piston shock tube. These measurements of heat transfer at laminar, transition and turbulent boundary layer conditions will be used to further refine a numerical method capable of estimating entry heat transfer rates to planetary entry probes. Studies are underway to incorporate the finite-rate kinetics with simplified flow-field analysis to yield optimum shapes of Saturn and Uranus entry probes with corresponding entry angles that will minimize the heat shield weight consistent with proper aerodynamic stability. A 6-degree of freedom computer program, and low-speed testing, will be used to investigate the aerodynamic stability of outer planet entry probes during their travel thru the atmosphere.

W75-70381 506-26-30
Langley Research Center, Langley Station, Va.

SPACE SHUTTLE DEVELOPMENT SUPPORT
E. S. Love 804-827-2893

This RTOP focuses Langley’s expertise in configuration aerothermodynamics and operational flight mechanics on those concerns having greatest impact on successful development of the shuttle. The RTOP supports the shuttle program by: (1) providing time in Langley ground-based facilities for direct OMSF/contractor-requested support, (2) continuing independent in-house shuttle technology and development studies, (3) responding to specifically requested task-study areas from the Program Office at JSC, and (4) maintaining a strong basic aerothermodynamic supporting technology program. In addition, Langley will perform independent evaluations and assessments of the configurations and operational modes and requirements as necessary. This RTOP’s program is coordinated with other NASA centers and the phase C/D Orbiter through appropriate Program Office Engineering Coordination Panels at JSC.

W75-70382 506-26-31
Ames Research Center, Moffett Field, Calif.

SPACE SHUTTLE: CONFIGURATIONS AND AEROTHERMODYNAMICS
Dean R. Chapman 415-965-5065

The objective is to evaluate the aerodynamic performance, stability and control, and heating of the space shuttle orbiter and launch configuration to pinpoint and find the solution to aerothermodynamic environments vehicles in support of the Phase C/D studies. Accordingly, models resulting from contractor and in-house studies will be tested in subsonic, transonic, supersonic, and hypersonic facilities of the Ames Research Center. Shadowgraph and oil-flow photographs, flow field pressure surveys, heat transfer and static aerodynamic data will be obtained. The wind-tunnel data will be used by NASA and shuttle contractors to evaluate the space shuttle characteristics. The effects of realistic gaps, joints, and surface conditions on boundary layer transition and heat transfer will be examined. Numerical methods and computer programs will be developed for calculating the three-dimensional chemical-nonequilibrium inviscid and viscous real gas windward flow around space shuttle orbiter configurations at an angle of attack. Codes will be written for parallel and serial computers and parametric studies of shuttle entry flow fields will be performed in Illiac IV when it becomes operational.

W75-70383 506-91-10
Lewis Research Center, Cleveland, Ohio.

APPLICATIONS DATA SYSTEM SUPPORT
George Mandel 216-433-6285

The objectives are: (1) to establish an aerospace safety data bank to gather, analyze, evaluate, retrieve, and disseminate safety-related technical information available to all elements of NASA, its contractors and the technical community; and (2) to assure that information on the latest state-of-the-art regarding safety is available for use in planning, design, fabrication, testing and operation of aerospace vehicles and systems and associated ground facilities. The ASRDI will use the resources and services of the ASRDI to have its information files available for retrieval at remote consoles at every NASA installation. The ASRDI will call on all elements of NASA, its contractors, and other organizations to provide basic, applied, and operational data related to ground based and flight safety experience for the aerospace safety data bank. Cooperative and exchange programs have been, and will continue to be, established with similar information activities in government and industry with the intent of utilizing existing compilations of accurate data. Liaison is being established with like activities to assure access to the information contained in these sources as needed. The information will be analyzed, verified, correlated and qualified as required. This information will be made available to all elements of NASA, its contractors, other government agencies and the technical community. Improved methods of storing, searching, retrieving and disseminating information are being developed and implemented.

W75-70384 790-40-31
Ames Research Center, Moffett Field, Calif.

STUDY OF FUTURE PAYLOAD TECHNOLOGY REQUIREMENTS
J. M. Deerwester 415-965-5897

This RTOP is to develop the technology requirements for future space payloads and a schedule of when these technologies must be started in order to be available when needed. The approach will be to use contractors where applicable, the NASA shuttle payload Planning Working Groups, and particularly the Space Transportation System Payload Technology Panel in defining these technology requirements. The FY-74 effort includes an examination of the technology requirements across the total spectrum of payloads to a limited depth. The task for FY-75 will be to analyze in depth certain critical technologies that emerge from the FY-74 study, as mutually agreed by RX and the study monitor. These requirements will be updated to
account for changes in the NASA Payload Model prior to the indepth analysis. The results of the FY-74 study effort to identify technologies which need further analysis, will focus on technol-
ogy requirements associated with the payload/shuttle interface.

**W75-70385** 790-40-41
Ames Research Center, Moffett Field, Calif.

**SPACE EXPLORATION - MISSION AND SYSTEMS ANALYSIS**
B. L. Swenson 415-965-5890

The objective of this work is to define the mission and spacecraft requirements to accomplish recognized scientific goals of exploration within the solar system. These studies will be aimed at determining mission strategies and the associated vehicle requirements to accomplish these goals with minimum cost and maximum scientific benefit. In this regard, examinations will be made of the benefits and cost of the use of advanced and evolving technologies, subsystems, and vehicles.

**W75-70386** 520-71-01
Langley Research Center, Langley Station, Va.

**SOLID STATE DATA RECORDER**
G. B. Graves 804-827-3745
(502-03-52, 502-33-52)

The overall objectives of this project are to provide by CY-1978, a 10 to the 8th power bit solid state data storage system suitable for replacing tape recorders in many aerospace vehicle applications. Specific intermediate objectives are: (1) to design a 10 to the 8th power bit data recorder using bubble technology; (2) develop and demonstrate a basic recorder in a breadboard configuration; and (3) Develop a prototype 10 to the 8th power bit recorder. A two phase developmental contract will be used to provide the 10 to the 8th power bit data storage system. This contract will be supplemented by analytical studies and laboratory investigations in critical areas of the recorder magnetic and electronic systems. These studies will be directed towards providing improved operational characteristics, longer useful life, and reduced costs. Current research efforts include refinement of the materials technology to build the recorder, development of a 0.00001 bit memory element, and the building and testing of a 6 x 0.0001 bit feasibility mode. The materials technology efforts will provide increased temperature stability and decrease memory element costs. The 0.00001 bit memory element development will make available a basic building block for the flight data recorder. The feasibility model demonstrates that all components of the flight data recorder can be integrated into an operational system. This current research, therefore, provides a sound technical basis upon which a 10 to the 8th power bit flight data recorder can be developed.

**W75-70387** 521-71-01
Flight Research Center, Edwards, Calif.

**ENTRY TECHNOLOGY CONFIGURATION FLIGHT EXPERIMENT**
J. L. Kolf 805-258-3311

The subsonic and low supersonic characteristics of a configuration representing an advanced class of entry vehicles is being studied by means of a coordinated flight and wind-tunnel test program with the X-24B. The program will yield the detailed aerodynamic characteristics of a high hypersonic L/D entry vehicle and an indication of the stability of these wind tunnels to predict these characteristics. A flight-test approach will assess the handling qualities and piloting problems of this class of vehicle while determining performance and stability and control characteristics. Energy management and approach schemes will also be investigated during unpowered flight periods.

**W75-70388** 750-01-01
Langley Research Center, Langley Station, Va.

**SYSTEMS DESIGN OF A SPACELAB COMPATIBLE ADVANCED TECHNOLOGY LABORATORY**
E. S. Love 804-827-2893

Langley Research Center in-house studies have established feasibility of a Spacelab compatible Advanced Technology Laboratory (ATL). These designs included definition of LRC experiments, ATL and Spacelab concepts and operational requirements. The objective of this effort is to provide a systems design of an ATL which utilizes the NASA shuttle and European Spacelab for advanced technology investigations. The ATL will provide LRC with the capability of implementing a spaceborne research program that is truly accessible to the ground-based researcher. This primarily contracted effort will focus on major ATL program functions, experimentally/payload layouts, interface hardware, display and controls, data management, mission analysis, interface GSE, etc. Design analyses will also be conducted to assess the impact of Spacelab on NASA's advanced technology program. In addition, costs, schedules, and implementation plans will be defined for phased follow-on activities. Further refinement of the ATL design will focus LRC shuttle sortie research requirements and make timely contributions to the concurrent NASA shuttle and European Spacelab design activities.

**W75-70389** 750-72-01
Langley Research Center, Langley Station, Va.

**LONG DURATION EXPOSURE FACILITY PROJECT**
E. S. Love 804-827-2893

The broad LDEF Project objectives are the following: to develop LDEF, a simple, low cost, free-flying facility for performing long duration technology and other experiments in the space environment using the STS; to develop a first set of experiments for the facility and, by the performance of these experiments obtain valuable technological data and demonstrate the unique Shuttle/LDEF capabilities and features; and to broaden the STS user community by providing a simple low cost approach to integrate and operate a large number of OAST and other unmanned long duration experiments via the STS. The LDEF is a reusable, unmanned, low cost, free-flying structure on which many different experiments can be mounted. The facility will be delivered to earth orbit by the shuttle. After an extended period in orbit, the facility will be retrieved on a subsequent shuttle flight and returned to earth for experiment analysis. Many of the experiments being considered for the LDEF are completely passive with the active data measurements being made in the laboratory after the experiments are returned.

**W75-70390** 750-73-01
Ames Research Center, Moffett Field, Calif.

**AIRBORNE SYSTEMS SUPPORT OF SPACE TECHNOLOGY SHUTTLE PAYLOADS**
Dean R. Chapman 415-965-5065

This RTOP is to provide a simulated Spacelab to be installed and flown aboard large aircraft. The aircraft containing the simulated Spacelab will be flown on a routine basis to test the operation of the entire complement of experiments by the actual teams of experiment operators as a last step in the prelaunch check-out of each Spacelab payload. The Shuttle Simulator/Airborne (SSA) facility will permit final payload and experiment operator check-out under conditions closely duplicating Spacelab operating conditions.

**W75-70391** 750-74-01
Langley Research Center, Langley Station, Va.

**DEFINITION OF PHYSICS AND CHEMISTRY EXPERIMENTS IN SPACE**
E. S. Love 804-827-2893

Space shuttle offers an unparalleled opportunity for scientific investigations in space covering a wide range of technical disciplines. Two important and related disciplines are physics and chemistry. NASA is planning a space laboratory to fly in shuttle to support a wide range of original physics and chemistry experiments which make use of the unique environmental conditions in space. It is envisioned that this laboratory will be available to university and research laboratory investigators, both in the U.S. and abroad, to conduct experiments with a minimum of expense and lead time, and thus allow new opportunities to experimenters who might otherwise be unable to participate in space experiments. Previous studies have developed a catalog of experiments considered representative of the experiments which will be performed in space in the next decade. The study covered by this RTOP will extend the work of the past by (1) defining specific experiments to be conducted in a Spacelab, (2) identifying
The principal objectives of the tasks outlined in this proposal are to identify, show feasibility, and define those key experiments which will form the nucleus of the physics and chemistry in space program to be pursued as a portion of the NASA space shuttle flight program. Those areas of research which are being investigated under these tasks relate specifically to the proposed Superfluid Helium and Drop-Particle Positioning Module and to the proposed wall-less Chemistry and Molecule/Ion Beam Module.

The scope of this work is threefold: first, to study the feasibility of experiments to be performed in an earth orbital laboratory, through research and tests both in the laboratory and in the weightless environment provided by rocket flights; and second to use the results of this study to provide a conceptual design for the experimental facility modules to be used in NASA's Physics and Chemistry in Space program. Pursuit of the second objective will help define the requirements to be met to accommodate these facility modules aboard the space shuttle. These objectives will be pursued with the help of the scientific community through international symposia and colloquia organized under this task, and through use by this community of the rocket-borne Physics and Chemistry in Space facilities to be developed under this task. The three types of experiments being studied are: superfluid helium and drop dynamics; gas chemistry; and molecular/ion beam reactions. The first experiment will form a nucleus for the Superfluid Helium and Drop/Particle Positioning Experiment Facility Module; the other experiments will form a nucleus for the Wall-less Chemistry and Molecule/Ion Beam Experiment Facility Module. These two facility modules have been identified by NASA HQ. as experimental facility modules to be used in carrying Physics and Chemistry in proprietary information contained in RTOP.

The objectives of this work are to define those experiments which can be conducted utilizing the shuttle as a research facility during ascent and reentry to advance the state-of-the-art of entry technology and to assess the impact of the experiments on the shuttle systems and primary mission. The approach for the first objective is to identify those experiments that will provide design verification data relative to the shuttle's aerothermodynamic and thermal performance and to identify additional experiments which could be conducted in support of basic entry research. Experimental definition shall include definition of the experimental objective and contribution to the existing data base. For the second objective the approach will be to define for each experiment the shuttle support and interface requirements. The cumulative impact of all the experimental support on the orbiter will be assessed.

The planned operational flight frequency of the shuttle coupled with its large payload carrying capability will provide an unprecedented opportunity to conducting aerothermodynamics research as an adjunct to orbital operations. This research capability can be separated into two categories: (1) those research experiments which will utilize the shuttle's normal interaction with it's environment during ascent and reentry; (2) those experiments which will utilize a vehicle launched from the orbiter for earth entry. The successful application of these experiments and the effective utilization of the shuttle flights for aerothermodynamics research with minimum impact on the shuttle system and primary mission objectives depends on the early definition, development, and system integration of the experiments into the system. It will, therefore, be necessary to (1) determine in-house research requirements applicable to shuttle flight; (2) perform experiment definition studies to determine measurement location(s), number of measurements/Flights required and hardware need; (3) conduct studies to identify and develop advanced measurement techniques; (4) conduct ground and flight research to verify experiment capability and applicability to flight; and (5) conduct studies to define feasibility and capabilities of various shuttle launched payload, design launch systems, and define shuttle interfaces and mission peculiar requirements.
acceptable manner. Substantial quantities of oil, natural gas and coal are presently consumed by the utility industry to generate electricity. Improving the conversion efficiency of stationary power systems and utilizing the powerplant waste heat would conserve scarce fuels, encourage the substitution of coal for oil and gas, and, at the same time, reduce the impact on the environment. The approach will be to explore new technological paths toward achieving more efficient conversion systems, conduct system feasibility tests, develop the technology of key components, and evaluate materials of construction crucial to the success of many of the advanced—

W75-70398 778-15-01 Lewis Research Center, Cleveland, Ohio.

HIGH TEMPERATURE GAS-COOLED REACTOR-GAS TURBINE ENERGY CONVERSION
M. H. Krasner 216-433-6911

The objective is to contribute to development of a new Power Conversion Loop (PCL) to be used in commercial nuclear plants for base electric load applications. The plants will use a developed High Temperature Gas Cooled Reactor (HTGR) as a heat source, and 1500 F helium available from the reactor will be used in a Brayton cycle turbine system to generate electricity. The advantages of this system stem from its ability to use dry heat rejection economically. AEC is the funded agency for the overall program. A second objective is to validate the PCL design for the AEC and plan, manage, and execute, as appropriate, an SRT program to allow for availability by FY 1980 of a full-scale prototype. The final aim is to design the construction and design of a facility capable of testing a full-scale prototype PCL. The facility will be operated in FY-80. 81 and 82 using a fossil-fueled heater to simulate a reactor. These tests will confirm system performance, establish transient characteristics and demonstrate maintenance techniques.

W75-70399 778-20-01 Marshall Space Flight Center, Huntsville, Ala.

EARTH BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS
W. E. Whitacre 205-453-3465 (647-10-01)

The objective of this total program is the generation and provision of a broad data and technology base for the development of large scale solar thermal electric power plants. The performance capabilities, costs, and technology areas involved in solar thermal power plants will be identified through a combination of system analysis, comparison, and economic studies and by further subsystem and component testing. The component testing will be parameterized to enhance the data applicability to other potential electrical power system concepts and to other energy source studies. Subsystem tests will provide additional data leading to the possible construction and operation of a pilot plant. System integration considerations, concepts comparisons, economic analyses and trade-offs, projected plant operating efficiencies, and the parameters for long term operation will be the products of this phase. This phase, which will build on the results of the previous efforts covered in the FY-74 RTOP, will be composed of the following tasks: economic evaluation of competitive systems concepts, and terrestrial solar heat fluxes.

W75-70400 778-24-01 Lewis Research Center, Cleveland, Ohio.

WIND ENERGY SYSTEMS
Ronald L. Thomas 216-433-6844

The objective is to develop the technology for cost competitive wind-turbine generators (WTG's) and demonstrate a sufficient number of WTG's in actual applications so commercial implementation will begin by 1980. Wind energy represents a nondepleting energy source that is available in sufficient quantities to provide a significant portion of the nation's energy needs for electricity. Tests will be made on wind-turbine generators to determine performance, operating and engineering data. Studies and designs will be made of minimum cost WTG's from 50 KW to 3000 KW. WTG's with potential for minimum cost will be demonstrated in actual applications and the program will also develop energy storage systems. The utilities will be involved early to remove barriers to implementation. The suppliers for the WTG's will be developed early in the program to aid the transition to commercial status. This program will provide the technology base and demonstrations to lead to commercial implementation beginning by 1980.

W75-70401 778-30-01 Lewis Research Center, Cleveland, Ohio.

IMPROVED FUEL ECONOMY AND REDUCED POLLUTION GROUND PROPULSION SYSTEMS
D. R. Packe 216-433-4000

The objectives are to improve existing engines for the near-term and to evaluate advanced engines for the 1980's. For the near-term, several approaches to extend operating limits of Otto cycle engines will be investigated, including hydrogen injection, high energy spark, and injection ignition. For the long-term, this program will result in a comprehensive analytical and experimental capability to assess and evaluate competing alternative ground transportation propulsion systems on a consistent basis. Analytical studies, design studies, and/or experiments will be conducted to assess the merits and technology requirements of advanced engines and new engine types.

W75-70402 778-31-01 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

CONTINUATION PHASE - HIGH-EFFICIENCY, LOW-POLLUTION ENGINE PROJECT
G. W. Meisenholder 213-354-4058

Three issues are embodied in the objective of this RTOP: (1) provide a logical continuation of the high-efficiency, low pollution engine program which considers the NASA funded Phase 2 work accomplished; (2) the partial funding by NASA of a Phase 2 effort, and tasks performed by JPL for the DOT/TSC and the EPA to date and to incorporate the solution of a critical project problem into this RTOP; and (3) to assure that project continuation beyond this RTOP is logical and orderly. The NASA Phase 1 provided a proof of concept, or a feasibility demonstration of the hydrogen injection scheme. The NASA Phase 2 effort through June 1974 permitted the following developments: (1) a high yield (90% of theoretical) hydrogen generator which requires no water addition, (2) reduced size of a generator unit, and (3) a control system for generator/engine operation.

W75-70403 778-31-02 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

HYDROGEN GENERATOR TECHNOLOGY
G. W. Meisenholder 213-354-4058

The objective is to demonstrate improved hydrogen yields in a partial oxidation reactor under stoet free conditions; to increase hydrogen content of product gas from 14 volume % (obtained in Phase 1) to 18-20 volume % and to reduce soot formation to enable operation at lower air/fuel mass ratios, close to the optimum value of 5.15. These improvements are needed to efficiently use the partial hydrogen injection concept for improving fuel economy and reducing emissions in gas turbines and internal combustion engines for aircraft. The specific emissions of all fuels from a combustor depend primarily on the air/fuel ratio in the flamefront. Lean operation at high air/fuel ratios results in low flame temperatures and low NOx emissions, as well as low CO and hydrogen levels. The efficiency increases with higher air/fuel ratios due to reduced heat losses and due to a decrease in the ratio of specific heats CP/CV of the combustion gases.

W75-70404 778-32-01 Lewis Research Center, Cleveland, Ohio.

EPA/NASA AUTOMOTIVE GAS TURBINE PROGRAM
J. A. Hellier 216-433-6632

The objective is to transfer current and ongoing aerospace technology, particularly in the areas of turbomachinery, materials, and combustion and, by this means, to improve the fuel economy by 30% beyond the planned 100 hp EPA/Chrysler upgraded engine performance, while maintaining emissions below the 1977 standards; and to achieve this goal by FY-78. Current aerodynamic turbomachine technology will be applied to the design of EPA's
new 100 hp upgraded gas turbine, and proven new technology will be retrofitted into the new engine after delivery. Results of advanced gas turbine studies will identify new technology required and guide new and on-going advanced automotive gas turbine technology.

W75-70405 778-33-01
Flight Research Center, Edwards, Calif.

AERODYNAMIC DRAG OF GROUND VEHICLES
E. J. Saltzman 805-258-3311

Flight Research Center technology will be used to investigate means of reducing the aerodynamic drag of box-shaped ground vehicles, such as trucks and recreation vehicles, which have very high drag and thus are a factor with regard to the nation's energy management problems. Rectangular vehicles have high drag coefficients. This has been known for a long time, but now several factors are converging which make their high drag very important. There are several configuration changes which can substantially reduce aerodynamic drag without compromising volumetric efficiency to a significant degree. Baseline data for the drag of a real vehicle having a sharp-cornered box shape, including large tractor-trailer combinations, will be obtained for interstate highway speed conditions (and lower). Then the same chassis will be used to carry the same volume in follow-on tests for modified geometry. In addition, various add-on devices to existing trucks will be evaluated as part of a cooperative effort with DOT.

W75-70406 778-40-02
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ENERGY SYSTEMS STUDIES
M. E. Alper 213-354-6948

The objective is to provide broad systems study support to the Office of Energy Programs. The support will include specific technical studies, as well as requirement definition studies, program planning definition studies, and support of ongoing programmatic activities. Specific tasks will be identified as required by the Office of Energy Programs and specific plans will be developed for each task. The first task to be undertaken will be in the area of energy extraction and utilization. This study will include definition of system functional requirements of an advanced coal mining system, capable of extracting thick seam western coal at a rate commensurate with 1985 coal demand requirements. The second task will be to provide a participant in the NASA Management Development Program to the NASA Energy Office, Energy Systems Division, for a term of approximately one year. He will perform program management duties as specified by the Energy Systems Division Director.

W75-70407 778-52-01
Langley Research Center, Langley Station, Va.

ENVIRONMENTAL ENGINEERING AND ENERGY MANAGEMENT (FLYWHEEL ENERGY STORAGE SYSTEM)
G. B. Graves 804-827-3745
(909-74-35; 506-19-13)

The objective is to apply advanced space technology to the development of flywheel energy storage systems for application to ground transportation. The technical approach will include in-house studies and system simulations, and contracted efforts to fabricate the composite material flywheel energy storage system, mobile test vehicle, and test equipment. After interim testing of the vehicle with a battery set, the flywheel system will be integrated and final testing accomplished. The flywheel energy storage system for use on mobile vehicles for ground transportation will provide benefits in the areas of pollution control and more efficient utilization of energy sources. In addition, low maintenance and long life are expected from this concept.

W75-70408 778-53-01
Lewis Research Center, Cleveland, Ohio.

ENERGY STORAGE SYSTEMS
D. L. Nored 216-433-6386

The objective is to demonstrate efficient, low cost energy storage systems by 1980. Bulk energy storage in the form of thermal, electrochemical, chemical, mechanical, pneumatic, or hydraulic energy is attractive for many varied applications, such as: (1) uninterrupted power supply from variable sources; (2) continual operation of a power system at high efficiency during lowpower demand periods, with subsequent use of stored energy during peak demand periods; (3) recovery of waste heat or energy; or (4) operation of zero pollution vehicles. Such storage systems will be evaluated relative to energy sources and applications to establish system criteria and requirements, to identify problem areas, and to identify required constituent technology. Design and technology efforts on attractive storage systems and their components will be conducted. Included initially, for example, will be redox flow cells (which have unique features, allowing them to be built in any size and sited anywhere), thermal (heat) storage, heat pumps (for both thermal storage charging and other special applications), and perhaps hydrogen energy storage (for peaking plants and wind power). Experimental investigations will be performed at both the component and system level. Previously defined technology requirements of the redox flow cell will be addressed by suitable electrochemical experiments, materials development, design studies, and tests.

W75-70409 778-60-01
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

HYDROGEN ENERGY SYSTEMS STUDY
M. E. Alper 213-354-6948
(647-20-03; 778-60-02)

The objective is to provide the basis for a decision regarding the inclusion of hydrogen in the National Energy R and T Program in FY-77 and to identify NASA's role in that program. This will be accomplished through a program in FY-75 which will (1) develop an overview of the potential role of hydrogen within the national energy complex, including the advantages and implications; (2) provide a program definition and justification; and (3) identify and justify FY-76 NASA budget requirements for the accomplishment of this task. The use of hydrogen as a fuel, as an energy storage medium, as an energy transmission medium, and as an interim chemical in chemical processes will be considered, as well as hydrogen production and distribution. Working closely with NASA Headquarters, JPL will establish a NASA-wide team to conduct the study and define the FY-76 activities and the technology program for FY-77 and beyond. The team will be under the leadership of a study manager from JPL, drawing personnel and expertise from the NASA Centers and JPL. Organization of the team will include an Intercenter Working Panel and Working Groups on specific issues as required. Members of the panel will be made of results of other ongoing studies of energy usage and hydrogen production, both within and outside NASA. Also, recognized experts from industry, universities and other government agencies will be asked to participate on a review and Advisory Group, and to supply information in both the technical and nontechnical areas. As appropriate, they will also be asked to participate in working groups.

W75-70410 778-60-02
Marshall Space Flight Center, Huntsville, Ala.

HYDROGEN PRODUCTION AND UTILIZATION
William D. Powers 205-453-2817

The objective is to carry out detailed feasibility studies of selected processes of hydrogen production, and to provide cost estimated for the development and operation of selected hydrogen production processes. Hydrogen production methods that have the best potential for commercial exploitation will be selected for in-depth technical feasibility analysis and cost projections. Some feasibility demonstrations on laboratory scale may be undertaken. Development plans, including production facility costs will be prepared for each system. An energy balance analysis showing the total energy input required per unit of hydrogen produced will be prepared for each process.

W75-70411 790-40-45
Ames Research Center, Moffett Field, Calif.

TECHNOLOGY REQUIREMENTS FOR OPERATIONAL EARTH OBSERVATION SYSTEMS
J. M. D. Deenewerth 415-985-5897

The ultimate objective of this RTOP is to identify technology requirements needed for earth observation systems that might be operational during the 1980's. To meet this objective, it is...
Weather and Climate SR&T

OFFICE OF APPLICATIONS

DETERMINE THE POTENTIAL ROLE AND TECHNOLOGY REQUIREMENTS FOR A RELAY SATELLITE AS PART OF THE USER DATA DISSEMINATION NETWORK; AND (3) DETERMINE THE POTENTIAL UTILITY AND SYSTEM COSTS FOR A FLEET OF RPVs TO CONDUCT EARTH OBSERVATION MISSIONS. RESULTS OF THESE STUDIES, TOGETHER WITH RESULTS OF PRIOR AND CURRENT IN-HOUSE AND CONTRACTED STUDIES OF THE SYSTEMS STUDIES DIVISION, OTHER OAS1 ORGANIZATIONS, AND THE OFFICE OF APPLICATIONS WILL FORM THE BASIS OF THE OPERATIONAL SYSTEMS STUDY TO BEGIN IN FY-76. THE APPROACH WILL BE TO EXPLORE THE COST-EFFECTIVENESS OF OPERATIONAL SYSTEM OPTIONS WITH RESPECT TO SENSOR COMPLEMENTS; DATA PRODUCTS; COVERAGE FREQUENCIES; SYNERGISTIC COMBINATIONS OF SUNSYNCHRONOUS AND GEOSYNCHRONOUS SATELLITES, AIRCRAFT, RPVs AND IN SITU SENSORS; AND SPATIAL, SPECTRAL AND TEMPORAL RESOLUTION.

OFFICE OF APPLICATIONS

WEATHER AND CLIMATE SR&T

W75-70412 175-11-41
RESEARCH ON NUMERICAL MODELING OF THE GLOBAL ATMOSPHERE AND THE WORLD OCEANS
M. Halem 212-866-3619
Research will be carried out on numerical modeling of the world oceans for use in GISS long-range forecast studies with coupled ocean-atmosphere dynamics. Satellite data will be used to verify long-range predictions and to check climatology of atmosphere, and hydrosphere. A simple ocean model developed and tested at UCLA will be coupled to the advanced multi-level GISS model. In addition, improvements in the ocean modeling will be made to include salinity, bottom-ocean topography and ice configurations. The intent is to develop a more realistic model for data assimilation, and forecasting studies. Since the ocean surface provides the temperature boundaries for the atmospheric model, the ocean dynamics and accompanying changes in ocean surface temperature are required as an input to all forecasting studies beyond 5 to 7 days. A new area of theoretical study involves the development of a parameterization of aerosol distribution for the GISS model. Values of global aerosols and sample methods of flux calibrations to predict global heating or cooling effects will be studied.

W75-70413 175-11-42
Goddard Space Flight Center, Greenbelt, Md.
RADIATIVE TRANSFER MODELS RELATING TO ATMOSPHERE AND SURFACE CHARACTERISTICS
R. Fraser 301-982-4235
(175-61-41)
The objectives are to determine the radiative characteristics of gaseous and particulate constituents of the atmosphere and of natural surfaces. This basic knowledge will be used to develop satellite methods for measuring atmospheric and surface parameters. The proposed work supports all six of the NASA Meteorology Program objectives. The radiative characteristics of gases will be obtained from laboratory measurements, theory, high altitude balloon observations, and satellite observations. Cloud radiative parameters will be derived from aircraft and balloon measurements. Radiative transfer models of clouds will be developed. The feasibility of utilizing satellite polarization observations to measure particulate properties will be determined with computer modeling studies. Models of the scattering characteristics of oceans will be developed. Atmospheric models for the inversion of ultraviolet measurements to obtain ozone profiles and infrared measurements to obtain temperature profiles will be improved.

W75-70414 175-11-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
EFFECT OF SNOW AND ICE FIELDS ON WEATHER AND CLIMATE
D. P. Burcham 213-354-3028
Marshall Space Flight Center, Huntsville, Ala.
GENERAL ATMOSPHERIC AND OCEANIC CIRCULATION EFFECTS ANALYSES
W. W. Vaughan 205-453-3106
(645-10-01)
The objectives are to increase our understanding of the general circulations of the oceans and atmospheres and the effects on these circulations of small term perturbations in heat inputs. The approach is to develop the theoretical models required to provide criteria for the development of a three-dimensional dishpan type experiment to be flown in the space laboratory. These models will be used to define the equipment and procedures required to conduct the experiment as a payload in the low gravity environment of the shuttle spacetab.

W75-70415 175-11-71
Marshall Space Flight Center, Huntsville, Ala.
MICROPHYSICAL PROCESSES IN ATMOSPHERIC CLOUDS
W. W. Vaughan 205-453-3106
(645-10-01)
The objectives are to develop and/or establish the physical basis and quantitative techniques to be used in defining specific experiments concerning ice nucleation, ice crystal growth habits, collision induced freezing, and ice multiplication to be flown in the Zero-Gravity Atmospheric Cloud Physics Laboratory in the space lab shuttle. These techniques will also be used in evaluating the experimental results. The approach is to develop sets of analytical expressions for the microphysical processes of the ice phase of water that can be used to establish experiment equipment and protocols necessary to conduct experiments in both ground based and orbit laboratory. These expressions will also be used to evaluate the results and provide a basis for the comparison of the one-g and zero-g results.

W75-70417 175-21-11
Ames Research Center, Moffett Field, Calif.
NUMERICAL MODEL AND SIMULATION OF COUPLED EARTH ENERGY AND POLLUTION TRANSFER CYCLES
Dean R. Chapman 415-965-5065
The objective is to investigate the utility of satellite and airborne observations to mesoscale meteorological and air pollution problems. The approaches are develop computer programs to model mesoscale meteorological and photochemical dispersion problems which are susceptible to numerical study; these models to evaluate various methods of interpreting and applying satellite and airborne observations, as well as to investigate the use of such observations in development of the models themselves; evaluation to include both the current and planned satellite and airborne platforms, such as ERTS, Nimbus G, and U-2's, as well as the definition of additional capabilities desirable in future satellite developments.

TECHNIQUES FOR MEASUREMENT OF STRATOSPHERIC CONSTITUENTS

D. J. Grubbs 301-982-6421

New measurement techniques will be utilized and developed for the measurement of trace constituents in the stratosphere. The research will be directed towards those constituents which are insignificant in terms of the overall content of the stratosphere but which control the solar energy input into the stratosphere and biosphere. If altered they can produce significant long term climatic changes. The investigations will be concerned primarily with those whose natural concentration may be altered by pollution of the stratosphere. The initiation of supersonic aircraft flights in the stratosphere with the subsequent introduction of significant quantities of NO, H2O, HCl, and particulate matter has produced a continuing need for realistic assessments of their potential effects on world climatology. Some areas of special concern are a reduction of the global budget of atmospheric ozone, changes in the ultraviolet atmospheric radiance and solar irradiance and possible corresponding changes in the earth thermal at the ground. A long term monitoring of the size and particle distribution of stratospheric aerosols from in-situ measurements would be highly desirable. New remote and in-situ sampling techniques are needed to establish a baseline of the trace constituents in the stratosphere in order to be able to assess in future years the seriousness of the introduction of pollutants into the stratosphere.

OFFICE OF APPLICATIONS

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to improvements in tornado detection and warning systems. This work was motivated by the experiments of W. L. Taylor of NOAA/ERL who had reasonable success at identifying an HF electromagnetic signature which is a characteristic of tornadic activity. This feasibility study will be approached as follows: (1) Previous measurements of severe storm emissions will be collected and examined for characteristics which distinguish tornadoes from other severe storm activity. (2) Additional data will be collected on those parameters, such as power spectrum and polarization, which are essential to evaluating the signal available to satellite sensors. (3) The physics of tornados will be studied in order to identify those mechanisms which could generate a characteristic signature and in order to identify other features potentially suitable for monitoring from space. (4) Evaluation will be made of system concepts whereby a satellite sensor might be incorporated into an improved tornado detection and early warning system.

W75-70425 175-21-46
Goddard Space Flight Center, Greenbelt, Md.

STUDIES OF SATELLITE SUPPORT TO WEATHER MODIFICATION
L. J. Allison 310-982-2624
(175-91-41; 175-91-43; 175-61-41)

The objective is to apply satellite observations in support of the conventional quantitative measurements of meteorological parameters during weather modification projects over the United States. Both intentional and inadvertent aspects of weather modification will be studied. Special attention will be made to determine under what cloud conditions weather modification efforts are feasible and to evaluate the effectiveness of the cloud seeding procedures using satellite sensing techniques.

W75-70426 175-21-47

SENSITIVITY STUDIES RELATED TO ATMOSPHERIC REMOTE SENSING EXPERIMENTS
Richard W. Stewart 212-866-3603

The objective is to determine the effects of noninstrumental sources of systematic and random error on temperature and minor constituent density profiles retrieved by remote sounding instruments. The approach will be to identify those factors in the process of random error which give rise to systematic or random errors; to assess the effects of systematic errors by means of simulation studies; and to describe mathematically the propagation of random error through the numerical calculations used to obtain temperature and composition profiles from observed radiances. These studies will provide an assessment of the relative importance of errors involved in remote sensing experiments. In the case of systematic errors they will illuminate those factors which must be taken into account in interpreting the data obtained from sounders. In the case of the propagation of random errors through numerical calculations they will show which, among alternate computation schemes, gives the smallest error in retrieved profiles.

W75-70427 175-21-48
Goddard Space Flight Center, Greenbelt, Md.

CLOUD TOP SCANNING RADIOMETER DEVELOPMENT
D. S. Smith 301-982-4591
(176-21-43; 175-61-4-1)

The objectives are to develop a cloud top scanning (CST) radiometer, integrate it with a high altitude aircraft, and analyze the measurements. The emphasis on the utilization of measurements from future meteorological geosynchronous satellites is becoming centered on the investigation of mesoscale phenomena (thunderstorm, fog, tropical cyclones, etc.). Winds (as derived from cloud motions), surface temperatures, and cloud structure are some of the key meteorological parameters that can be measured from geosynchronous satellites that are associated with these phenomena. The accurate specification of satellite sensing requirements to measure the parameters is very important. A scanning radiometer mounted on a high altitude aircraft will be able to establish these specifications and improve the interpretation of the measurements. In addition, the sensor can be used to improve multispectral techniques that have already been developed with past satellite data that can be used with future satellite systems. An example of an important investigation that can be made with the radiometer is to establish the equivalent blackbody temperature differences between overshooting cloud domes and the surrounding cirrostratus anvil. These domes are related to the type of weather activity that is associated with the thunderstorm (Heavy rain, hail, tornado, etc.). It has been assumed, but never verified, that—

W75-70428 175-21-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

APPLICATION OF SATELLITE DATA TO ATMOSPHERIC MODELS
D. P. Burcham 213-354-3028

Theoretical and applied studies will be conducted with the following objectives: (1) application of new analytical techniques for the determination of temperature profiles in the presence of clouds, using infrared and microwave data from Nimbus F. and from Nimbus S. NOAA 2 and NOAA 3 sounders; (2) adaptation of the resulting temperature profiles to the requirements of the general circulation model (GCM) of the Goddard Institute for Space Studies (GISS) in order to demonstrate the impact of remote sounding data on weather forecasting; (3) to improve the accuracy of computed atmospheric transmission functions needed for data interpretation; and (4) to define and propose a new all-weather satellite experiment concept for routine sounding of temperature and humidity in the earth's atmosphere.

W75-70429 175-21-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SENSING OF CLOUDS AND AEROSOLS FROM METEOROLOGICAL SATELLITES
D. P. Burcham 213-354-3028

A program of theoretical and experimental studies related to remote sensing from meteorological satellites of properties of earth's clouds and aerosols (nature, structure, dynamical evolution) will be conducted with the following objectives: (1) development of concepts of scattering and polarization theory that can form the basis of sensitive techniques for real-time sensing of cloud and aerosol characteristics (type, particle shape and size distribution, complex refractive index, total number density); (2) application of these developments to the optimized design of particle size spectrometers and refractometers appropriate for meteorological measurements; and (3) construction of prototype instrumentation for laboratory and field experiments. The studies to be conducted in FY-75 will pertain essentially to: (1) optimization of a newly developed technique utilizing the properties of the angular and spectral variations of forward scattered light, and (2) extension of this technique to the forward scattering of thermal radiation in the case of aerosols and thin clouds. Subsequent objectives will be: detailed feasibility study for a satellite experiment based on thermal formal scattering; investigation of scattering and polarization in nonforward directions; and potentialities of angular and spectral polarization.

W75-70430 175-31-31
Langley Research Center, Langley Station, Va.

MICROWAVE RADIOMETRY FOR REMOTE SENSING OF OCEAN-ATMOSPHERE INTERFACE
G. B. Graves 804-827-3745
(161-05-07)

The objective of this work is to investigate the application of quantitative microwave radiometer measurements to the weather and climate disciplines, and particularly to the determination of ocean-atmosphere interface. Research is focused in three major areas: namely, radiometer hardware performance, radiometer measurement techniques, and radiometer data analysis and interpretation. The approach is to develop octave bandwidth, swept frequency microwave and millimeter wave radiometers and low noise high efficiency radiometer antennas for possible use on Nimbus, EOS, and/or space shuttle. Also, multispectral microwave emissivity signatures of the atmosphere and ocean will be used theoretically and experimentally to develop measurement and data inversion methods to infer physical properties from radiometric brightness temperatures.
OFFICE OF APPLICATIONS

W75-70431 175-31-41
Goddard Space Flight Center, Greenbelt, Md.

SENSOR SUBSYSTEM ANALYSIS AND DESIGN
J. B. Flaherty 301-982-6862

Large aperture high resolution earth observing scanning radiometers will be used in low orbit (ERS) and a synchronous altitudes (SEOS). The large radiometers will be flown when the space shuttle becomes available, either on a shuttle-launched spacecraft in low orbit (85 or less) or by being brought to synchronous orbit by a space tug. The impact of such large sensors on the various spacecraft subsystems will be studied. The use of large sensor mechanical scanning mechanisms has a substantial effect on the spacecraft attitude control and determination systems. The hardware requirements for the sensor attitude control to properly scan the earth and for attitude determination with accuracy comparable to the radiometer resolution will be developed. Both automated and earth landmark recognition systems will be used. Functional models of the sensor hardware will be developed where feasible. Structural requirements for supporting a large sensor scanning mechanism were developed without causing detrimental vibrations will be determined. The accurate referencing of the motion of the large sensor mechanism relative to the spacecraft is also necessary and high quality rate and position sensors will be developed for the scanning mechanism. The angular position of the spacecraft relative to the earth between and landmark references will be determined by a high quality rate gyro subsystem. Specific sensor scanning mechanisms will be investigated as well as spacecraft motion for scanning since this is integral with the spacecraft design.

W75-70432 175-31-42
Goddard Space Flight Center, Greenbelt, Md.

SPACECRAFT DATA PROCESSING
Marvin Maxwell 301-982-4036
(506-20-21)

Future earth observation spacecraft will generate very large quantities of data. This RTOP will investigate and develop systems that will provide the needed spacecraft and supporting systems to acquire, compact, process, and buffer this data. The first consideration is to optimize the sensor, multiplexer and ground processing elements as a total system to maximize the information to the users. Techniques are being developed to acquire and multiplex data efficiently from a variety of sensors for meteorological and earth survey applications. Magnetic tape recorder systems have been developed to provide long life and high performance spacecraft storage systems, but no further work in this area is proposed in the RTOP. On-board processing techniques and systems will be developed to optimize the information content of the data as delivered to the user. Many tasks in this RTOP are in the multidisciplinary areas of Earth Observation Satellite studies in which all of the various tasks are supporting activities primarily in weather and climate, but also in earth resources survey, and earth and ocean physics applications.

W75-70433 175-31-43
Goddard Space Flight Center, Greenbelt, Md.

MICROWAVE METEOROLOGY
J. L. King 301-982-5702
(175-44-51; 175-31-31; 645-25-08)

The objective is to develop microwave radiometer and radar technology for global surveillance of storms from orbit to determine precipitation rate profiles, liquid water content, cloud height, and cloud structure. Advanced spacecraft system studies will be conducted to define the microwave sensors needed to make the meteorological measurements. Both radiometer and radar systems will be studied and system comparisons made to select the optimum combination of the active and passive techniques to satisfy the meteorologist's needs within the constraints of reasonable shuttle era spacecraft technology. Antenna systems, receiver systems, transmitter systems, and APT microwave image transmission systems will be studied and hardware development undertaken where system deficiencies are identified. Three areas of deficiencies presently identified are (1) the two meter and larger scanning microwave radiometer antenna which will be studied under this RTOP's FY-75 funding, (2) a 37 GHz spacecraft parametric amplifier, and (3) an APT microwave image transmission system study.

W75-70434 175-41-75
Marshall Space Flight Center, Huntsville, Ala.

CLOUD PHYSICS OPTICAL AND IMAGING MEASUREMENTS RESEARCH
W. W. Vaughan 205-453-3106
(645-10-01)

The main objective of this RTOP is to assure the planning and executing of a coherent and coordinated measurements techniques evaluation and assessment research program for selection and definition of the optimum zero-g atmospheric cloud physics laboratory optical and imaging instruments. This will be accomplished by developing and/or improving techniques for making remote measurements of surface temperatures of liquid droplets and ice crystals, cloud droplet size distributions, condensation nuclei size distribution, and liquid water content. These techniques should be capable of detecting continuing incremental changes in the parameters being measured. The main techniques requiring assessment and research to develop new and/or improve existing optical detection and imaging devices for use in accomplishing cloud measurements in the low-gravity environment of the shuttle/Spacelab such as IR imaging, Raman spectroscopy, holography, X-ray diffraction, laser Doppler, light scattering, etc. The planning of this program will begin with the results of the measurements techniques supporting research and technology assessment as reported in NASA CR-123013. A group of advanced techniques have been initially selected for detailed study and advanced infrared imaging, Raman spectroscopy, ultraviolet water vapor profile determination, and X-ray diffraction. In addition, other advanced technology techniques will be studied. The entire evaluation program will be executed by an in-house MSFC research and test team.

W75-70435 175-51-45
Goddard Space Flight Center, Greenbelt, Md.

SEVERE STORM ANALYSIS USING GEOSYNCHRONOUS SATELLITE MEASUREMENTS
W. E. Shenk 301-982-5948
(171-61-41; 175-21-43)

The main purpose of this program is the development of methods to improve the detection and prediction of severe storms using geosynchronous satellite measurements. These storms include severe local storms (including those that produce tornadoses), tropical cyclones, and extratropical cyclones. Flood situations (which can be produced by any of the above storm types) will also be studied. In addition, at a lower level of effort, the geosynchronous satellite capability to detect and improve the prediction of fog, frost and freeze situations, and dust storms will be determined. The specific geosynchronous satellite measurements that will be used are from the Visible and Infrared Spin Scan Radiometer (VISSR) on the Synchronous Meteorological Satellite (SMS) and the Geosynchronous Very High Resolution Radiometer (GVRDR) on the sixth Applications Technology Satellite (ATS-6). Both sensors are working satisfactorily in orbit. The objectives of this RTOP are essentially the same as those of the proposal entitled A Proposal for the Acquisition, Processing, and Analysis of ATS-F GVHRR and SMS/GOES VISSR Visible and Infrared Measurements submitted to NASA Headquarters by GSFC on Sept. 5, 1973.

W75-70436 175-61-11
Ames Research Center, Moffett Field, Calif.

EFFECT OF ATMOSPHERIC CONSTITUENTS ON CLIMATE VARIATION
Dean R. Chapman 415-965-5065
(176-61-11; 175-21-11)

Long range goals are to assess the sign and magnitudes of climatic variations induced by changes in the amount of various atmospheric aerosols and trace gases. The effects of both natural and man-made perturbations will be considered, and attention will be given both to global effects and to effects in regions such as basins or valleys where local climates can be defined. A combination of laboratory measurements, theoretical modeling, and comparison with records of past climatic variations will be
utilized to assess the possible climatic effects of contaminant emissions into the atmosphere. Laboratory measurements will be made of the radiative properties of candidate contaminants. These include the specification of the optical properties of aerosols of interest. The theoretical modeling includes the development of radiation and dynamical processes. The three-dimensional model of the entire atmosphere will be applied on local, regional, and global scales. Studies of past records of climatic change, as illustrated by the investigation of polar ice cores, will supply clues on the past causes of climatic change, as well as permitting an assessment of the models. The use of remotely sensed parameters in the climatic models will be stressed. The sensitivity of the models to variations in the parameters that they utilize will be assessed, and the question of the utility of mesoscale models (which can be run only for short time periods) to the assessment of climatic effects will be investigated.

W75-70437 175-61-41
Goddard Space Flight Center, Greenbelt, Md.
TECHNIQUES FOR UTILIZING SATELLITE OBSERVATIONS IN METEOROLOGICAL APPLICATIONS
J. Theon 301-982-5249
(175-11-42; 175-21-43; 175-21-46)

The objective is to apply satellite observations to the quantitative measurements of meteorological phenomena. Specifically the satellite data are applied to determine the location and intensity of rainfall, the vertical distribution atmospheric temperature, humidity, wind profiles in the region from 15 to 50 kilometers, and its interactions with the sun and distributions of minor constituents are investigated. This encompasses absorption, scattering and emission of solar and atmospheric radiation by constituents of the stratosphere and mesosphere. The photophysical and chemical reaction in the upper atmosphere, horizontal and vertical transport processes, gravity waves, turbulence, and tides originating in the lower atmosphere are investigated. Satellite data on global ozone distributions and ultraviolet solar radiation and their variability with time in conjunction with standard meteorological parameters will be investigated in terms of possible relationships between the entire atmosphere from geostationary satellites. Applications of these derived parameters may then be made to studies of mesoscale systems, planetary scale phenomena, stratospheric circulation, the radiation heat budget and climatic change. Special focal points of this research are the establishment of a basis for the specification of the remote sensing of the global meteorological observing system required for large-scale, long term weather forecasts (viz. the Global Atmospheric Research Program-GARP), and, similarly, the establishment of a basis for the specification of a system for continuous observations of weather features so that these observations can be applied to short-term weather forecasts.

W75-70438 175-61-42
Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF THE ENERGY INTERACTIONS BETWEEN ATMOSPHERIC LEVELS AND OF SOLAR TERRESTRIAL RELATIONSHIPS
D. F. Heath 301-982-6421

The interactions of mechanical, radiation, and chemical energy exchange between the lower and upper atmospheres and its interactions with the sun and distributions of minor constituents are investigated. This encompasses absorption, scattering and emission of solar and atmospheric radiation by constituents of the stratosphere and mesosphere. The photophysical chemical reaction in the upper atmosphere, horizontal and vertical transport processes, gravity waves, turbulence, and tides originating in the lower atmosphere are investigated. Satellite data on global ozone distributions and ultraviolet solar radiation and their variability with time in conjunction with standard meteorological parameters will be investigated in terms of possible relationships between the entire atmosphere from geostationary satellites. Applications of these derived parameters may then be made to studies of mesoscale systems, planetary scale phenomena, stratospheric circulation, the radiation heat budget and climatic change. Special focal points of this research are the establishment of a basis for the specification of the remote sensing of the global meteorological observing system required for large-scale, long term weather forecasts (viz. the Global Atmospheric Research Program-GARP), and, similarly, the establishment of a basis for the specification of a system for continuous observations of weather features so that these observations can be applied to short-term weather forecasts.

W75-70440 175-61-61
Wallops Station, Wallops Island, Va.
OZONE MEASUREMENTS
J. F. Spurling 801-524-3411
(176-11-61; 176-11-62)

The objective is the improvement of techniques for the measurement of ozone. The approach is to: (1) improve the methods of evaluation of remote optical measurement of ozone and other atmospheric trace constituents by improved utilization of the theory of atmospheric transmission of light; (2) evaluation and intercomparison of satellite-borne, aircraft-borne, balloon-borne, and ground based sensors for the measurement of ozone; (3) development of system design parameters of a system for routine synoptic measurement of total atmospheric ozone and vertical ozone profile; and (4) utilize the ground-based and balloon-borne ozone measurement systems to provide truth data for the calibration and validation of rocket and satellite-borne experimentors, for example, limb radiance inversion radiometer (LRI), scheduled to fly on Nimbus F in 1974 and measure ozone profiles in the region from 15 to 50 kilometers.

W75-70441 175-61-71
Marshall Space Flight Center, Huntsville, Ala.
INTERRELATIONS BETWEEN ATMOSPHERIC MOTIONS OF DIFFERENT SCALES
W. W. Vaughan 205-453-3106
(175-61-72)

Past research has demonstrated the existence of significant relationships between small size systems which are detectable in synoptic data and sub-synoptic or mesoscale systems. The results show the relationships are complicated and depend on the four-dimensional structure of the entire atmosphere from the stratosphere to the ground. The best and most promising approach is to define small-scale synoptic systems and then relate these systems to weather events. This approach will allow an attack on the problem on a theoretical basis using principles of hydrodynamics, kinematics, and thermodynamics. In numerical weather prediction models, systems with a dimension of less than 500 km, generally assumed to be functionally related to larger scale or mean motions. The proposed research is to investigate the relationships that exist between mesoscale atmospheric phenomena and larger-scale averages of the same or related phenomena. In addition, the atmospheric structure derived from polar orbiting and geostationary satellite remote sensing measurements will be assessed relative to applicability of mesoscale structure definition. This will be revealed by selected
atmospheric variability experiments involving radiosonde, rocket-
sonde, and satellite soundings data sets.

W75-70442  175-91-11
Ames Research Center, Moffett Field, Calif.
AIROCRAFT SUPPORT OF THE METEOROLOGY PROGRAM
Dean R. Chapman 415-965-5065
This RTOP is to provide an airborne platform, carrying
instrumentation for meteorological measurements. Experiments
will be mounted and flown aboard the Convair 990 (NASA 712)
to conduct basic meteorological studies and to support satellite
instrumentation development and data analysis. A necessary first
step in the development of satellite instrumentation for remote
sensing of the earth and atmosphere is to obtain information
to the understanding of factors influencing the spectral
signals to be observed from space. This information must be
obtained aboard aircraft because measurements must be made
from the ground to the stratosphere with speed and flexibility
in geographical location to obtain data under the many desired
meteorological conditions. Scales ranging from local to global
are amenable to study by an aircraft such as the CV-990.

W75-70443  175-91-41
Goddard Space Flight Center, Greenbelt, Md.
SYSTEMS AND MISSION ANALYSIS OF METEOROLOGY
PROGRAM ELEMENTS, METEOROLOGY PROGRAM
OFFICE
E. A. Neil 301-982-6291
The objective is to provide financial support to the NASA
Meteorology Program Office (MPO) in the conduct of its business
in support of the Office of Applications and the various program
offices represented. Results of efforts under this RTOP will be
used in performing evaluations, providing recommendations, and
developing future plans for NASA’s Weather and Climate mission
and programs. Funding will be utilized through in-house and
available support services contractors for selected efforts in
fulfilling the objectives of the MPO as defined in the proposal
dated 10 July 1972, covering the formation of the MPO at
GSFC. Emphasis will be placed on solicited areas of particular
importance to future programs. Studies will be focused on new
technology already emerging so as to expedite applications of
these developments and on future requirements so as to identify
areas requiring initiation of new technology development.
Functional expertise available at GSFC and other centers
involved in Weather and Climate activities will be drawn upon
to the maximum extent possible. Quick-reaction task order
contractors will be used for support for technical writing/editing,
preparation of visual aid materials and other resources not
otherwise available. Support also will be provided for meetings
and/or symposia having a programmatic input and as sponsored
by Headquarters.

W75-70444  175-91-42
Goddard Space Flight Center, Greenbelt, Md.
EARTH OBSERVATIONS LABORATORY FIELD EXPERI-
MENTS, AND CALIBRATION OF RADIATION SENSORS
Warren A. Hovis 301-982-6465
The objective is to provide laboratory calibration facilities,
sensor technique research, sensor component evaluation and test
and to conduct field programs where new concepts in meteorologi-
cal remote sensing and new sensors are tested prior to flight
on spacecraft. An in-house calibration facility is maintained and
continually updated to provide calibration support to both field
projects and spacecraft sensor projects. The present capability
extends to sensors with up to 46 cm diameter aperture and
will be increased to meet the demand for larger aperture sensors.
Calibration sources and consultation are supplied to projects such
as SMS VISSR, HIRS, ITOS VHRR, TIROS N, AVHRR, and the
Nimbus G Sensors. The new and rapidly developing microwave
sensing effort is supported with laboratory measurements of the
basic properties of natural and artificial materials in the microwave spectral
region utilizing in-house measurements in various frequencies.
The laboratory measurements are utilized to guide development
of aircraft and eventually spacecraft borne techniques and to
provide data handling experience before spacecraft flights. The
field experiments on aircraft are supported with equipment such
as data processing equipment, digitizers, tape recorders, auxiliary
sensors and aircraft housekeeping recorders that are common
to any aircraft field program.

W75-70445  175-91-44
Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF THE ECONOMIC BENEFITS OF METEOROL-
OGICAL SATELLITE DATA
E. A. Neil 301-982-6291
The objective is to demonstrate that meteorological satellite
data, based on space technology that has been, or is planned
to be developed, can be utilized for applications having a definable
economic and social benefit. The Meteorology Program Office
(MPO) will complete a review of existing studies that relate to
social and economic benefits. The MPO will also define the
multiplicity of interests to be served by improved forecasting and
delineate the benefits to be gained by selected, special
interest groups. The MPO intends to formulate a baseline for
future study to complete this in-depth understanding of the
economic benefits. The data will be used by the MPO as a
basis to recommend future research and operational requirements
based on needs of the ultimate user. The study will provide for
a continuing update, evaluation, and set of recommendations
based on a defined need as reflected by accurate data obtained
from the user community. This will assist in guiding future plans
in the field of meteorology with regard to sensor development,
Improved analysis, and information dissemination.

Pollution Monitoring SR&T

W75-70446  176-24-31
Langley Research Center, Langley Station, Va.
NUMERICAL MODELING OF POLLUTANT TRANSPORT
AND DISPERSION
E. S. Love 804-827-2893
Analytical models will be developed and studies carried out
to determine the nature of significant changes in the stratospheric
temperature or constituents that occur as a result of stratospheric
emissions due to natural causes or due to aircraft operations.
Interactions between radiative energy transfer, diffusive mass
transfer, and chemical transformations occurring in the strato-
sphere will be considered. Studies will also be made to determine
the impact light-scattering particulates or aerosols have on the
atmospheric energy flux, heat balance, and photochemistry. The
stratospheric effects problem is being attacked using single and
multidimensional diffusion and radiation models which incorporate
stratospheric chemistry and photochemistry. The radiation
transport submodel is based on a recently developed solution to
the radiative transfer equation and accounts for emission and
absorption of nongray radiation. An analysis of the effect of
particulates and aerosols on the atmospheric energy balance will
use a time relaxation technique and the method of moments, a
more approximate solution. The temperature in the atmosphere
will be determined under the assumption of radiative equilibrium
with a convective correction for the troposphere. Parametric
studies will be made to determine the importance of particulate
and aerosol vertical distributions, concentrations, size distributions,
and optical properties. The effects of scattering, due to aerosol
layers in the stratosphere, on stratospheric photochemical
processes (particularly those related to the O3 concentrations)
will be---

W75-70447  176-11-41
Goddard Space Flight Center, Greenbelt, Md.
DISPERSION MODELING OF ATMOSPHERIC CONTAMI-
nants
Richard W. Stewart 212-866-3603
The objective is to develop a capability for calculating the
distribution of gaseous and particulate contaminants in the earth’s
atmosphere on local, regional, and global scales. The approach
is to develop techniques for obtaining simple and reliable solutions
to the equations describing the convective and diffusive transport
removal mechanisms and chemical interactions of the contaminants. Two methods for predicting dispersion of inert pollutants in urban areas were developed. One method consists of obtaining an approximate analytical solution of the transport equation using integral methods, and the other is a numerical method based on the multiscell concept. These methods will be extended so that they can be applied to large regions and to the global atmosphere. Further generalization is necessary to include the effects of temperature stratification of the atmosphere, linear and nonlinear removal effects, chemical interactions between different pollutants, and other pertinent phenomena.

W75-70448 176-11-42
Goddard Space Flight Center, Greenbelt, Md.
**STUDY OF THE PHOTOCHEMISTRY OF THE NATURAL AND PERTURBED STRATOSPHERE WITH GLOBAL ATMOSPHERIC MODELS**
Richard W. Stewart 212-866-3603
The objective is the theoretical determination of self-consistent temperatures, radiation fields, and minor constituent distributions in the stratosphere and the calculation of the chemical and thermal response of the stratosphere to the injection of contaminants at prescribed rates. Changes in stratospheric ozone levels resulting from hydrochloric acid or nitric oxide injection are of special interest. The constituent distributions as functions of latitude and altitude will be computed by simultaneously solving the energy balance equation for the temperature field and the coupled continuity equations for the species of interest in the stratosphere. These equations will include descriptions of the advective and turbulent transport, as well as the photochemistry of all species of interest. Primary inputs to the model are zonally averaged winds and diffusivities, and absorption cross sections, quantum yields, and chemical reaction rate coefficients. The results of these calculations will comprise a self-consistent description of the temperature and composition of the stratosphere and of the response of the stratosphere to chemical perturbations. This study will provide an assessment of the impact of space shuttle and high-altitude aircraft operations on stratospheric ozone levels.

W75-70449 176-11-11
Ames Research Center, Moffett Field, Calif.
**LABORATORY INVESTIGATION OF MINOR ATMOSPHERIC CONSTITUENTS**
D. R. Chapman 415-965-5065
The objectives are to provide the spectroscopic data for detection and quantitative abundance determination of minor constituents in the earth's atmosphere and to develop new techniques for remotely sensing minor atmospheric constituents and pollutants. The gases to be studied will include pollutants such as NO2, SO2, CO, HCl, and O3. High resolution grating spectrometers and interferometer spectrometers will be used in conjunction with a variety of existing absorption techniques to measure the absorption spectra of the minor constituents. Data obtained in the Laboratory will be used (1) to interpret the spectra of gas samples obtained via horizontal and vertical aircraft flights and (2) to define the spectral region(s) most useful for remote sensing techniques. Emphasis will be given to stratospheric pollutants.

W75-70450 176-11-31
Langley Research Center, Langley Station, Va.
**DETECTION AND CHARACTERIZATION OF ATMOSPHERIC AEROSOLS**
G. B. Graves 804-827-3745
Techniques are to be developed which apply to future space missions for determining the origin and role of aerosols in the atmosphere and their impact on atmospheric pollution and changes in the earth's albedo. Specific tasks include: (1) analysis of remote measurements data taken from helicopter, balloon, and shipboard measurements, to establish inversion techniques for the visible radiation polarization measurement and solar extinction techniques; new sensing methods are also to be investigated; (2) development of and constituent analysis of aerosols; and (3) theoretical investigation of light scattering from nonspherical particles.

W75-70451 176-11-61
Wallops Station, Wallops Island, Va.
**LABORATORY INVESTIGATIONS OF MINOR ATMOSPHERIC CONSTITUENTS**
Shardanand 804-824-3411
The objective is to carry out an integrated laboratory study in order to provide the spectroscopic data that are required to assess the effects and to determine the amounts of minor constituents in the earth's atmosphere. In the later part of the program the development of new techniques of measuring the minor species may be undertaken. The basic technique used in measuring these species is to monitor the transmitted or scattered radiation (Raman, resonance-fluorescence) through the atmosphere assuming that the species are in equilibrium. For this, reliable spectroscopic data, such as absorption and scattering (Rayleigh, Raman, resonance-fluorescence) coefficients are required. Although the bulk of absorption coefficient data for most of the individual gases do exist, a careful consideration is required in their use when more than one gas is simultaneously present and subject to photochemical changes. However, knowledge of photon scattering (Rayleigh, Raman, fluorescence) is very meager. Therefore, the absorption data will be obtained in simulated conditions of photochemical equilibrium (dynamic and/or static) for chemically active constituents (NOx, SO2, O3, ...). For this purpose the multiple gas cells in series which can be connected to each other for reactions to occur will be utilized. The study of photon scattering will also be an integral part of this program to obtain the spectroscopic data of electromagnetic radiation interaction with atmospheric constituents.

W75-70452 176-11-62
Wallops Station, Wallops Island, Va.
**DETECTION, CHARACTERIZATION AND ANALYSIS OF ATMOSPHERIC AEROSOLS**
A. C. Holland 804-824-3411
Objectives are to develop the analytic techniques necessary to interpret remotely sensed data on the atmospheric aerosol and to develop the models necessary to evaluate the impact of atmospheric aerosols on the earth's albedo. Models of radiative transfer through the earth's atmosphere for both plane wave and finite beam illumination will be developed and tested. The model atmospheres used will be: (1) plane-parallel, stratified and (2) spherically symmetric, stratified models. These simulations will be used to determine the best strategies for the remote detection of atmospheric aerosols using both passive and active techniques. The models will further be used to calculate the effect of varying amount of atmospheric aerosols on the earth's radiation budget.

W75-70453 176-13-11
Ames Research Center, Moffett Field, Calif.
**WATER QUALITY AND POLLUTION SENSING**
D. R. Chapman 415-965-5065
Objectives are to measure and study those characteristics of water pollutants and water quality indicators which are accessible by remote sensing in order to provide techniques for the identification, quantification and mapping of water pollution by remote sensors. Field studies of water bodies containing predominantly one type of water pollutant will be conducted to develop basic data on various pollutants regarding spectral signatures, thermal effects and, possible, active or passive fluorescence. Laboratory and analytic investigations will be conducted when necessary to separate competing processes and where sufficiently real situations can be simulated in the laboratory. Candidate water bodies will be selected for study by preliminary multispectral aerial photography. Field investigations of spectral signatures will be conducted on the surface and from aircraft using a fast 500-channel radiometer of the vidicon type and both laboratory and surface field investigations will use a conventional spectroradiometer. Thermal effects will be studied using an airborne RS-25 calibrated thermal IR line scanner in conjunction with simultaneous in situ temperature measurement in the water body. Multispectral photography will be conducted simultaneously on all aerial missions, sometimes with narrow
band filters to pick out special effects for future sensor definition work. Possibilities for real-time multispectral imagery will be investigated using a field-sequential color television camera system.

W75-70454
Langley Research Center, Langley Station, Va.
WATER QUALITY AND POLLUTION SENSING
G. B. Graves 804-827-3745

The objective is to determine remotely observable characteristics of water pollution and water quality indicators and develop remote sensing techniques for the identification, quantification, and mapping of water pollution. Initial effort will concentrate upon the use of AAFE developed instrumentation to identify remotely observable water quality parameters. The multichannel ocean color sensor will be flown over a variety of water masses to measure visual spectral characteristics of water pollutants including algae, sediments, and industrial pollution. Simultaneous water temperature and thermal infrared spectral measurements will be made with the Hadamard transform spectrometer. Algorithms which treat collected data to maximize sensitivity to specific pollutants will be developed and used for plotting color coded contour maps of pollutants. Also, techniques will be developed for providing a real-time operational indication of pollutant level for use of editing data and for in-flight operation control. The results of the above efforts will be used to define optimized design parameters for spacecraft and/or aircraft pollution monitoring systems.

W75-70455
Langley Research Center, Langley Station, Va.
STATISTICAL INTERPRETATION OF REMOTELY SENSED POLLUTION DATA
E. S. Love 804-827-2893
(176-24-31)

The objective is to develop statistical techniques for deriving the maximum possible information on the spatial and temporal distribution of pollution from satellite, aircraft, and in situ measurements. The techniques will be developed for both air and water pollutants. Maximize the use of data includes, for example, the statistical interpretation of measurements of air pollution from Nimbus-g and the Aircraft Regional Monitoring System (ARM). Other information (such as meteorological data, pollution dispersion models, and a pollution source inventory) must be coupled with the remote and in situ measurements to achieve the end objectives of the program: pollution monitoring and source location. The equivalent techniques will be developed for water pollution using data from Seasat, ERTS, and the second pollution monitoring satellite as well as aircraft and in situ (buoy) measurements.

W75-70456
Langley Research Center, Langley Station, Va.
ATMOSPHIC POLLUTION SENSING
G. B. Graves 804-827-3745
(176-21-33; 176-91-32; 638-00-00)

The objective is to develop techniques and sensors to measure atmospheric trace constituents, primarily gases. The primary emphasis is on development of remote sensors for measuring pollutant distributions over regional and/or global areas from aircraft and space platforms. Spectral signatures of important trace constituents and interferants will be determined accurately for temperature and pressure conditions in the earth's atmosphere, and current work includes O3, HNO3, NO2, and stratospheric particles. Multigas radiative transfer models describing EM signals as functions of realistic atmospheric parameters are being developed, using line-by-line absorption characteristics, for inverting data from Nadir sensors: and inversion algorithms for limb-scanning sensors are being optimized. The development of a brass-boat gas-filter radiometric sensor (GFRS) for CO was completed and aircraft flight tested during FY-73-74, and data reduction techniques developed. A companion GFRS for SO2 will be assembled, and tested during FY-75. An active technique for measuring tropospheric pollutants will be studied during FY-75. The differential absorption lidar is a concept using a UV laser and atmospheric aerosols as scattering centers to obtain range resolved measurements of SO2 and NO2 and O3.

W75-70457
Langley Research Center, Langley Station, Va.
LANGLEY RESEARCH CENTER–GEORGE WASHINGTON UNIVERSITY ENVIRONMENTAL MODELING PROGRAM
E. S. Love 804-827-2893

The objectives of this educational and research program conducted in cooperation with George Washington University (GWU) are: (1) to expand the environmental modeling activities at Langley in a manner which directly supports the Office of Applications' remote sensing activities, Langley Research Center's involvement in the Nimbus G satellite experiments in the stratosphere, and other environmental modeling activities at Langley; (2) to strengthen and expand the research and educational opportunities within the Joint Institute for Acoustics and Flight Sciences (JIAFS) at Langley; (3) to increase the quality and number of trained research scientists in the area of atmospheric environmental modeling; and (4) to promote cooperation between NASA, GWU, and other organizations and agencies involved in this work area (EPA, NOAA, etc.). The approach taken to accomplish these objectives will be to establish within JIAFS, a research and education program in environmental modeling in conjunction with GWU. Senior faculty members and qualified graduate research assistant scholars will be recruited by GWU. The faculty and research assistants will conduct research in conjunction with Center professionals which is supportive of the needs of Langley and the Office of Applications. The research and educational efforts of the research assistants will lead to a Master of Science degree from GWU upon completion of the basic requirements, normally 2 years. The program will be managed by a coordination committee composed of NASA and GWU personnel.

W75-70458
Langley Research Center, Langley Station, Va.
REMOTE SENSING CONCEPTS FOR TROPOSPHERIC POLLUTANTS
G. B. Graves 804-827-3745
(176-21-31; 176-91-32; 638-00-00)

The objective is the analysis and development of remote sensing techniques to measure pollutant concentrations in the troposphere from aircraft and satellites. Special emphasis will be given to measurements of near surface pollutant concentrations and of the vertical distribution within the troposphere. Remote sensors for tropospheric pollutants now under development are limited to measurements of total burden beneath the observation platform. The radiative transfer technique for use of a side or upward viewing spectral radiometer from aircraft will be studied to evaluate the usefulness of the concept for measuring vertical pollutant distributions within the troposphere. Nadir-viewing remote sensors are subject to errors introduced by temporal and spatial variations of the observed earth background. An analytical and experimental study to evaluate the magnitude of background induced errors as a function of sensor footprint, spectral interval, modulation transfer function, and pointing stability will be initiated in FY-75.

W75-70459
Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING CONCEPTS FOR TROPOSPHERIC POLLUTANTS
C. L. Korb 301-982-4347

The purpose is to identify and assess the feasibility of using different concepts for measuring near surface concentrations and the total vertical path content of trace gases and pollutants which are primarily concentrated in the troposphere. The atmospheric transmission spectrum of trace gases and interfering spectral bands will be modeled in conjunction with various instrumental methods of detecting the scene energy. Particular attention will be given to high spectral resolution techniques using the reflected infrared portion of the spectrum which are thus, sensitive to the effects of gases near the earth's surface. Preliminary studies indicate that instrumental techniques and methods of data processing can be devised so that the experimental measurements
yield the total pollutant content in a vertical atmospheric path and so that the measurements are relatively insensitive to sensor calibration, and scene reflectivity and temperature variations. Instrumentation will be developed based on the results of the modeling and field experiments will be carried out to develop and test new remote sensing techniques. The determinations of total gas content are to be supported with surface truth and test new remote sensing techniques. The determinations of atmospheric constituents (O3, H2O, NO, NO2) are being studied in order to determine how well the airborne, down-looking active system would be able to produce concentration versus altitude profiles for each constituent. Experimental work involves several remotely sensed activities which generally point toward the goal of operating the active system in an aircraft. In the first experiment, published spectra of several important atmospheric constituents (O3, H2O, NO, NO2) are being studied in order to determine how well the airborne system works in a look-downing system. Experimental work involves several related activities which generally point toward the goal of operating the active system in an aircraft. A ground-based active instrument is set up for monitoring ozone and nitric oxide. Experimental laser vapor transmission measurements are being conducted to provide high resolution spectral data for calibrating the laser instrument in atmospheric monitoring. Albedo measurements and aerosol scattering studies are planned with the ground-based system in order to better understand flight operation conditions. More compact lasers are also under construction. Concurrent analysis will continue on the potential of other remote sensing systems which make use of laser technology and appear to offer advantage over present instruments.

**W75-70460**  
Lewis Research Center, Cleveland, Ohio.  
**LAND POLLUTION MONITORING FEASIBILITY STUDIES**  
H. Mark 216-433-4000

The objective is to detect, identify and monitor by remote sensing techniques, land pollution due to stripping of coal, and to determine the degradation of streams due to runoff from this polluted land (toxic spoilbanks). Eventually, optimum techniques for stripping and related pollution monitoring will be transferred to data obtainable from ERTS-1 and for other earth observation satellites.

**W75-70461**  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena  
** ATMOSPHERIC POLLUTION SENSING, HETERODYNE SPECTROSCOPY**  
D. P. Burcham 213-354-3028

The general objective is to develop instruments which utilize infrared laser and heterodyne receiver technology for the remote monitoring of atmospheric pollutants from aircraft and spacecraft altitudes. The instruments under investigation and development are of both active and passive types. The active system, based on differential absorption, is presently being emphasized. Both systems provide certain capabilities which are not available using existing passive radiometers or solar absorption spectrometers. At present the task covers both analytical and experimental work. In the first experiment, published spectra of several important atmospheric constituents (O3, H2O, NO, NO2) are being studied in order to determine how well the airborne, down-looking active system would be able to produce concentration versus altitude profiles for each constituent. Experimental work involves several related activities which generally point toward the goal of operating the active system in an aircraft. A ground-based active instrument is set up for monitoring ozone and nitric oxide. Experimental laser vapor transmission measurements are being conducted to provide high resolution spectral data for calibrating the laser instrument in atmospheric monitoring. Albedo measurements and aerosol scattering studies are planned with the ground-based system in order to better understand flight operation conditions. More compact lasers are also under construction. Concurrent analysis will continue on the potential of other remote sensing systems which make use of laser technology and appear to offer advantage over present instruments.

**W75-70462**  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena  
** ATMOSHERIC INTERFEROEMETRIC MEASUREMENTS OF ATMOSPHERIC TRACE CONSTITUENTS**  
D. P. Burcham 213-354-3028  
(645-20-02; 501-24-20)

The composition of the atmosphere over a large portion of the Northern Hemisphere will be investigated by means of remote infrared sensing techniques in a series of aircraft flights extending over a period of three years. The objective of the observational program is to obtain a complete inventory of atmospheric trace constituents and pollutants with a sensitivity extending down to the 10 to the minus tenth power range, and to study their three-dimensional and temporal variation in the troposphere and stratosphere. The experimental approach involves the use of a very high resolution fast Fourier interferometer spectrometer to obtain absorption spectra in the 1 to 9 micron region in short time intervals (approximately 200 sec). The instrument will be mounted in aircraft flying at altitudes ranging from 1 km to 20 km. Observations will be made by viewing the earth's surface in the Nadir mode to study tropospheric composition, and by observing the sun through long atmospheric paths traversing the stratosphere in the horizontal-looking mode. The work to be accomplished includes fabrication of an improved version of the existing Fourier spectrometer which is presently being used in programs making preliminary compositional measurements, installation of the new instrument in the various aircraft, completion of the observational program, data analysis and interpretation of the results.

**W75-70463**  
Goddard Space Flight Center, Greenbelt, Md.  
**DEMONSTRATION OF THEMATIC DATA BASE USE FOR POLLUTION MONITORING IN THE MID- ATLANTIC STATES**  
Phillip Cressy 301-982-5483

The objectives are to integrate remotely sensed and other data pertinent to environmental problems in a limited test area; to identify, in that area the disparate users on the operational level and to define technical data products which can most readily and advantageously be applied by operational level users having similar needs in other regions. At the center of this effort is a task for a land use-environmental study which has, as its purpose, (1) the integration of the data produced in the several tasks of the study; (2) the development of a base (in map and computerized form) of regional land use information; (3) the identification and stimulation of a local user community; (4) the dissemination of data in a form in which it can readily be applied by the users; (5) the assessment of the efficacy of the regional survey, especially in comparison with alternative methods; and (6) the identification of system modifications required for greater utility and efficiency. The objectives of the tasks are to explore the important environmental problems of silt-, chemical- radionuclear and land pollution and their sources in this geographic area, and how remote sensing can contribute to their alleviation.

**W75-70464**  
Ames Research Center, Moffett Field, Calif.  
**REMOTE SENSING OF EUTROPHICATION AND OTHER LAKE PROCESSES**  
D. R. Chapman 415-965-5065  
(176-13-11; 177-54-13)

The objectives are to study lake eutrophication and associated processes in California in cooperation with federal, state and local agencies by means of remote sensing (satellite and aircraft) in conjunction with water property measurements to provide the synoptic and sequential coverage necessary to understand whole lake processes to the extent required for monitoring and control. Processes in Lake Tahoe and Clear Lake will be studied using earth resources technology satellites (ERTS) I and B and aircraft remote sensing techniques (multispectral images, color images, chlorophyll detection, thermal images, multispectral video images) coordinated with water property studies. Studies at Lake Tahoe will continue to concentrate on biostimulation by sediment plumes and other nutrient inputs during snowmelt periods and after rainstorms. Studies at Clear Lake are directed toward: (1) documentation of the time and spacial sequence of noxious (blue-green) algal blooms in this naturally eutrophic lake; (2) relating these blooms to nutrient sources and/or physical conditions; and (3) to test aeration control measures designed to inhibit development of floating noxious algal mats.

**W75-70465**  
Lewis Research Center, Cleveland, Ohio.  
**MARINE POLLUTION MONITORING AND ASSESSMENT**  
H. Mark 216-433-4000

Remote sensing systems are developed for monitoring water quality and for limnological measurements in the Great Lakes. The systems to be developed are to be applied to entire Great Lake water bodies to fully utilize the synoptic advantages of remote sensing. Observations by aircraft and by the Earth Resources Technological Satellite (ERTS) of the spectral response (visible and IR) of the lakes with special emphasis on Lake Erie will be correlated with water sample measurements made at the surface and at several depths including the lake bottom. Correlation of the remote sensing data with biological, chemical,
and water current models will be made to demonstrate the utility of the remote sensing systems. The main objective of the systems is to provide data which can aid in the management of the Great Lakes water resources including the specification of pollution restrictions. Because of this objective the systems will be developed in cooperation with the Environmental Protection Agency, NOAA, and the Canada Centre for Inland Waters, and once developed will be turned over to them for their own use.

**W75-70466** 176-53-32
Langley Research Center, Langley Station, Va.

**MARINE POLLUTION MONITORING AND ASSESSMENT**

Eugene S. Love 804-827-2893

Remote sensing work with user institutions to quantitatively measure the ecological consequences of specific man-made and natural pollutants in the Chesapeake Bay, in adjacent coastal zones, and in nearby rivers. Work includes evaluation of remote sensing and remote readout instrumentation for applicability to marine pollution measurement, study of oil spill effects, study of trace organic compounds in the air, water, and biota of the marine environment, and studies of spectral reflectance signatures of water pollutants. Satellite and aircraft data will be employed to correlate remote data with sediment transport and chlorophyll concentration of selected areas in the Chesapeake Bay, and its estuaries. Spectral reflectance signatures of various pollutants in water will be obtained in the laboratory as well as in the field, and comparisons made with remotely sensed data. Data analysis will be applied to determine sensor requirements, and multiresolution scanner sensing of water pollutants will be developed. Samples taken from air, water, sediments, and marine biota are analyzed for trace synthetic organic compounds, in parts per billion, using advanced sampling and concentrating techniques in conjunction with microwave spectrometry to assess the effects of these organic compounds on marine ecology.

**W75-70467** 176-53-71
Marshall Space Flight Center, Huntsville, Ala.

**REMOTE SENSING: FRESH WATER AND LAND POLLUTION; BIOTIC AND ABIOTIC DEGRADATION, ENERGY BUDGET AND CULTURAL PRESSURES**

H. G. Hamby 205-453-0089

(177-32-71; 176-54-71)

Objectives are: (1) to establish in controlled laboratory remote sensing tests basic capabilities of state of the art sensing systems to measure water quality parameters in polluted turbid waters typical of the Tennessee River; (2) to establish a definition of the optimum role of in situ instrumentation used in support of remote sensing and to conceptualize a prototype system of instrumentation; (3) to develop a system for utilizing remotely- and in situ sensed water quality parameters in controlling the release of effluents into streams, rivers and estuaries in Alabama; (4) to examine the potential of remote sensing for detecting acquirers in limestone cavities which are potential contamination sources as a result of established waste control techniques in Alabama. Activities under associated RTOPs and Earth Resources Technology Satellite (ERTS-1) and EREP experiments will be utilized: these will be augmented by laboratory work to answer certain questions raised in examination of ERTS-1 and other remotely sensed data. Through established user/partner relationships with local, state and federal agencies working on water quality problems in Alabama, the techniques of remote sensing and in situ monitoring will be combined, supplemented by an information system, and put to use in a real-life situation.

**W75-70468** 176-53-73
Marshall Space Flight Center, Huntsville, Ala.

**REGIONAL WATER POLLUTION SENSING SYSTEMS**

H. G. Hamby 205-453-0089

(177-54-70)

Consultation with state planning agencies and user groups relative to water pollution problems and control has identified two major research needs. These are: (1) the development of planning procedures and systems analysis techniques whereby water characteristics can be forecast without the necessity of long historical records, particularly for regions where history means very little due to the rapid change within the region; and (2) the development of a systems approach toward the needs and requirements of an integrated pollution sensing system. The Environmental Applications Office (S and E-EA) has made some preliminary reviews of the needs in these areas. There has been one new study started to develop a hydrological planning model which will be designed to provide adequate accuracies when applied to ungauged watersheds and to measure those shifts in regions undergoing very rapid development. This research study has as its first phase requirement the (1) critical investigation of 'driver' phenomena, (2) construction of generalized planning models, and (3) the sizing of the role of remote sensing in the construction of watershed planning models. In the area of specific sensor requirements, all remote sensing satellite programs are being used to provide the DCP's for the Earth Resources Technology Satellite (ERTS-1) of the Alabama region was made and some preliminary recommendations for further improvements have been made. For this phase of work, it is proposed...

**W75-70469** 176-61-11
Ames Research Center, Moffett Field, Calif.

**GLOBAL STUDY OF STRATOSPHERIC CONSTITUENTS**

D. R. Chapman 415-965-5065
(185-47-67)

Long range goals are to reach as complete and understanding as possible of stratospheric chemistry and physics by developing computer models of the chemical, transport and radiative properties in the stratosphere. Measurements and model predictions and model predictions against which to compare future measurements and evaluate the effect on stratospheric structure of artificial perturbations (space shuttle, SST). Models are being developed for two purposes: (1) chemical and transport studies of minor atmospheric constituents in order to determine their spatial distributions and understand their respective roles in stratospheric processes; and (2) radiative balance studies to evaluate the long term effects of gaseous and particulate pollutants on global climate. 1-D models which compute transport as well as chemistry have been developed, 2-D models are under development; development of a 3-D model has been initiated. The 2- and 3-D models are being developed and programmed to utilize the power of the Illiac 4 system. Airborne measurements of stratospheric minor constituents including particles in the 0.1 to 1 micrometer range are being made over large geographic areas using aircraft capable of flying in the stratosphere. The measurement of most of the materials of interest is within the state-of-the-art, but instruments are available only for a very few. An instrument package has been assembled, and flight tests have been made in the CV-990 and the U-2 aircraft. A sampling program using the U-2 to measure O3, NO and aerosols is now underway. Data on atmospheric constituents are thus being collected for use with operating 1-D---
for operational applications in developing areas that are under environmental stress. The entire Sahelian Zone of Africa is such a region - one in which current land use practices are leading to rapid deterioration of the resource base and environmental quality. The Sahelian zone will be one test site to evaluate the effectiveness of the...

**Earth Resources Survey - SR&T**

**W75-70474**

Goddard Space Flight Center, Greenbelt, Md.

**SYSTEM REQUIREMENTS DEFINITION STUDY**

C. C. Schnetzler 301-982-2282

The study has two objectives: (1) the definition of a facility through which Earth Resources Satellite system requirements are derived from user needs; and (2) pilot demonstration of the operation of this facility in two selected disciplines: water resources and mineral/oil exploration. The requirements which will be considered concern three aspects of the total earth resources system: (1) spacecraft/sensor characteristics (including spectral band definitions, sensitivity, signal/noise ratios, coverage frequencies and time of day of coverage); (2) data interpretation and data products (including the degree of interpretation required by operational and experimental users, map formats, data transmission alternatives); and (3) conceptual and mathematical models and ancillary data needed to derive useful information from earth resources data.

**W75-70475**

Marshall Space Flight Center, Huntsville, Ala.

**INTEGRATED LAND USE AND WATER MANAGEMENT APPLICATIONS**

G. F. McDonough 205-453-2880

The basic capabilities to determine land use and the associated environmental parameters and to monitor water resources and the processes that affect these resources have been or are being established at MSFC under related RTOP's. In many cases the most significant parameter affecting land use change, particularly in the southeast and other regions for which water resources are important, is the development of a water resource. The Tennessee Valley development is a prime example in which development of the water resource, the Tennessee River, had led to widespread urbanization and industrialization of the Valley with obvious far reaching impacts on the land use patterns within the Valley. The Tennessee-Tombigbee Waterway development will produce impacts of the same magnitude as it progresses and the experience with the Tennessee Valley will be extremely useful in planning to minimize adverse effects. Similarly, experience gained in studying the impacts of land use on water quality, gained in part from ERTS and other studies of strip mining effects, can be extended to establish the overall interaction of land and water quality. This interaction has been recognized by regional development planners as one of the central points on which decisions regarding development are based. This has become even more important since the requirements for environmental impact statements have been increased.

**W75-70476**

Goddard Space Flight Center, Greenbelt, Md.

**VISIBLE AND IR SENSOR SUBSYSTEMS**

Harvey Ostrow 301-982-4107

High performance visible and infrared IR sensor systems are required for future earth survey missions, such as EOS and SEOS. Increased spatial and spectral resolution, improved signal to noise ratio, response into the emissive air and inherent registration between spectral channel are required. The tasks included in this RTOP will be used to achieve this improved sensor performance. Improved visible and IR detector will be
developed and evaluated with special emphasis placed on self-scanned linear arrays. Included will be photodiode arrays, CCD arrays and hybrid structures in which HgCdTe elements are coupled to a silicon CCD in order to provide performance in the 10 micrometer spectral region. New computer programs will be developed to permit the design and analysis of advanced optical systems, such as those using non-rotationally symmetric aspheric correcting elements, among others. Optics of this type are required in wide field, high spatial resolution, broad spectral bandwidth sensor systems. The development of a laboratory to permit in-orbit evaluation of sensor performance will be continued in order to identify those elements of the sensor systems that need to be modified or improved. Another objective of this laboratory will be to introduce commonality in the calibration and testing of new sensors and allow a feedback path into instrument design and test programs based on data obtained from actual orbital operation.

W75-70477 177-22-42
Goddard Space Flight Center, Greenbelt, Md.
EARTH OBSERVATION SENSOR SUBSYSTEMS
Harvey Ostrow 301-982-4107
The basic objective is to develop advanced high resolution sensor subsystems to meet the anticipated requirements of future earth observation missions. Effort will be concentrated on developing new scanning techniques, including systems for providing constant resolution as a function of scan angle, high scan efficiency systems and methods for providing commandable pointing of the optical field-of-view. Low noise preamplifiers will also be designed and combined with photodiode detectors to eliminate the need to use photomultiplier tubes in many applications, since such tubes have demonstrated a number of disadvantages in earth observation sensors. A second objective is to develop analytical or semi-analytical techniques for optimally selecting and characterizing the spectral channels required in multispectral sensors. The data developed in this area will be used to guide further sensor subsystem development as well as to assist in sensor selection for future multispectral imaging missions.

W75-70478 177-22-81
Lyndon B. Johnson Space Center, Houston, Tex.
VISIBLE INFRARED SENSOR SYSTEM TECHNOLOGY DEVELOPMENT
S. Gaudiano 713-483-2497
An activity will be undertaken to upgrade several technical areas critical to the performance evaluation or improvement of remote sensing technology used in the Earth Resources Aircraft Program in the ultraviolet, visible, and infrared spectra. (1) A study will be conducted to determine which solid-state technology best satisfies both the spectral and spectral requirements of the scanning imaging spectroradiometer (SIS) developed for the Earth Resources Program. The results will be applied to a development which demonstrates the feasibility of solid-state imagers in this application. (2) Sensors will be developed which provide multiple spectral response at a single focal point. Layered or sandwich techniques will be evaluated wherein the upper detector is transparent to the responsive wavelengths of the lower detector. (3) New materials will be used for the fabrication of detectors in the ultraviolet and near infrared (NIR) spectrum which provide characteristics superior to those in current use.

W75-70479 177-22-91
John F. Kennedy Space Center, Cocoa Beach, Fla.
REMOTE SENSING OF SEA TEMPERATURE AND TURBIDITY
Roy A. Bland 305-867-4541 (177-569-91)
A study to determine whether or not it is feasible to measure the shifted and unshifted return radiation of the Raman and Brillouin effects that results when a laser beam is directed through water is proposed. The study will conclude whether or not these measurements can furnish the needed data to derive the vertical temperatures and turbidity of the water. The study approach will include laboratory experiments which will augment literature research and theoretical analyses. The study will thoroughly discuss the feasibility or non-feasibility of using a laser device as a remote sensor for vertical temperature and turbidity.

W75-70480 177-23-91
John F. Kennedy Space Center, Cocoa Beach, Fla.
THE USE OF AIRBORNE IMAGING RADARS (L AND X-BAND) FOR SOLUTIONS TO EARTH RESOURCES PROBLEMS
E. J. Hecker 305-867-7705
The purpose is to further develop the usefulness of airborne imaging radars for water resources management, rural land use and urban land use. By further analysis and interpretation of existing radar imagery, thermal scanner data and photography of the Brevard Country, Florida, test sites, extract the maximum of user oriented data available by manual techniques. The relationship of detectable features to radar imaging parameters frequency, polarization, look angle, depression angle is defined. Alternate optical processing techniques by which a substantially larger portion of the radar's dynamic range can be presented for interpretation is investigated. Concurrently, means by which radar data may be formatted for automated or semi-automated data reduction are studied.

W75-70481 177-25-41
Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT AND EVALUATION OF ON-BOARD DATA COMPRESSION TECHNIQUES
T. J. Lynch 301-982-6969
Because of the growing volume of digitized data in the earth observations programs, the total cost of the missions involved will be increased. However, much of the data involved contains redundancy which may be removed or reduced by presently-known techniques. The purpose of this RTOP is to assess the feasibility of applying these redundancy-reduction techniques in the spacecraft for the purpose of achieving a cost reduction in the total data handling system. This RTOP has the following three objectives: optimum choice of a redundancy-reduction technique, on-board redundancy reduction systems, and error protection for redundancy-reduced data. These objectives will be met through the following three tasks: redundancy-reduction algorithm selection study, on-board redundancy reduction study, and error control study for redundancy-reduced data.

W75-70482 177-26-41
Goddard Space Flight Center, Greenbelt, Md.
SENSOR CALIBRATION, TEST AND SIMULATION
Warren A. Hovis 301-982-6465
The objective is to provide calibration support for earth observation sensors in the applications program, to devise and produce new calibration devices for new, advanced sensors of large aperture and to extend the spectral range of calibration to accommodate new areas of interest, such as ocean color sensing. New sensor techniques are developed and tested and spacecraft sensor performance simulated to guide development of spacecraft sensors. The radiance standards of the National Bureau of Standards are utilized to calibrate sources compatible with large aperture scanners made to view extended sources. These sources are then provided to applications satellite programs such as Nimbus G, ERTS, and EOS to assure commality of calibration and intercomparability of results. Calibration sources for spacecraft sensors are evolved from the laboratory experience and new problems in sensor technology, such as elimination of polarization sensitivity, are studied using breadboards before flight sensor construction is begun.

W75-70483 177-42-42
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED IMAGE PROCESSING TECHNIQUES
W. L. Alford 301-982-5515 (177-42-41)
The trend in the development of image sensors is to obtain more spatial samples. However, analysis results indicate that similar effects can be gained by better definition of sensor parameter and analysis techniques. Analyses within the last few years have and optimization shown that more information than had been expected is available within a 'resolution cell'. The
objective of this RTOP is to refine and test these results over a diverse set of data and user requirements. The outcome of this effort can be used to define spatial parameters in future sensor developments and to improve analysis techniques. The benefits of optimization will be: (1) to transmit more information over a limited communication channel, (2) to minimize the data volume to be stored and disseminated to users, and (3) to reduce the computational requirements for transforming this data to useful information.

W75-70484  177-42-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
EARTH RESOURCES GEOLOGY/MINERAL EXPLORATION
D. P. Burcham 213-354-3028

Computer image enhancement of digital ERTS images has proved necessary to extract specific sub-sets of information useful for geologic mapping and mineral identification. Application of the techniques, developed by the JPL Image Processing Laboratory (IPL), to problems brought by outside investigators has been very fruitful. The objective primarily is to make better geologic maps through identification and separation of different lithologic units. Spacecraft and aircraft multispectral images provide the data base. Ground truth spectroradiometry using the previously developed backpack field spectrometer will be correlated with the spacecraft and aircraft images. Specific objectives will include the detection of uranium sands in cooperation with the University of Wyoming, study of the Baghdad, Arizona porphyry copper deposits in cooperation with Goddard Institute of Space Science and a concentrated effort in cooperation with Continental Oil Co. to study the use of ERTS in the search for porphyry copper deposits. An investigation of some surface effects correlated with oil bearing structures detectable on ERTS will be undertaken in cooperation with the USGS and perhaps the Union Oil Co. which has expressed interest. Assistance will be provided to other outside investigators on the basis of the potential application of the investigation and the suitability of the application of IPL techniques.

W75-70485  177-32-71
Marshall Space Flight Center, Huntsville, Ala.
DATA MANAGEMENT AND INTERPRETATION TECHNIQUES FOR EARTH RESOURCES SURVEY
Robert E. Cummings 205-453-2144

This effort is directed to the development of more refined and cost effective techniques and conceptual/mathematical models for the processing, display, and management of large amounts of earth resources data. Results will provide essential support to those discipline-oriented projects involving land use, hydrology, geology, and vegetation resources that ultimately depend on automated strategies for data acquisition and management techniques for timely earth resources planning and decision making. In general, this work will include the investigation and evolution of earth resources data analysis techniques, the development and demonstration of automated data analysis systems, the research and analysis of user needs to determine information and format requirements, the development of prototype earth resources data management techniques and systems, the distribution of information to users, interactive application demonstrations, and the documentation and transfer of the technology to user agencies for their pilot and/or operational applications.

W75-70486  177-32-81
Lyndon B. Johnson Space Center, Houston, Tex.
OPTICAL/DIGITAL PROCESSING OF MULTISPECTRAL DATA
J. Dragg 713-483-4761

The objective is to test and evaluate a multispectral classification procedure which is based upon performing a correlation between a transformed measurement vector and vectors which describe the transformed measurements of known target classes. This procedure is attractive because it offers extremely high classification rates, even when using many data channels, within a variety of computational technologies, including digital electronic and analog optical. It is particularly attractive when classifying data sets with large numbers of channels, both because of the increased accuracy afforded, and because, even in a general purpose computer, it can run faster with 24 channels than Gaussian maximum likelihood classifiers (LARSYS) can run with 4. The optical implementation of this scheme is considered particularly attractive because it offers substantial advantages in data storage density and, potentially, in computation speed.

W75-70487  177-32-82
Lyndon B. Johnson Space Center, Houston, Tex.
TRANSFER OF REMOTE SENSING ANALYSIS TECHNOLOGY VIA COMPUTER TIME-SHARING ORGANIZATIONS
J. D. Sargent 713-483-6478 (177-42-83)

Transferring of NASA developed or supported technology to other federal, state and local governments, the university community, and to the private sector is a major agency objective. This task is proposed for the purpose of establishing structured means of expediting the transfer of remote sensing analysis techniques and capabilities to these other organizations. During the course of implementation of this task, selected remote sensing analysis algorithms will be identified for dissemination to a wide community of users. The goal for dissemination of this information will be the implementation of the algorithms on selected commercial time-sharing systems. Such an approach provides the capability to support a diverse community of users in widely separated geographical areas. This approach provides a comprehensive facility encompassing the most current techniques available to the user with limited resources and secondly provides the training, background and sets the stage for organizations to expand to an in-house capability if desired.

W75-70488  177-40-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
OPTICAL TEXTURE ANALYSIS OF ERS DATA
D. P. Burcham 213-354-3028

In order to display digital images effectively, optical techniques are required. In addition, it is economically reasonable to supplant certain digital techniques for processing images with optical techniques. This is attractive especially where digital processing is inconvenient, for instance, at the stage of data acquisition. The objective is to study development of optical techniques for texture analysis techniques at a single pixel level to guide the specification of new sensor requirements.

W75-70489  177-42-21
Lewis Research Center, Cleveland, Ohio.
REMOTE SENSING DATA MANAGEMENT AND INTERPRETATION TECHNIQUES FOR EARTH RESOURCES SURVEY
H. Mark 216-433-4000

The objectives are to develop data acquisition, handling, processing, display, and management techniques and conceptual/mathematical models essential for translation of remote sensing data into information suitable for decision by resource managers. The area of interest includes automated recognition and inventory of surface mining operations as well as general soil and surface feature recognition, also automated ice classification and mapping. To achieve these goals, selected sample spectral signatures will be obtained and examined in the laboratory and compared with field measurements to develop interpretation capability required for a real system development. In the ice studies, pattern recognition computer programs are being developed to add to spectral data for practical ice classification. In the surface feature recognition studies, additional efforts will be made to extend recognition capabilities to include other soil features needed in land capability determinations that must be inferred (an additional step) from remotely sensed data.

W75-70490  177-42-41
Goddard Space Flight Center, Greenbelt, Md.
INFORMATION EXTRACTION TECHNIQUE DEVELOPMENT
W. L. Alford 301-982-5515 (177-31-41)

Existing systems contain many features useful for experimen-
ters such as interactive, user-oriented fast execution. However, none of these systems incorporate all of the major features required in a general purpose system. The broad objectives of this RTOP are (1) to develop techniques, systems, and interfaces for disciplon oriented researchers to perform multispectral image analysis and manipulation, (2) to transfer existing technology to local users and assess the utility of this technology, and (3) to provide analysis capability for local users. Near term objectives include the continued operation and assessment of the Purdue/LARS remote terminal. Other systems will be investigated also. Based on these investigations and a close working relationship with users, a general purpose interactive image processing system will be developed and implemented. This system development will concentrate on the user interface including a flexible interactive terminal, a user language and system executive, and output result presentation.

W75-70491 177-42-81
Lyndon B. Johnson Space Center, Houston, Tex. DEVELOPMENT OF MATHEMATICAL TECHNIQUES FOR THE ANALYSIS OF REMOTE SENSING DATA Kenneth Baker 713-483-2382
The primary objective is to develop the mathematical techniques that are needed to perform the data analysis for specific applications of remote sensing, such as a large area crop inventory. Research will be conducted in areas of applied mathematics such as statistics, matrix theory, and numerical analysis with the aim of improving data analysis algorithms and procedures until they meet the performance levels and cost constraints that are necessary for a major application of remote sensing. The research will be conducted by local universities on a task-by-task basis as problem areas in the analysis of remote sensing data are identified. The second objective is the development of a source of continuing education for JSC personnel in the areas of mathematics that are basic to the analysis of remote sensing data. This will be accomplished through seminars, and personal consultation.

W75-70492 177-42-82
Lyndon B. Johnson Space Center, Houston, Tex. TECHNIQUES DEVELOPMENT FOR MULTISPECTRAL SCANNER IMAGERY A. E. Potter 713-483-2071
The objectives are assessment of existing techniques for computer-aided imagery analysis and the development and test of new techniques as required by applications projects. The assessment of existing crop inventory techniques was a large part of the effort during FY74. With the exception of work on proportions of unresolved objects, it is expected that these analyses will be concluded during FY74, and that final reports will be issued early in FY75. The new work proposed for FY75 is focused on the solution of technical problems related to the applications of crop inventory over large areas. These problems have been defined by JSC/University crop inventory design teams during early CY74. About 85% of the total effort will be spent in this area. Tasks dealing with advanced remote sensing research are the remainder of the effort. The work related to crop inventory over large areas must be completed according to schedules provided by JSC, and will use either the CITARS baseline data set or a crop inventory data set as defined by the Joint JSC/University crop inventory design team.

W75-70493 177-42-83
Lyndon B. Johnson Space Center, Houston, Tex. APPLICATIONS RESEARCH AND TECHNIQUES DEVELOPMENT FOR REMOTE SENSING A. E. Potter 713-483-2071
The objectives are: (1) assessment of existing techniques for computer-aided imagery analysis, (2) development of new techniques to satisfy major applications requirements, and (3) demonstrating feasibility for new applications of computer-aided imagery analysis. The assessment of crop inventory techniques was a large part of the effort during FY74. It is expected that the analysis will be concluded during FY74, and that the final reports will be issued early in FY75. The major new direction for LARS is a realignment of LARS projects in direct support of JSC applications projects. The needs of these projects have been surveyed, and new technology development tasks have been defined as required by the applications projects. These tasks comprise about 70% of the total effort. It is recognized that a portion of the LARS effort should be set aside for new techniques development and applications demonstrations without a current applications project in mind. Current plans call for about 30% of LARS effort to be spent in such research.

W75-70494 177-44-41
Goddard Space Flight Center, Greenbelt, Md. HCMM APPLICATIONS: SURFACE CHARACTER MAPPING Warren A. Hovis 301-982-6465 (177-51-41)
The HCMM will fly in 1977 on the AEM Satellite. Prior to that flight it is essential to develop the techniques to process the data into thermal inertia maps and gain experience in the use of the thermal inertia measurements in areas such as roof-type mapping, soil moisture mapping, coastal zone studies, and plant canopy studies. In order to accomplish this effort, a simulator of the Heat Capacity Mapping Radiometer has been constructed for flights on aircraft in the NASA Applications Aircraft Program. Aircraft flights will be conducted over selected areas at times corresponding to the expected times of HCMM overpasses. The data will be processed, utilizing the temperature and thermal inertia measurements from the simulator, to thermal inertia maps. Thermal inertia maps will be analyzed to determine their utility in the areas under consideration and the results will be compared with surface truth measurements accomplished by competent investigation in each area.

W75-70495 177-44-42
Goddard Space Flight Center, Greenbelt, Md. REMOTE SENSING OF OCEAN COLOR, TEMPERATURE Warren A. Hovis 301-982-6465
The object is to conduct laboratory and field experiments, in advance of the launch of Nimbus G, to develop data analysis and processing techniques and interpretation skills for use with data from the Coastal Zone Color Scanner. Aircraft investigations will be carried out with a Coastal Zone Color Scanner Simulator (CZCSS) aboard a NASA U2 over a variety of areas with differing quantities of chlorophyll containing plankton and sediment. These overflights will be coordinated with surface truth measurements to be carried out by government agencies and university scientists. The scanner data will be processed in a manner similar to that planned for the Nimbus G data and analyzed, in cooperation with the surface truth investigators, to determine how best to carry out the same procedure with the spacecraft data.

W75-70496 177-44-82
Lyndon B. Johnson Space Center, Houston, Tex. RADAR STUDIES FOR EARTH OBSERVATIONS A. E. Potter 713-483-2071
Radar may be an important sensor in future earth observations projects. While there have been some applications demonstrated with photointerpretation of radar imagery, further progress requires a more quantitative approach. Of particular interest is the capability of radar for crop inventory. For this, it is necessary to determine the optimum conditions for crop discrimination with radar by means of ground-based measurements using a radar spectrometer, and to assess the performance of modern image analysis techniques when applied to radar imagery. The specific objectives of this work are to: (1) relate quantitatively to vegetation type, moisture content, and plant morphology to radar cross sections; and (2) to determine the capability for discrimination of agricultural scenes by application of pattern recognition techniques to radar imagery. (a) A ground-based radar spectrometer will be used to measure the radar backscatter from various crops as a function of radar frequency, polarization and incidence angle. Results will be statistically analyzed to determine the inherent capability of radar for discrimination between agricultural scenes. (b) Four-band radar imagery (X-, L-band at H and V polarization) of agricultural regions in Huntington County, Indiana, will be analyzed by pattern recognition techniques developed for analysis of multispectral data.
pectral scanner data. The capability for crop type discrimination with this imagery will be evaluated.

W75-70497
Goddard Space Flight Center, Greenbelt, Md.

THE APPLICATION OF MICROWAVE TECHNIQUES FOR THE REMOTE SENSING OF PARAMETERS OF HYDROLOGICAL INTEREST
T. J. Schmugge 301-982-6360

The objective of this effort is to study the use of active and passive microwave techniques for use in the remote sensing of water resource parameters. These include the observation of changes in the emissivity or reflectivity for soil as a function of moisture content and similar changes for a snow pack as a function of depth and liquid water content. The feasibility of using microwave radiometers for the remote sensing of soil moisture has been demonstrated using data obtained from aircraft. The remaining problem is to quantify the relationship between soil moisture and emissivity in presence of perturbing surface conditions such as surface roughness and vegetative cover. The primary approach will continue to be the use of data obtained from aircraft platforms flown over selected ground truth sites. A natural extension of this technique is to consider the use of active microwave systems which with the use of synthetic aperture techniques can yield much higher spatial resolution. The dependence of the backscatter coefficient on soil moisture has been demonstrated in field measurements and needs to be followed up with aircraft experiments. The capabilities of microwave techniques for snow measurements are less well defined. It has been observed that dry snow of sufficient depth has a low emissivity at certain wavelengths and that the presence of liquid water in the snow produces a dramatic rise in the emissivity. The objective of this study will be to determine how well parameters such as snow depth and liquid water content can be extracted from these phenomena by observations at several wavelengths.

W75-70498
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

IPL EQUIPMENT UPGRADE
D. P. Burcham 213-354-3028
(177-31-51; 177-52-51; 177-53-51)

The first objective is to continue the development of digital interpretive techniques relative to earth resources image applications. Widespread use and processing of the ERTS MSS data has led to the development of interpretive techniques for digitally processing this data. Although numerous techniques for extracting information from the data were derived, there is a continual need to develop new or improved techniques to increase the efficiency and/or accuracy of those techniques which are now becoming classical and to develop new techniques for which digital processing is uniquely suited. A second objective is to meet the needs of the increasing number of outside users and their increasingly complex processing by augmenting the IPL to allow its use as an Earth Resources Interpretation Assistance Center, to be used by selected investigators for image enhancement, registration, thematic classification, and other general purpose image processing in the solution of their problems. The third objective is the provision of a geocoded data conversion and field system for land use and resource inventories that will provide rapid up-to-date information access. The problem is complex, requiring simultaneous attack by various different organizations. Site selection will be based on the availability of remotely sensed data and the capability of the approach to yield good results. The fourth objective is the provision of a geocoded data conversion and field system for land use and resource inventories that will provide both rapid up-to-date information access. The problem is complex, requiring simultaneous attack by various different organizations. Site selection will be based on the availability of remotely sensed data and the capability of the approach to yield good results.

W75-70499
Ames Research Center, Moffett Field, Calif.

ON-LINE PEST MANAGEMENT SYSTEM
J. M. Deenewster 415-955-5897

The objectives of this RTOP are: (1) to evaluate the utility of a regional on-line pest management system that includes a network of remote data collection platforms; (2) to study the application of this technology to nationwide control of a wider variety of economically important pests and to other agricultural services; and (3) in so doing, to illustrate and document, credible means for arriving at functional system requirements from a basic understanding of the control function to be performed. Our basic approach to satisfying these objectives is to have two faculty members of Michigan State University work with us at ARC during the summer of CY-1974 and to monitor research grants to MSU beginning in FY-1975. For the last several years MSU has been developing, primarily via funds from the U.S. Department of Agriculture and the NSF/RANN, a system for real time monitoring and control of the cereal leaf beetle. This system is nearing the pre-operational demonstration phase. It is the intent of this RTOP to consider the attendant networks between the remote platforms and the central processor; between the classification sites and the processor; and between the processor and the farmer and make comparisons with rational alternatives such as in-situ measurements and pest state predictions.

W75-70500
Lyndon B. Johnson Space Center, Houston, Tex.

FORESTRY APPLICATIONS PROJECT STUDY (FORMERLY SAM HOUSTON NATIONAL FOREST STUDY)
Bryan R. Erb 713-483-4623

The JSC Earth Observations Division's Applications Office and Southern Region, U.S. Forest Service began a cooperative effort in July 1971, to investigate the applications of remote sensing to Forestry. Two Forest Service employees were assigned to the Applications Office. Since then the Forestry Applications Project Team has determined that the following tasks should be developed into applications procedures: forest resource inventory, timber volume measurement, and extensive soil survey - using computer processing of multispectral data. The overall objective is to assess the utility of remote sensors and their related processing as a tool for assisting in making forest inventories and monitoring of management activities and to develop procedures for implementing suitable techniques in the southern region. The approach will be to meet this objective through a thorough investigation and implementation of the following tasks: (1) Determine which requirements can be accomplished by remote sensing techniques. (2) Establish task objectives and procedures for remote sensing studies involving those requirements. (3) Perform the above tasks utilizing present state-of-the-art remote sensing techniques, define areas of needed technological research and direct that research toward satisfying project objectives. (4) Evaluate the results of the investigations and assess their economic feasibility. (5) Verify techniques developed for different forest ecosystems to determine breadth of application. (6) Transfer to the user agency the acceptable techniques and assist them in the implementation of the applications.

W75-70501
Lyndon B. Johnson Space Center, Houston, Tex.

JOINT EXPERIMENT ON REMOTE SENSING OF SOIL MOISTURE
A. E. Potter 713-438-2071

Because soil moisture greatly affects the radar cross section and thermal emissivity in the microwave frequency range, microwave remote sensing techniques can be exploited to detect soil moisture. Other surface features such as roughness and vegetation also influence emissivities. Ground based observations show that these effects can be minimized if one chooses: (1) a multispectral approach, and (2) to make observation at a high depression angle. The problem is complex, requiring simultaneous attack by hardware groups, soil experts, etc. The objective of this task is to organize and execute an attack on the problem in a joint effort, including all the required elements drawn from several different organizations. Sites will be chosen that have irrigated fields (to get a wide variety in soil moisture). It will be desirable to have some fields bare and some covered with wheat. This would have the added benefit of assisting those who are analyzing data from the Large Area Crop Inventory Project (LACIP). Preliminary ground based measurements should be made close to the time of the flight experiment. Analysis of data from the flight is expected to provide an estimate of the feasibility of remote sensing of soil moisture beneath vegetal covering. Groups from ERIM, Texas A and M,
THE APPLICATION OF REMOTE SENSING TO EVALUATING SURFACE TEMPERATURE DURING FREEZING CONDITIONS

Paul D. Toft

The primary objective of this investigation is to establish a cost-effective method using remote sensing to accurately determine the amount (temperature and duration) of crop freeze exposure over large geographical areas, and to develop a comprehensive cold weather climatology classification and geoastronomic model of Florida's citrus areas for accurate freeze exposure forecasting. The approach selected utilizes airborne thermal scanning data to measure the earth-air interface temperatures over selected agricultural areas during freeze conditions. These data are then used for comparison with actual freeze conditions and inputted into computer models. These models would then be improved as indicated by the comparison of the predicted vs. measured temperatures.

Goddard Space Flight Center, Greenbelt, Md.

APPLICATION OF INTEGRATED THEMATIC DATA BASE AND DEMONSTRATION OF ITS USE IN REGIONAL ENVIRONMENT/LAND USE MANAGEMENT

J. Schubert

The objectives of this program are to integrate remotely-sensed and other data relevant to environmental/land use problems in a limited test area; to identify, in that area, the disparate users on the operational level and to define technical data products which can most readily and advantageously be applied by operational level users having similar needs in other regions. At the center of this effort is a task for a land use - environmental study which will have, as its purpose, (1) the integration of the data produced in the several tasks of the study; (2) the development of a base (in map and computerized form) of regional land use information; (3) the identification and stimulation of a local user community; (4) the dissemination of data in a form in which it can readily be applied by the users; (5) the assessment of the efficacy of the regional survey, especially in comparison with alternative methods; (6) the consideration of system modifications required for greater utility and efficiency.

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

LOS ANGELES COUNTY LAND USE ANALYSIS

M. E. Alper

The objectives of this project include a short-range task of developing a land use information system for the Los Angeles Santa Monica Mountains and the initialization of a longer range plan for a Los Angeles city geographically based urban information system. Both systems would be based on the New York State Land Use and Natural Resources (LUNR) system. The Santa Monica Mountains land use system would consist essentially of LUNR with major modifications to analyze present land use policy effects and open space planning on the natural resources and scenic beauty of the roughly 1000 square kilometer mountain range. It is anticipated that the background study and research associated with this phase of Los Angeles land use planning would be completed under this RTOP. In addition, a natural resources inventory in the more northern Santa Susanna Mountains and Verdugo Mountains would be initiated under this RTOP with funds to complete the work coming from other sources. The city-wide information system would incorporate the modified LUNR system as an information provider for the urban environmental and transportation models presently used for planning functions in the metropolitan area of Los Angeles. In this respect LUNR would be used as an aggregative base for assessor file and census tract data as well as functional land use (as opposed to strictly vegetative cover). The desired product under this phase of the program is to provide the city's planning models with reliable, up-to-date, easily accessible information of both socio-economic and physical resource types. This RTOP would include a significant beginning into this phase of the program; it is envisioned that this urban information system would be developed simultaneously with the Santa Monica Mountains system.

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ECONOMIC ASSESSMENT OF INCORPORATING LAND USE/NATURAL RESOURCE DATA INTO CITY PLANNING

M. E. Alper

A methodology is to be developed whereby a city planning department can readily identify those subsets of their general comprehensive plans where remote sensing land use data might provide one or more of the following benefits: (1) a reduction in litigation costs to the city, costs due to individual or public challenges of proposed plans or environmental impact reports (EIR); (2) an improvement in the rather nebulous 'quality of life' indices due to the better understanding of present land uses and potential conflicts among proposed land uses; and (3) an increased capability of the planning department to achieve significant gains in their general plans by freeing manpower presently required to inefficiently gather environmental data which tends to be inadequate, subjective, and poorly organized to be accepted as credible. Methods of quantifying these benefits will be investigated under this RTOP by economically assessing results of the Santa Monica Mountains land use system being developed simultaneously under approved RTOP 177-52-51-01-00-'Los Angeles County Land Use Analyses'. It is envisioned that as this land use/natural resources system is expanded into the environmental data system to be appended to Los Angeles' Block Level Reporting System, the economic assessment studies will be continued in order that an effectiveness criteria can at any time be applied to the urban management systems being developed.

Marshall Space Flight Center, Huntsville, Ala.

LAND-USE MAPPING FOR RESOURCE MANAGEMENT

C. T. Paludan

The objective is to develop and demonstrate a useful system for land-use information derivation and retrieval. Accomplishment of this depends upon three areas of research: (1) determination of user requirements, (2) development and demonstration of an automated information retrieval system, and (3) refinement of the technology for classification and retrieval, both software and hardware. Determination of user requirements will be accomplished by continued joint activities with state agency personnel in several Southeastern states. These activities will be accompanied by demonstration projects which are designed to maximize the user's feedback of adequacy and utility. An area of emphasis for these demonstrations will be use of interactive terminals and mini-computers in conjunction with a computerized data bank utilizing information from EREP, ERTS, and aircraft derived through automatic processing techniques developed at MSFC.

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

MULTIPLE RESOURCE SURVEYS IN THE TENNESSEE VALLEY AREA

C. T. Paludan

The objective is to develop and apply methods of using remote sensing and automatic data handling for delineation and description of resources, with emphasis on cooperative activities with regional planning and development organizations. Because they are basic to comprehensive understanding and management of multiple resources, emphasis is on land-use and water resources. Operations of the Tennessee Valley Authority (TVA) and the Tennessee-Tombigbee Waterway Development Authority (TTWDA) provide the key emphasis of this research. Studies of selected test sites are conducted to establish guidelines for
management and planning of lands and waters under their jurisdictions. Application of remote sensing, automated classification, automated retrieval, decision-modelling and predictive modeling are among techniques refined and demonstrated in this multi-agency research activity.

**W75-70508**

Lyndon B. Johnson Space Center, Houston, Tex.

**LAND USE AND RESOURCE INVENTORY**

R. O. Piland 601-688-2034

This RTOP will: (1) conduct research investigations in the Mississippi/Louisiana/Gulf areas in land use classification applications of remote sensing, stressing the interests and needs of agencies in the area; (2) extend these research investigations into experimental demonstration projects in cooperation with local agencies where appropriate; (3) use existing aircraft and satellite programs as a primary source of remote sensing data, and collect and analyze surface data for correlation with these flight data; and (4) conduct continuing studies of user requirements of the potential land use classifications in order to guide future research efforts. Land Use/Resource Inventory tasks fall into three major categories, with subdivisions as follows: State wide land use system applications (small scale photographic application, ERTS MSS imagery application, ERTS MSS digital application); Technique development, agricultural, forestry.

**W75-70509**

Lyndon B. Johnson Space Center, Houston, Tex.

**REGIONAL APPLICATIONS PROJECT**

G. E. McKain 713-483-4623

Regional Councils of Government have been established throughout the State of Texas each having specific need for regional planning and management information. The Governor has formed an Interagency Council on Natural Resources and the Environment (ICNPE) to ensure a well coordinated focus on all aspects of land resource planning. ICNRE has established a Remote Sensing Task Force to determine the utility of remotely sensed data as a source of land resources information. NASA has been contacted by the Governor’s office to explore a cooperative program to transfer remote sensing and information systems technology to the state. Working jointly with the ICNRE, the remote sensing task force and various state agencies, several significant accomplishments have been made: a procedure for the utilization of ERTS-1 MSS data to detect and locate surface water was developed, tested and transferred to the state; a Purdue Terminal has been installed in Austin and is currently being used to train state personnel in the utilization of pattern recognition techniques; the state has submitted a proposal for an ERTS-1 follow-on investigation; and a joint state/NASA remote sensing project is currently being planned, with the objective being to design, develop and demonstrate a pilot regional land resources inventory and monitoring system.

**W75-70510**

Ames Research Center, Moffett Field, Calif.

**GEOTHERMAL RESOURCE INVESTIGATIONS**

D. R. Chapman 415-965-5065

(177-53-11)

The objective is to determine if increased mercury vapor concentrations can be combined with remotely sensed thermal anomalies to identify potential geothermal sites. The approach was to measure field concentrations of mercury vapor at sites where anomalies are recognized with thermal infrared images. This will be a cooperative project with the AEC/Lawrence Berkeley Laboratory (LBL) to help evaluate four sites in Nevada for construction of a geothermal power plant.

**W75-70511**

Ames Research Center, Moffett Field, Calif.

**EVALUATION OF REMOTE SENSING APPLIED TO CIVIL WORKS PROJECTS**

D. R. Chapman 415-965-5065

(177-53-13)

The objective is to determine the feasibility of assessing civil works sites by measuring soil moisture using remote sensing in the 0.4 to 14 microns wavelength region. The approach was to perform investigations to determine the conditions underwhich soil moisture can be correlated with remotely sensed reflected energy (0.4 to 2.5 microns) and emitted energy (8 to 14 microns). Apply these results to civil works sites to evaluate their usefulness to field conditions. Applications to be studied include: landslides, levees, highways, ground water localities and dams. Application studies will be cooperative efforts with USACE and California State agencies.

**W75-70512**

Goddard Space Flight Center, Greenbelt, Md.

**GEOMICROCLIMATIC INVESTIGATIONS USING ERTS AND RELATED DATA**

N. M. Short 301-982-6603

The purpose of this RTOP is to fill major gaps in the continuing program support for the use of Earth Resources Technology Satellite Data in geologic studies and applications. Recent program reviews indicate these gaps to be (in order of priority): (1) preparation of geoenvironmental maps from ERTS, (2) use of ERTS data in petroleum exploration, (3) development of a working model for metals exploration using space imagery, (4) analysis of lines as geologic features. Research and field projects designed to develop and assess specific contributions of ERTS data towards geoenvironmental mapping, petroleum and metals exploration, and lines identification will be carried out through this RTOP. In addition, a relevant study of the use of thermal and reflected IR data in solving certain geologic problems will be included in the proposed tasks. The approach is twofold: first, certain aspects of each task, including special data processing and representative site studies, will be conducted in-house at Goddard Space Flight Center; second, most of the remainder of these tasks will be performed under contract outside GSFC, especially where extensive field work requires proximity to individual test sites.

**W75-70513**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**THERMAL INERTIA AND GEOTHERMAL MAPPING**

D. P. Burcham 213-354-3028

Thermal inertia (TI) is a body property rather than a surface property of earth materials. Therefore TI can be used as another parameter, along with surface reflectivity, in tele-geologic mapping. Initial steps in this direction have been taken by Watson and Pohn of the USGS, Denver, using Nimbus data. The heat capacity mapping mission (HCMM) will be flown by GSFC in 1977. This mission will supply the bulk of the high resolution data needed to produce thermal inertia maps. The inventory of existing geothermal anomalies, and discovery of new ones by satellite mapping, is an order of magnitude more difficult task than TI mapping. TI itself is a noise source. Mapping of accurate temperature differences of 1 °C or less is necessary. It is not clear whether it will ever be possible to map accurately such small differences from satellite altitudes. Much of the work required to reduce, analyze, and interpret thermal data for geothermal applications is identical to the HCMM work. Problems such as elevation, slope, albedo, vegetation, etc. are common to the two methods. Work toward evaluation of a geothermal satellite must include TI work first. It is proposed to begin reducing data from NIMBUS NOAA DAPP and Skylab to make thermal inertia maps in anticipation of HCMM. Work in thermal modeling will be done experimentally with use of tethered balloons as well as with instrument data. Modeling work will be done in cooperation with the USGS Denver.

**W75-70514**

Marshall Space Flight Center, Huntsville, Ala.

**REMOTE SENSING FOR GEOLOGICAL RESOURCE SURVEY**

J. Berko 205-453-0187

(177-51-71; 177-52-71)

The objective is to investigate the applicability of remote sensing and other space technology to the problems of federal and state agencies with planning or other direct responsibilities for producing decision-base information necessary for effective resources management in the areas of environmental geology, engineering geology, mineralogy, geobotany, and geothermal technology. The approach of selected state and federal user-partner agencies together with MSFC technical personnel will define
basic problems and will develop a project plan for alternate solutions. The plans will include (1) acquisition of remote sensing data, processing, and analysis; (2) discipline expertise, data analysis, instrument evaluation, and application by the user agencies.

W75-70515

Ames Research Center, Moffett Field, Calif.

REMOTE SENSING FOR SNOW AND ICE MAPPING AND MONITORING

D. R. Chapman 415-965-5065

Snowpack measurements by use of remote sensor technology, to obtain hydrological cycle data, so as to achieve better utilization of water resources, flood forecasting, and related activities. Remote sensing techniques will be applied for the measurement of the extent, depth, density, and percent moisture of snowpack, to assist in water resource management. Specific techniques include surface, airborne, and satellite-based instrumentation. Surface systems are needed for ground truth data: depth and density by standard snow sampling, percent moisture by our new method to obtain the change in dielectric constant and loss tangent of snow sample before and after freezing. Time-progressive ground truth information will also be obtained by completely automatic, remote installations using a profiling system to measure moisture in the snow by attenuation of microwaves between source and receivers that move vertically within a dielectric tube. Data would be relayed via ERTS satellite. This is a joint project with the U.S. Forest Service. Airborne systems will be investigated using passive and active electromagnetic measurements, the latter being based on multifrequency sounding to obtain snowpack depth, density, and moisture. Calculations will be made for representative models of air, snow, ice, water, and earth, including dry or wet conditions of the snow. Actual field site measurements will be employed in the models.

W75-70516

Ames Research Center, Moffett Field, Calif.

HYDROLOGIC MODELING

D. R. Chapman 415-965-5065

The primary objective is to develop a management-oriented hydrologic model, taking into account supply, demand, and impact, that makes optimal use of modern remote sensing capabilities. To study the cost-effectiveness of such a model as compared to the utility of conventional, presently used models. Large water basins and regional water distribution systems, e.g., the California Watershed Project, will be the focus of study. Three aspects of such a system, i.e., supply, demand, and impact, will be initially studied separately as benefitting from the application of remote sensing techniques in their effective consideration as components of a water delivery system. Results will then be integrated into a simple comprehensive model which will be tested in its usefulness to resource managers.

W75-70517

Lewis Research Center, Cleveland, Ohio.

REMOTE SENSING FOR SNOW AND ICE MAPPING AND MONITORING

H. Mark 216-433-4000

The objectives are to extend or adapt existing hydrologic models to incorporate remote sensing data for parameter determination. To reduce requirements for historical rainfall/streamflow data by improving predictive capabilities using remote sensing. (2) To apply advanced modeling concepts, such as finite element techniques to make existing models more amenable to remote sensing parameter determination. (3) To improve and extend existing river and estuarine mathematical models to full three-dimensional descriptions so that surface or near surface remotely sensed parameters can be utilized most efficiently to monitor streamflow, temperature profiles and other significance parameters. (4) To develop a predictive model of river dynamics such that water agencies might determine real-time characteristics using remote sensing, thus deleting dependence on long historical records and fully gaged watersheds. Existing models for watersheds, streams and rivers, deep lakes, and bays and estuaries will be augmented, modified and improved to incorporate remotely sensed data from aircraft and satellites as well as in-situ measurements. Advanced three-dimensional modeling techniques developed for rocket exhaust plume analysis and finite element analytical techniques will be adapted to watershed and waterbody analysis. Existing user expertise, in particular the Tennessee Valley Authority, ---.

W75-70518

Goddard Space Flight Center, Greenbelt, Md.

INVESTIGATIONS OF THE HYDROLOGICAL CYCLE AND LARGE HYDROLOGICAL SYSTEMS

V. V. Salomonson 301-982-6481

(177-54-42)

The thrust of this effort is to (1) seek means of incorporating remotely-sensed data from spacecraft and high altitude aircraft into deterministic watershed models in such a way as to improve their accuracy and timeliness, and (2) develop means of analyzing and processing these same remotely sensed data so as to repetitively monitor and measure hydrologic parameters over large regions in such a way as to improve our understanding and ability to manage dynamic, large scale water resource systems. The current efforts will involve demonstration of hydrologic processes on the Monocacy and Patuxent Rivers using updated versions of the Stanford Watershed Model. Data processing and interpretation efforts involving land use, flooding, and physiographic features will be continued on the above rivers and the Anacostia Basin in Md., several watersheds in Colorado, Wyoming, Washington, Pennsylvania, and along the Mississippi River. In particular, efforts will be extended to better map flood plains, snowcover, impervious area, and drainage density in these areas using photo-interpretation and digital-multispectral classification methods. Meteorological, satellite, ERTS, Skylab, and aircraft data will be examined. Means of interpreting and applying data from future spacecraft missions such as EOS, SEDS, and HCM will also be investigated.

W75-70519

Marshall Space Flight Center, Huntsville, Ala.

INVESTIGATIONS OF THE HYDROLOGIC CYCLE AND LARGE SCALE HYDROLOGIC SYSTEMS

H. G. Hamby 205-453-0899

(176-53-71)

The objectives are: (1) to extend or adapt existing hydrologic models to incorporate remote sensing data for parameter determination. To reduce requirements for historical rainfall/runoff/streamflow data by improved predictive capabilities using remote sensing. (2) To apply advanced modeling concepts, such as finite element techniques to make existing models more amenable to remote sensing parameter determination. (3) To improve and extend existing river and estuarine mathematical models to full three-dimensional descriptions so that surface or near surface remotely sensed parameters can be utilized most efficiently to monitor streamflow, temperature profiles and other significance parameters. (4) To develop a predictive model of river dynamics such that water agencies might determine real-time characteristics using remote sensing, thus deleting dependence on long historical records and fully gaged watersheds. Existing models for watersheds, streams and rivers, deep lakes, and bays and estuaries will be augmented, modified and improved to incorporate remotely sensed data from aircraft and satellites as well as in-situ measurements. Advanced three-dimensional modeling techniques developed for rocket exhaust plume analysis and finite element analytical techniques will be adapted to watershed and waterbody analysis. Existing user expertise, in particular the Tennessee Valley Authority, ---.

W75-70520

Langley Research Center, Langley Station, Va.

COASTAL PROCESSES

E. S. Love 804-827-2893

This RTOP includes the preparation of a Coastal Zone Applications Plan, which will be in part an expansion of the recommendation of the Environmental Quality Enhancement Program Study prepared for the Office of Applications by the Langley Research Center. Work on Task 1 (water measurement and analysis on the continental shelf) and Task 2 (current circulation studies on the continental shelf) will be accomplished. Included also is the development of remote monitoring techniques for wetlands and organic vegetation, work previously carried under 177-55-33. Objective of work on the continental shelf is to develop a predictive capability for the wave and current environment for application to areas in these waters. Problem areas of interest include pollution distribution and circulation on the shelf, sedimentation, thermal properties of shelf
OFFICE OF APPLICATIONS

waters, wave climate, and shoreline alteration. For vegetation studies, the objective is to develop remote signatures for specific species. The approach includes the development of analytical and wave current models and the measurement of conditions in the coastal zone by various means to provide data for preliminary model verification, and to develop input measurement techniques for eventual use with monitoring systems. Measurement methods to be used include remotely sensed data from satellites (such as EOLE) and aircraft, in situ measurements and surface observations from drifting or fixed stations with location information and measured data relayed in some cases by satellite (such as EOLE) and aircraft.

W75-70521 177-55-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
EARTH/COASTAL ZONE STUDIES, RADAR
D. P. Burcham 213-354-3028

The purpose of this task is to apply radar techniques to the investigation of ocean wave/coastal topography interaction. The major objective is to develop an operation airborne/spaceborne system for earth/coastal region observation which would help in the conservation of coastal regions, mapping of bottom topography and the determination of safe locations for deep harbors, power plants, and off-shore nuclear plants. A second objective is to conduct some observations of the Colorado plateau for geological studies and development of future ground water supply. Another major objective of this work is to complete a breadboard of a spacecraft digital system (DDS) which is required for future spacecraft radar imaging systems. The approach is: to use the existing MPL multispectral (3 cm, 25 cm, 200 cm) imaging radar in conjunction with the NASA CV-990 or other airplane provided by NASA to make flights over specific coastal regions to acquire the necessary ocean wave patterns, and sea state of ocean profile data. The areas overflown will be selected during a users/scientists meeting in April 74. Most probably we will emphasize the East Coast (New York, New Jersey, ... ) because of the critical need of energy plants in that region. Preference will be given to regions where coastal topography and wave diffraction models are available. During one of the flights multispectral radar data will be collected over the Colorado Plateau. The radar imagery will be correlated with the ERTS imagery, high-altitude conventional photography and extensive ground truth mapping which is presently being studied in detail as part of the ERTS program at JPL. The digital data system will be mated to the L-band radar, and output imagery of both the optical and digital systems will be compared to evaluate the DDS performance.

W75-70522 177-55-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
MICROWAVE RADIOMETRIC MEASUREMENT OF ICE THICKNESS
D. P. Burcham 213-354-3028

The objective of this task is to perform ground based experiments with microwave radiometers operating at 1.42, 10.69, and 31.4 GHz. These experiments were made to: (1) demonstrate the feasibility of remotely measuring the thickness of lake ice with a microwave radiometric system, (2) determine the microwave properties of newly formed sea ice and, if feasible, multi-year ice, (3) determine the feasibility of remotely measuring the thickness of sea ice with a microwave radiometric system, and (4) support the 1975-1976 ALABEX mission by measuring the microwave signatures of various ice types and thicknesses. This is a three-year program based on a logical progression of experimentation with definitive reportable objectives for each year of experimentation (see attached schedule). During FY-74, dual-polarized microwave radiometers operating at 1.42 GHz, 10.69 GHz, and 31.4 GHz were used to perform experiments on both controlled and natural samples of sea ice. The experiments were conducted from a van in the Great Lakes area and demonstrated a correlation of radiometer data with thickness of fresh water ice. Accuracies will be required to prove usefulness. Test techniques are being defined to extend the application to sea ice.

W75-70523 177-55-51
Lyndon B. Johnson Space Center, Houston, Tex.

M ARSHLAND ECOCOLOGICAL SURVEY
R. O. Piland 601-688-2034

The objective of this task is to test and demonstrate an automated environmental information system based on remotely sensed data for the updating of basic environmental data in a predominantly wetlands area. The Corps of Engineers have a continuing need for basic environmental information for planning projects and assessing the resulting impact. An Atlas Inventory of Basic Environmental Data, South Louisiana had been produced from existing data. The Corps of Engineers requested NASA to assess the atlas to determine which sets of data could be updated using remote sensing. Data dealing with land use and vegetation classification were identified as candidates for automated classification utilizing remote sensing data. A number of ERL SR and T projects in South Louisiana and Mississippi and associated software and hardware projects have provided the basis for developing an automated system to meet--

W75-70526 177-55-91
Lyndon B. Johnson Space Center, Cocoa Beach, Fla.

APPLICATION OF REMOTE SENSING TO DETECTING
THERMAL POLLUTION
Roy A. Bland 305-867-4541
The effects of hot discharges from nuclear power plants can have detrimental effects on the ecological systems. Proper management of thermal pollution will be based on our ability to choose the most advantageous sites for future power plants. The approach is to develop a generalized, predictive, analytical model involving remote sensing and in situ measurements. Output of the model will include the motion and diffusion of thermal discharges and the extent of the region affected.

W75-70527 177-57-81
Lyndon B. Johnson Space Center, Houston, Tex.
EARTH SURVEYS IN SUPPORT OF THE LIFE SCIENCES
C. M. Barnes 713-483-5406
This research program is designed to explore the possibilities for the use of remote sensing systems technology for the life sciences. During the past year, the NASA and support contractors have investigated the aircraft and spacecraft imagery and ground truth data of the Earth Resources Program. The Health Applications Office has directed the acquisition of additional data pertinent to the health related remote assessments of the environs. Responsible scientists in the health field have emphasized that remote sensing is not only a highly desirable way of collecting data in field situations but may indeed be the only means of acquiring such information. While the use of remote sensing technology has not yet been forcefully applied in field situations by the responsible public health authorities, preliminary data collected by the Johnson Space Center has generated considerably enthusiasm in the health community. In addition to continuing investigation into feasibility of the use of remote sensors for health purposes, it is proposed that a close liaison be developed with general life science users and regulatory agencies and that pilot-type eradication and control programs be initiated during the coming year.

W75-70528 177-60-41
Goddard Space Flight Center, Greenbelt, Md.
APPLICATIONS SYSTEMS VERIFICATION TESTS (ASVT) - OPERATIONAL APPLICATIONS OF SATELLITE SNOW COVER OBSERVATIONS
A. Rango 301-982-6481
(177-54-41; 177-54-52)
The objectives are: (1) in the initial ASVT phase - to map snowlines and areal snow cover and associated changes in snow cover using satellite data for 1972-73 and 1973-74, (2) to continue study through FY-78 and extend the mapping in objective 1 to a total of six years, (3) to compare satellite snow mapping products to products from conventional information sources, and (4) to develop or modify methods in an operational framework that would allow incorporation of satellite derived snowpack observations for prediction of snowmelt runoff. The rationale for such a study is that snowmelt is the source for greater than 50% of streamflow in most areas of the Western United States.

W75-70529 177-60-72
Marshall Space Flight Center, Huntsville, Ala.
DEMONSTRATION OF APPLICABILITY OF NASA DATA ACQUISITION AND MANAGEMENT PROCESSES TO RESOURCE MANAGEMENT PROBLEMS IN THE ATCHAFALAYA RIVER BASIN
J. M. Batch 601-688-2121
The objective of this plan is to demonstrate to selected user agencies, federal and state, the beneficial application of NASA-developed technologies in acquiring, processing and managing data to meet selected resource management information needs in the management of natural resources of the La. Atchafalaya River Basin and to provide a basis for those agencies' expanded adoption of such technologies to meet operational requirements. The plan is to engage in a joint effort with the DOI, Bureau of Sport Fisheries and Wildlife, U.S. Geological Survey, EROS; U.S. Army Corps of Engineers; U.S. Fish and Wildlife Commission; and the La. Dept. of Public Works. The joint effort will provide for this collection on a near real-time basis, by the use of data collection platforms and the ERTS Data Collection System, measurements including water stage, turbidity, DO, temperature and pH from selected remote sites in the Atchafalaya Basin to provide input data for verification and operation of predictive eco-system models being prepared by participating agencies from existing broad-scale data. Also NASA/MTF will provide data management techniques to establish an archive of information over a selected small-scale grid in the Basin and will exercise mathematical predictive models on existing ADP equipment to correlate hydrological data with biological data, collected by others. The resultant information will be the basis for the formulation of a resource management plan by Bureau of Sport Fisheries and Wildlife with special emphasis on fish and wildlife management as related to flooding and flood control structures, for one or more Atchafalaya Basin management areas. Cooperating agencies will make various contributions ranging from the purchase of DCPs and sensors by the Corps of Engineers to calibration and maintenance of sensors by the USGS (funded by La. Dept. of Public works).

W75-70530 177-61-81
Lyndon B. Johnson Space Center, Houston, Tex.
GLOBAL WHEAT ASVT (LACIP)
John Overton 713-483-4776
The objective of the large area crop inventory project (LACIP) is to demonstrate the capability to perform a Global agricultural production assessment of a selected crop through the use of remote sensing in a quasi-operational mode. In order to demonstrate the capability to conduct a large area crop production assessment through the use of remotely sensed data, the crop of interest must be clearly identified, the area limits must be estimated and the yield per unit of area must be estimated. The approach is to sample the area of interest, classify the crops and statistically estimate the production of crop grown in selected regions. Three major elements are required to support this approach -- a data system, a statistical sampling scheme, and an analysis procedure. The system is to be designed, developed and operated in cooperation with the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration. The project will be a phased effort beginning in 1974 and running through 1977 consisting of a planning phase, two one year quasi-operational phases and resulting documentation. During the first two phases, directed in-house and university R and D activities will be conducted to support and improve the quasi-operational phases. These activities will include procedures for acreage determination from ERTS data, development of yield determination from meteorological data, improvement of sampling ---

W75-70531 177-61-82
Lyndon B. Johnson Space Center, Houston, Tex.
NATURAL RESOURCES INVENTORY SYSTEM (ASVT)
Dr. Armond T. Joyce 601-688-4254
(177-52-81)
The objective of this project is to test and demonstrate an automated natural resources inventory system based on remotely sensed data oriented to state or regional use and directed at specific applications. States and other governing bodies have a need for accurate up to date natural resource inventory information for managing resources, optimizing growth and development and minimizing environmental impact. The large geographical areas involved make surface inventory difficult and encourage the use of remote sensing. The resulting large quantities of data imply the desirability of automatic processing, access, and correlative capability. The ERL SR and T effort for the past three years has been oriented to the development of software, hardware and disciplinary techniques suitable for incorporation into such an automated system. The state of Mississippi is proposed as an initial test area for reasons of logistics.---

W75-70532 177-71-01
National Aeronautics and Space Administration, Washington, D.C.
EARTH RESOURCES SURVEY, GENERAL STUDIES
Richard T. Hibbard 202-755-8623
The objectives of this RTOP are to conduct studies and various activities that are of a general nature which are applicable
to earth observations and earth resources survey in particular. These studies may be in such areas as land, water, air environments, and the pollution of the environments. The studies may be in the form of theoretical, paper, or demonstrated types, and fundamental and basic research.

W75-70533 176-91-31
Langley Research Center, Langley Station, Va.
COORDINATION AND PLANNING ACTIVITIES FOR THE ENVIRONMENTAL QUALITY PROGRAM
E. S. Love 804-827-2893
The purpose is (1) to continue the planning and coordinating activities necessary to implement the Environmental Quality Enhancement Program; (2) to coordinate with user agencies, and to explore with these user agencies cooperative programs that will take advantage of NASA's expertise in the area of environmental quality monitoring; (3) to continue studies of economic parameters relating to environmental monitoring with emphasis to be placed on regional and global problems; (4) to extend the agreement between NASA Langley and the Region 6, Virginia State Air Pollution Control Board which provides for assistance in the area of sampling techniques, analysis and dispersion modeling; and (5) to provide Headquarters-0A with technical assistance involving preparation of material for programmatic recommendations, congressional briefings, budgetary submissions, preparation of material for new program emphasis and cooperative programs with user organizations. This RTOP is also intended to cover the extensive coordination activities required between other lead centers and assignments to committees in support of the lead center role.

Energy Applications

W75-70534 647-10-01
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SPACE BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS
M. E. Alper 213-354-8948
(647-30-01)
This is a continuation of an RTOP initiated April 1974 which seeks to establish the most effective means of utilizing solar energy in the large scale production of power in the 1990's and beyond and to compare this option with other means of generating power, such as nuclear. The study will perform system type economic comparisons between orbital power generation/transmission concepts and ground based power generation and distribution. The work is being closely coordinated with a parallel effort being conducted by the Marshall Space Flight Center. The study will build upon the results of previous technical and economic investigations of orbital and terrestrial power systems including satellite solar power systems, microwave power relay systems, nuclear power plants in earth orbit, terrestrial hydrogen energy transport, and other known new concepts for power generation and transmission. During FY-74 a thorough literature review was initiated, identifying the work that has been done to date and the technologies which have been developed or which are required. In addition during FY-74, a detailed program plan coordinated with the MSFC effort was developed. The plan included milestone schedules and cost. During FY-75 this program plan will be implemented. The overall study will focus on an economic comparison of terrestrial and space based solar and nuclear power system concepts and will establish the unique advantages of each technology required and the cost and schedule associated with a fully developed system.

W75-70535 647-10-01
Marshall Space Flight Center, Huntsville, Ala.
SPACE BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS
W. E. Whitacre 205-453-3465
(647-10-02)
The objective of this continuing effort is the performance of economic and technology assessment comparisons between space based power generation/transmission concepts and other ground-based conventional modes of production and distribution of electrical energy to be used in the 1990's and beyond and to define the near-term activities on which to proceed, if warranted. This 10-month study will build on the results of the previous conceptual feasibility studies, the MSFC in-house investigations, and the FY-74 contracted effort. It will consider in greater depth the various facets of the many proposed new concepts for both power generation and distribution. This study will focus on the economic comparison of these new proposed approaches with the evolutionary trends of the more conventional power generation and transmission concepts. Special emphasis will be placed on the development of trends for the items that affect the establishment of new energy sources to a major extent and on the areas of major concern identified as a result of the FY-74 funded effort.

OFFICE OF SPACE SCIENCE

Launch Vehicle Development SR&T

W75-70536 180-06-50
Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF ADVANCED PROPULSION SYSTEM REQUIREMENTS
R. E. Coady 301-982-4731
A continuing program has been underway for several years aimed at evaluating and analyzing the capability of existing and proposed propulsion systems for accomplishing planned or proposed automated mission. The theory, analytic approaches and computer implementation necessary to conduct this work have been pursued at the Aerospace Systems Lab of Princeton University, Analytical Mechanics Associates, Inc. and by the MIT Charles Stark Draper Laboratory. Current efforts are directed at extending the capabilities of these computer programs, as well as the use of the programs already developed, toward the generation of mission data for a broad range of missions and toward updating NASA's Launch vehicle Estimating Factors booklet for solar electric propulsion. Included in the current efforts has been work directed toward making the relationship between impulsive and finite thrust trajectories mathematically explicit and the implementation of this work into an operational tool. Currently, work is in progress to extend the capabilities of present programs to include more realistic performance and environmental models. Additionally, work has begun to study the behavior of several proposed guidance schemes in an attempt to establish the criteria on which a judgment can be made about the relative merits of one mode over another. The approach to be taken in the next few years is to study selected earth orbiting, planetary and interplanetary missions where preliminary work has indicated that low thrust propulsion systems show a distinct advantage in either payload or trip time.

W75-70537 180-06-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ELECTRIC PROPULSION RELIABILITY
P. J. Meeks 213-354-2546
(506-22-31)
An electric propulsion system/stage reliability computer code is under development. When completed, the code will allow propulsion system design optimization based upon failure mode analysis and mission reliability requirements. The assessed reliability of the various subsystems of an autonomous stage must meet the mission requirements. Use of the system code will provide sensitivity analysis and will provide information such as (1) where to put redundancy for highest payoff and (2) where the emphasis for increased reliability is needed. The development of the computer code will be accomplished with close coordination with the JPL Office of Quality Assurance and Reliability. This work will be fully documented for export to other NASA Centers.

W75-70538 180-06-51
Goddard Space Flight Center, Greenbelt, Md.
GENERALIZED ACOUSTICAL STUDY FOR PAYLOAD ENCLOSURES
D. J. Knighton 301-982-4258

Increasing sensitivity of space-vehicle payloads to increased launch vehicle engine generated and in flight acoustic fields has focused more attention on the noise reducing properties of payload enclosures. In some cases the optimization of structural enclosures for aerodynamic, weight and structural constraints have lowered the acoustic insulation characteristics of the enclosure and thereby increased the acoustic levels incident on the payloads. To further complicate the problem the analytical prediction methods used today do not correlate well with actual acoustical test and flight measurements. The purpose of this study is to develop a generalized acoustical prediction technique which would result in design guidelines and monographs; thus, providing designers the analytical tools to more accurately determine payload acoustical environments. In formulating the analytical techniques the prodigious quantity of acoustical test and flight data acquired under the Delta, Saturn, and Titan Programs on payload shrouds will be utilized. The structures tested included aluminum integral machined skin, aluminum semi-monocoque skin-frame and stringer and fiberglass fabrication methods. Available acoustical test data on aluminum honeycomb panels will also be used. In addition, the effects of a gaseous---

W75-70539  180-06-52
Langley Research Center, Langley Station, Va.
LAUNCH VEHICLE CONCEPTS AND ANALYSIS
E. S. Love 804-827-2893

The following programs will be accomplished: (1) to determine the feasibility of using launch vehicles of the Scout class to perform earth escape missions. These missions shall include probes, solar and planetary (both in the ecliptic and out-of-ecliptic planes), and planetary transfer orbits. Further, a simple means will be identified, to the extent possible, to enhance the capability of the launch vehicle to perform these missions. (2) To extend the successful design principles, experience, and operations technology of the Scout booster system by modifications which will enhance its current stability and cost effectiveness. The broad study will evaluate configurations, changes in terms of performance, cost, and scheduled phase-in with the present systems. (3) To provide a trajectory analysis tool enabling a more rapid and realistic determination of the actual rocket motor performance. Any off-nominal system performance or system constants will also be revealed. This will be of special value in evaluating new configurations. (4) To compare measured bending moments of the Scout vehicle during flight with moments calculated based on measured inflight input parameters.

W75-70540  180-06-60
National Aeronautics and Space Administration, Washington, D.C.
LAUNCH VEHICLE PLANNING STUDIES
B. C. Lam 202-755-3726

The objective of this task is to provide the studies and analyses required for OSS Launch Vehicle and Propulsion Programs planning and OSS level space program planning. Individual tasks are formulated and assigned by the Office of Space Science or by launch vehicle and propulsion programs. The contractor conducts studies and analyses (OSS planning studies, economic analyses, trade-off studies, investigations in areas of launch vehicle technology, etc.) that provide a base of technical information that can be drawn upon in the formulation of program recommendations.

W75-70541  180-17-50
Marshall Space Flight Center, Huntsville, Ala.
SYSTEM PERFORMANCE AND TECHNOLOGY ASSESSMENT FOR UNMANNED MISSIONS
G. Wittenstein 205-453-0359

Methods and computer programs, developed under NAS12-550 and updated and tested under NAS8-26491, allow the definition of systems parameters for planned OSS missions. These parameters include data needed to identify astrionics/astronics subsystems and hardware requirements. The sensitivities of these requirements to mission and systems changes or modifications will be included. The methods and computer programs allow one to enter technical data of known applicable aerospace or commercial subsystems. The output will be a comparison of requirements for specific OSS missions with available subsystems. This comparison will aid NASA Management to take advantage of subsystems already developed or being developed for other programs and to identify new technology needed where applicable subsystems are not available.

W75-70542  180-17-50
Langley Research Center, Langley Station, Va.
ASTRONICS SYSTEMS EVALUATION
E. S. Love 804-827-2893

A feasibility study will be conducted to define a guidance and control system concept for application to a spin-stabilized final stage of a launch vehicle, based on tradeoff studies, stability and control analyses, guidance and trajectory error evaluations, and a preliminary design utilizing the concept selected. Tradeoff studies will emphasize versatility of use in satisfying varied mission requirements, capability for improving vehicle overall performance accuracy, and minimal impact on vehicle interface changes, system weight, and cost of implementation. Also, a survey of industry and government agencies will be conducted to determine the availability of state-of-the-art guidance packages (miniaturized gimbal or strapdown, conventional gyros or laser gyro) which could be utilized in launch vehicles. Evaluation points will be weight, volume, cost, ease of maintenance, reliability, and accuracy. A detailed systems analysis shall be performed using the results of the above feasibility study. Detailed system specifications and requirements shall be prepared.

W75-70543  180-17-53
Marshall Space Flight Center, Huntsville, Ala.
DYNAMIC TESTS OF INERTIAL SENSORS
B. J. Gaines 205-453-0795

The objective is to determine the performance quality of inertial sensors designed for astrionics' application. The approach followed is: (1) to determine the suitability of existing methods and equipment for dynamic tests of inertial sensors developed as experimental prototypes for astrionics' applications, (2) to develop the necessary test data reduction methods, (3) evaluate the sensor coefficients of designated error models for astrionics' systems, with and without any error compensation equipment, (4) conduct performance tests with the inertial sensors combined into an astrionics sensor package, and (5) analytical studies will be performed as required to develop specifications for inertial measuring units.

W75-70544  180-17-54
Marshall Space Flight Center, Huntsville, Ala.
GUIDANCE COMPUTER TECHNOLOGY
J. B. White 205-453-4129

The coming decade of vigorous space activity by NASA and other organizations will require an increasingly reliable launch vehicle family. This includes the development of technology to provide flexible and reliable computation for future space missions. High performance data processing configurations with useful lifetimes up to five years for long duration earth orbital and planetary missions are being emphasized. Digital logic, circuits, packaging techniques, and computer configurations are being developed to meet the reliability and environmental constraints of these advanced missions. Emphasis is being given to continuation of research in modular computer configurations. Existing software is being refined and expanded and new software developed in the areas of failure detection, switching control, and recovery. The culmination of these developments and evaluations will result in the fabrication of a breadboard modular computer system which demonstrates and verifies the objectives, approach, and architecture of a long life fault tolerant computational systems.

W75-70545  180-17-55
Marshall Space Flight Center, Huntsville, Ala.
CONTAMINATION CONTROL IN HYBRID MICROELECTRONIC MODULES
Salvatore V. Caruso 205-453-1505 (502-23-51)
The objective of this effort is to develop, test, and evaluate coating materials, processes, and process controls for protection of spacecraft modules from contamination. The materials selected and tested shall be for the purpose of passivation and particle immobilization in hybrid packages. Investigations will be performed to select and test contamination coating materials and processes for applications in particulate contamination control. The materials shall be selected from the general chemical categories such as high purity silicones, resins, polyimide, etc. The materials selected by the current investigations will be thoroughly tested and screened on operating microcircuits. Processes will be developed for coating microcircuits and additional programs performed to determine long-life investigations will be thoroughly tested and screened on operating microcircuits. Processes will be developed for coating microcircuits and additional programs performed to determine long-life reliability, compatibility and chemical and thermal stability of the materials. Investigations will be performed to determine the relationship of these process controls and materials on such key assembly techniques as package sealing, wire bonding, rework, testing, long-life reliability, etc. This activity would continue the investigation in order to provide a means of preventing particulate contamination in hybrid microcircuit package.

W75-70546 180-17-56
Marshall Space Flight Center, Huntsville, Ala.
SOLAR ELECTRIC PROPULSION STAGE (SEPS) TECHNOLOGY
J. P. Hethcoat 205-453-5584
This RTOP represents the total FY-75 SEP Stage SRT effort excluding the solar array which is being pursued under a related RTOP (180-17-57). Technology research to be performed under this project will support advanced SEP stage definition activities and the detail design and development of a SEP stage or an evolutionary design that is to evolve into a mature SEP stage. Advanced study and ongoing in-house activities have identified areas where technology research is deemed important. These areas were selected following consideration of technical, operational, and program requirements. Under this project detailed technology requirements for critical SEPS subsystems will be defined and analysis tools (software) will be developed for use in SEPS definition activities and to support the subsystem requirements definitions. In pursuit of these objectives our FY-75 program will continue investigation of critical subsystems and subsystem interactions and will continue software development, systems simulations, and high energy radiation effects analyses. Systems simulations will proceed toward the development of a simulator for detailed definition of control subsystem requirements. Tasks are to be initiated to develop the thermal control interactions between the SEPS solar array and power conditioning, determine the impact of potential surface coatings on the SEPS vehicle, and develop a mockup of the SEP stage.

W75-70547 180-17-57
Marshall Space Flight Center, Huntsville, Ala.
SOLAR ARRAY TECHNOLOGY FOR SOLAR ELECTRIC PROPULSION STAGE
L. E. Young 205-453-4566 (502-24-17)
The objective of this RTOP is to insure the availability and adequacy of technology to support the solar electric propulsion stage solar array. The approach is to perform a preliminary design in order to identify the solar array technology required by the solar electric propulsion system (SEPS). This technology will be compared with the state-of-the-art to identify areas where demonstration or further development of technology is needed. These areas will be worked as specific problems with results being fed back into the design effort. The availability of overall array technology will be demonstrated by fabricating and testing a full-scale wing.

W75-70548 180-24-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ENGINEERING INSTRUMENTATION
P. J. Meeks 213-354-2546
It is the objective of this applied research program to (1) develop and demonstrate comprehensive nondestructive test (NDT) techniques for electroexplosive devices (EED's), (2) develop designs and techniques to reduce or eliminate the electrostatic hazards to EED's, and (3) to develop an EED simulator which can be used repetitively to measure pyrotechnic system susceptibility to incorrect explosive loading by building devices with known fault types and then testing them with use of the thermal coupling technique. Each fault type or failure mode will have its own unique signature or profile. This effort will result in a complete characterization of EED faults, previously undetectable by any NDT method, versus signal output obtained by the thermal coupling technique. It is planned also to design and fabricate a prototype set of instrumentation to automate the transient pulse test technique. This system will include data measurement, storage, calculation, and recording capabilities. Second, with regard to (2), the application of miniature nonlinear shunts to EED's appears to be an excellent means to reduce the hazard of premature actuation caused by electrostatic discharge. It is planned presently to conduct a two-pronged approach namely: (1) to design the shunt as a component within the electrode portion of the device apart from the pyrotechnic, and secondly, to include the shunt materials within the--
the Scout vehicle, and identify those areas where the design and/or process controls are inadequate. A development program will be conducted to determine the selection of an improved material to replace graphite materials currently used for nozzle throat inserts on solid propellant motors. A program will identify the critical design parameters that affect the reliability of pyrotechnic systems so that low cost, simple, and reliable systems can be used. An investigation shall determine what materials and designs are necessary for solid rocket motors, including those used in new high energy propellant programs. Studies and demonstrations of high energy propellants in existing solid rocket motor hardware shall be initiated.

W75-70552 180-32-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SOLID PROPULSION TECHNOLOGY
P. J. Meeks 213-354-2546
(506-21-32)

The first objective is to study future mission applications of solid propellant rocket motors, and to investigate technical problem areas arising from on-going project applications of such motors. A principal activity will be to provide solid propulsion technical support to the Scout Project Office. The support will include: (1) consulting services, (2) critiques of contractor supplied documents, (3) aid in solving solid rocket motor problems, or verify contractor efforts, and (5) assistance in the definition and technical management of programs relative to providing thrust termination capability to the Scout system. The second objective is to develop an analytical technique that can be employed effectively in the prediction of the limit to which a solid rocket motor can be tested without experiencing failure. Through contractor and in-house efforts an analytical method will be developed to predict the failure modes, and the limits at which failures will occur when a motor is subjected, singly and in combination, to: (1) temperature cycling, (2) vibration, (3) acceleration, and (4) shock. Several surplus motors will be acquired, analyzed by the failure prediction technique, and tested to verify the adequacy of the prediction technique.

W75-70553 180-59-01
Goddard Space Flight Center, Greenbelt, Md.
INTEGRAL VARIABLE THRUSTING SEPARATION JOINT
D. J. Knighton 301-982-4258

The present thrusting joint designs are limited to a maximum of 160 F environment. This qualification test limitation is based on a thermally insulated joint temperature reaching a maximum of 140 F during the Delta launch vehicle flight. Available data, however, indicates that the separation system may be able to operate efficiently up to approximately 200 F. To prove this several tests are planned utilizing the test fixture already developed under this RTOP during Fiscal Year 1974. Successful test results would permit the variable thrusting separation system (currently being developed under this RTOP) to require less external insulation and/or to be incorporated in future higher thermal input launch vehicle missions. Data obtained from these temperature tests has potential application to Delta, shuttle and/or space tug and Titan launch vehicle Programs.

W75-70554 180-72-50
Langley Research Center, Langley Station, Va.
ATMOSPHERIC EFFECTS RESULTING FROM EFFLUENTS PRODUCED DURING NASA UNMANNED ROCKET LAUNCHES
E. S. Love 804-827-2893
(502-24-88)

The objectives of this research are to examine the effluent from NASA unmanned launch operations which may alter the environment and to conduct a program to assess the possible impact of these operations on the environment. The type and amount of effluents from launch operations will be determined from studies of the launch systems. Analytical models are being developed and applied by the Marshall Space Flight Center to describe increases in concentration and dispersion of launch vehicle effluents. Measurements of the concentration and dispersion of effluents from selected launches will be made by

the Langley Research Center. The analytical predictions and the experimental measurements will be used jointly to assess the effects of NASA unmanned launch operations on the environment.

The primary environmental effects that will be determined are: (1) the spatial and temporal distribution of toxic materials in the vicinity of the launch site resulting from NASA unmanned launch operations; (2) possible adverse effects of exhaust effluents on vegetation and man in the vicinity of the launch sites, by studying the environmental effects of the effluents; and (3) the type and amount of material deposited in the troposphere during launch operations. This study is being coordinated with other related studies on the environmental impact of exhaust effluents through the NASA Panel on Shuttle Exhaust, OAST Shuttle Technologies Office. This work is also being coordinated with related DOD studies. Previously developed measuring techniques and hardware will be used whenever practical.

Planetary Exploration SR&T - Science

W75-70555 185-47-51
Goddard Space Flight Center, Greenbelt, Md.
ABSOLUTE PRESSURE, ATOMIC OXYGEN, AND ENERGETIC BEAM CALIBRATION FOR MASS SPECTROMETERS
H. B. Niemann 301-982-4706

The objective of this work is to refine laboratory techniques and construct test facilities for testing and calibration of instruments to measure the neutral particle composition and temperature of the planetary atmospheres. The large pressure range over which the instruments are required to operate and the different chemical properties of the various atmospheric constituents make it necessary to build several separate systems each with a limited range and flexibility which together satisfy the test requirements. A pressure calibration system has been constructed for mass spectrometer calibration with non-reactive gases, i.e., N2, O2, CO2, H2, He, Ar, etc., in the pressure range from 10 to the minus 3rd power to 10 to the minus 10th power torr. Liquid helium cryogenic pumps and sputter ion pumps are used to provide efficient pumping to low pressures without hydrocarbon contamination. High speed computer compatible data recording is planned to improve measurement accuracy and data handling efficiency. Particle beam systems of chemically active species, i.e., O,N,H, are developed for mass spectrometer calibration, and gas surface interaction studies. Atomic oxygen and hydrogen are produced by thermal dissociation on heated tungsten surfaces with kinetic beam energies of approximately 0.2 eV. To simulate satellite environments, a sputter beam system is developed with the intent to produce atomic beams of nitrogen and oxygen with average kinetic energies of 10 eV. Static high pressure and temperature test facilities are designed to test mass spectrometer components and sample inlet systems. Conditions expected to be found in the lower atmospheres of Venus and the outer planets will be simulated.

W75-70556 185-47-52
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENT DEVELOPMENT FOR NEUTRAL GAS COMPOSITION MEASUREMENT IN PLANETARY ATMOSPHERES
H. B. Niemann 301-982-4706

This research plan is concerned with the overall improvement of neutral gas composition measurements planned for the atmospheres of the planets and comets. In general, improvements are sought in two basic areas, (1) sensor concept and application, and (2) optimization of basic instrument parameters in anticipation of restrictive mission constraints. In the first area, sensor development will be directed toward (1) the improvement of ambient gas sampling techniques for high velocity probes into high density atmospheres (e.g., Saturn or Uranus entry probes), (2) the design of more efficient ion sources of both the open type which provides ion focusing, and the closed type which increases the thermalization of the gas being measured, and (3) development of a neutral particle retarding potential.
The purpose of this RTOP is to support instrument development for optimizing the direct measurement techniques used in the detection of ambient thermal ion composition and concentration from planetary probes, orbiters, and cometary probes. The desirability for optimizing the Bennett RF ion mass spectrometer measurement technique is brought about by the mission constraints anticipated for flight opportunities such as the Pioneer-Venus Probe and cometary wake exploration, both of which demand a maximum degree of automatic inflight adaptability in response to limitations such as low telemetry rate, power, and weight. Realization of these objectives in the midst of a constantly evolving technological development in turn requires a continuing evolution of instrument concepts. To realize this objective, improvements in the Bennett spectrometer instrument are planned in the areas of (1) step-dwell ion peak detection, replacing a continually scanning spectral sweep and (2) implementation of a servo system for automatically adapting the accelerating voltage and retarding potential to optimized values for the detection of resonant ions in the spectrometer sensor. These tasks involve electrical design enhancements, emphasizing a controlled and reliable extension of present technology. It is planned that these improvements will be evaluated as part of an earth flight test program involving cooperative participation as a piggyback instrument on a forthcoming Javelin rocket payload.

The objectives of this program are to measure the optical and chemical properties of atoms and molecules which are important in understanding the composition of planetary atmospheres and comets. Emphasis is placed on those problems which are of immediate concern for interpreting the results of rocket and satellite observations. In these investigations the well-known techniques of optical spectroscopy and of photochemistry are applied under well-defined experimental conditions. Sophisticated techniques have been developed for data reduction and for handling the small signal levels which are usually encountered.

Measurements on phodissociative excitation of CO2 have been extended to include cross sections for producing CO(3p), CO(1+) (A2Pi), and CO2(1)+ (3Sigma u) and a function of incident photon energy. Excitation cross section for electron impact on CO, NH3, and CO2 have been measured for the spectral feature which lie between 1100 and 2000A. The electron excitation apparatus was modified and results have been obtained for electron impact on N2 and O2 to produce emission in the EUV (lambda < 1050A). A series of sounding rocket observations of the aurora in the EUV are planned which will complement the laboratory measurements in the EUV. An experiment has been set up at the University of Maryland, in collaboration with Dr. M.A. Coplan, which has measured cross sections for producing ions in excited electronic states via charge exchange of He+ with CO2 and CO. The flash photoisolation-resonance fluorescence apparatus is now equipped with a---
under controlled laboratory conditions. The recombination of CO and O to produce CO2 will be investigated under conditions simulating the CO2-rich atmospheres of Mars and Venus. Similar studies for the reaction CO + OH will be undertaken. The recombination process in the presence of O or S will be considered to assess the effectiveness of these species in catalyzing the reaction. This study is relevant to the CO2 photochemistry on Venus. The ultraviolet photolysis of CH4, NH3, and H2 will be investigated and the fluorescence emission cross sections determined. These studies will contribute to our understanding of the photochemistry of reduced atmospheres (e.g. Jupiter) and will provide scientific support for future Jupiter missions.

W75-70563 185-47-67
Ames Research Center, Moffett Field, Calif.
STRUCTURE OF PLANETARY ATMOSPHERES
Dean R. Chapman 415-965-5065
(185-47-66; 384-47-68)

The basic goal is to connect atmospheric observations with theory. Immediate objectives are to determine: (1) structure of the ionospheres of Venus, Mars, Jupiter and the moons of Jupiter and Saturn, (2) interactions of planetary ionospheres with the solar wind; (3) dynamics of the Venus atmosphere; (4) atmospheric structure of Jovian planets and Titan, and (5) mean particle sizes and optical depth of Saturn's rings. The abundances and distribution of ions and electrons and minor constituents on Mars and Venus are being studied theoretically, using data from observations and laboratory measurements. In each case this work involves numerical solution of appropriate conservation equations; for example, we solve the complete set of coupled mass, momentum and energy conservation equations in the case of the upper ionosphere of Venus. Thermal structure models have been constructed to understand the operation of the greenhouse effect on Titan. In order to understand the dynamics of Venus' atmosphere, calculations are being carried out to examine the effects of rotation, apparent solar motion, and the energy deposition profile on the circulation of the atmosphere. Estimates of the particulates in the rings of Saturn are obtained from analysis of observed near IR and microwave spectra measurements.

W75-70564 185-47-68
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERES - STRUCTURE AND COMPOSITION
Alvin Seiff 415-965-5685
(185-47-67)

The ongoing OSS program to explore the planets includes two missions, Viking and Pioneer Venus, on which properties of the planetary atmospheres will be measured during entry and descent to the surface by instruments carried by the probes. These experiments have grown out of research supported by this RTOP. The continuing studies will optimize the approach and maximize the return related to atmosphere structure from the Viking Entry Science experiment, and will further develop the capabilities of the Pioneer Venus experiment. A major thrust of this work recently has been the relationship of measured parameters to the winds at the entry sites and the overall circulation of the planets' atmospheres (not an area of emphasis in the early work). The further development of wind observational techniques will require continuing effort. (It is the writer’s opinion that the Russian failures to put a surviving probe onto the surface of Mars is quite possibly associated with wind-connected phenomena). In addition, work will be devoted to studies of atmosphere structure and composition experiments for future missions to Saturn, Uranus, and Jupiter.

W75-70565 185-47-69
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERES EXPERIMENT DEVELOPMENT
Dean R. Chapman 415-965-5065

The objective of this program is to establish the feasibility of experimentally identifying the composition of planetary atmospheres by utilizing the spectral signature of atmospheric components as measured with attenuated total reflection techniques (ATR) on atmospheric probes. The ATR techniques should be especially effective for monitoring the proposed organic and inorganic constituents of the atmospheres of Jupiter and Venus without the necessity of sample ingestion or erection of experimental components external to an atmospheric probe. The ATR technique will be based on the spectral characteristics of thin films of typical proposed constituents condensed onto the outside of simulated windows of an atmospheric probe. Commercially available apparatus will be employed to obtain the pertinent signatures, applying minor hardware modifications necessary for the particular requirements of the pertinent atmospheric constituents. The possibility of identifying several constituents from a layer of one constituent deposited on a sub-layer of another constituent, as well as single layers of mixtures of two or more constituents, will be investigated. Based on the results of the measurements, consideration will be given to the feasibility of incorporating a typical ATR apparatus into space experiment by considering component development requirements.

W75-70566 185-47-71
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ATMOSPHERIC EXPERIMENT DEVELOPMENT
D. P. Burcham 213-354-3028
(185-47-72)

This work defines, develops and evaluates new or improved remote sensing experiments for the exploration and study of the atmospheres of solar system bodies from spacecraft. The approach is through research in four broad categories: (1) the practical application of developments in radiative transfer theory to the problems of remote sensing of atmospheric structure, (2) methods for the inversion and interpretation of radiometric and spectroscopic measurements of atmospheric radiation, (3) experimental and theoretical studies of the spectral properties of atmospheric gases and possible cloud constituents at wavelengths of importance for remote sensing experiments, and (4) feasibility of obtaining specific scientific goals, with state of the art instrumentation and within a framework of spacecraft and mission constraints. Instruments and techniques are developed via detailed numerical studies and error analyses, and laboratory, ground based or airborne experiments as appropriate. The development of realistic atmospheric models as focal points for studies is an important subactivity. Major efforts for FY-75 are centered on: (1) exploratory remote sensing experiments for Uranus and Titan, (2) measurement of parent molecule distributions in cometary comas from spacecraft, (3) experimental evaluations of the dual frequency-dual field of view and zenith scanning approached to remote sensing of cloudy atmospheres, and (4) development of further improved model atmospheres for Venus and Jupiter by analysis of new earth-based spectra (including our anticipated high-resolution mid-infrared C141 observations) and Mariner 10/Pioneer 10 data.

W75-70567 185-47-72
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THEORETICAL STUDIES - PLANETARY ATMOSPHERES
D. P. Burcham 213-354-3028

A broad program of applied and theoretical studies related to planetary atmospheres will be conducted, with the following primary objectives: (1) understanding the properties and determination of the parameters of planetary atmospheres, (2) application of laboratory experimental data to the understanding and interpretation of spectral features and photochemical processes and mechanisms for complex planetary atmospheres, (3) applying these findings toward design of ground based and spacecraft experiments, and (4) interpretation of above data as well as other observations to aid in the evolution of valid planetary atmospheric models. This program contributes to NASA planetary missions both in its direct research relevance to planetary atmospheric science and in the maintenance within JPL of a staff of specialists who may evaluate and define scientific objectives and experiments for planetary flight projects. The studies to be conducted in FY-75 pertain to planetary atmospheric modelling, photochemistry of planetary atmospheres, radiative transport theory, spectroscopic theory development and microwave spectral studies of planetary atmospheres.
optically-forbidden electronic transitions in molecules and atoms... 

also used to locate and identify (as to symmetry) the low-lying 

analogous collision processes which occur in planetary atmospheres 

superelastic scattering from radical, atomic species, and metastable 

molecular states which are of importance in planetary atmospheres are also studied (O, O2[a 1 Delta g]). The ion-cyclotron 

resonance spectrometer (ICR), High-pressure mass spectrometer (HPMS), and photoionization mass spectrometer (PIMS) facilities 

in the JPL Laboratory for the study of ionization processes will be used to examine the ion chemistry of the outer planets and 

and their satellites. The objective of this work is to apply unique 

and complementary laboratory instrumentation towards the dedicated study of ionic processes and chemical synthesis in atmospheres with reducing and near-solar compositions. The addition of the PIAMS and HPMS instruments to the ICR Laboratory considerably widens the scope of these studies and allows for a more general and comprehensive attack on chemical reactions 

in planetary atmospheres. Specific objectives for the coming year include: (1) completion of the study of second stage ionic 

chemical reactions in mixtures of H2, He, CH4, NH3, H2O and 

H2S, (2) completion of the HPMS and begin the study of three-body ion-molecule reactions in H2-H2-CH4 mixtures, (3) attempt to study the very slow bimolecular reaction He + H2, using both the ICR and HPMS, and (4) begin studies of the reaction of ions with H atoms. These latter two studies are extremely important for modeling of the Jovian ionosphere.

The objective of tasks supported under this RTOP is to develop 

the instrumentation capability required for spacecraft exploration and study of planetary atmospheres and cometary gases. New concepts will be sought and evaluated, and known techniques and instruments will be modified and developed for specialized application. Studies essential to understanding the response and behavior characteristics of sensors and instruments will be conducted. Emphasis is being placed on three areas of development: (1) specialized sensors and instruments required for investigation of the lower atmosphere and cloud phenomena of Venus and Jupiter by entry probes, (2) instrumentation and experiments required for investigations of the atmospheres of the outer planets from flyby and orbiter spacecraft, and (3) design of experiments and instruments for in situ investigation of comets. Entry probes enter the atmosphere at high speed creating problems in sampling for mass spectrometer usage. In addition, it is necessary to provide the ability to determine the composition of atmospheres of planets such as Venus and Jupiter at low altitudes where pressures are much higher than the regime in which flight mass spectrometers have been used to date. Investigation of new concepts and improvements in existing techniques of sample acquisition and handling are required to solve the problems imposed by the high speed and high pressure environment.

The objectives of this RTOP are to support a broad base program of laboratory investigations directed at obtaining data essential to the analysis of flight experiments and the development 

of new and improved theories and explanations of atmospheric chemical processes. Research included under this program includes 

investigations of chemical kinetics, photochemistry, reaction mechanisms, intermediates and metastable reaction species, 

collision processes and other phenomena connected with the interchange of energy between photons, atoms, ions, and 

collisions and the interaction of such species with electromagnetic radiation. Also included is research concerned with determining the physical and chemical properties of low molecular weight 

collisions and the interaction of such species with electromagnetic radiation. Also included is research concerned with determining the physical and chemical properties of low molecular weight 

molecules, free radicals, and other species stable at cryogenic temperatures that are likely to be present in comets or 

atmospheres of the outer planets. In order to obtain a better understanding of planetary atmospheres it is necessary to have a quantitative understanding of the many different chemical reactions occurring in atmospheres and the responses to various energy inputs. As a result of solar irradiation the various chemical species present in planetary atmospheres are photolysed into 

ionized, dissociated, and excited states. The extent to which this occurs is highly dependent on the pressure (altitude), the identity of neighboring constituents, and the wavelengths of the solar radiation.
W75-70573  
Langley Research Center, Langley Station, Va.

**PLANETARY ATMOSPHERIC PROCESSES AND MEASUREMENTS**

E. S. Love 804-827-2893

Properties and processes of the earth's upper atmosphere, as well as the atmospheres of other planets, will be studied using ground-based and satellite measurements, laboratory simulations, and theoretical studies. Earth aeronomical measurements employing various techniques are compared with drag measurements of the NASA Langley Air Density Explorer satellites to obtain a more comprehensive picture of our thermosphere and exosphere. The vertical distribution of ozone in our atmosphere is determined spectrophotometrically from ground-based measure-
ments of satellites passing into the earth's shadow. Photochemical models of ozone are formulated. A number of studies concerning atmospheric processes and measurements apply to other planetary atmospheres. Studies of the meteorology of Mars, Venus, and other planets are being employed to evaluate and improve instruments and measurement techniques on other planets. A unique molecular beam mass spectrometer system is being developed to study reactive and non-reactive gases in planetary atmospheres. Theoretical studies are being performed on the composition, density, temperature, and evolution of the thermospheres and exospheres of Mars, Venus, and other planets and planetary satellites. Improved techniques are being developed to analyze radio tracking data, solar occultation data, and other data types to determine characteristics of planetary atmospheres. Design studies and formulation of design criteria for possible instruments, measurement techniques, and spacecraft to further our understanding of planetary atmospheric processes will be continued.

W75-70574  
Langley Research Center, Langley Station, Va.

**REMOTE DETECTION OF SURFACE PROPERTIES OF PLANETS**

E. S. Love 804-827-2893

The objective of this research is the determination of planetary surface properties (e.g., particle sizes, phase functions, interparticle separations, albedo, dielectric constants, and surface roughness) from analyses of the characteristics of radar signals and solar radiation that have been reflected from planets and are detected by planetary orbiters or earth-based instruments. The research is divided into three parts as follows: (1) a theoretical part that includes rigorous derivations of photometric functions that describe reflected radiation in terms of scattering geometries and surface properties, quantitative treatments of polarization phenomena, studies of the photometric effects of rough topographies, and the development of a comprehensive mathematical formalism for accurately interpreting radar-backscattered data from small planetary areas; (2) an experimental part that includes brightness measurements of laboratory soil samples for the purpose of verifying, refining, and supplementing the theoretical formulation; (3) an applications part that includes the interpretation (by means of the theoretical expressions) of existing and future photometric, polarimetric, and radar data on Mars and possibly other planets.

W75-70575  
Ames Research Center, Moffett Field, Calif.

**PLANETOLOGY: GEOMORPHOLOGY AND SURFACE PROCESSES OF PLANETARY BODIES**

D. R. Chapman 415-965-5065
(383-21-02; 384-50-60)

Objectives are to: (1) study the relative expressions of the impact processes on the production of surface features of inner planets and their satellites, (2) study volcanic regions in the United States to determine the origin, structure and geomorphology of analog basaltic features, (3) determine parameters governing eolian processes in the Martian environment and use this information to perform wind tunnel experiments, and (4) study the special distribution of craters on Mars to test the hypothesis that tidal fission of incoming bodies may produce crater clusters. The approach involves efforts to: (1) derive estimates of the flux of meteorite masses at the orbit of Mercury and compare cratering histories of Mercury, Mars and the Moon, (2) relate morphology of surface features to petrology and structure of basaltic units of the Snake River Plains, (3) construct a new wind tunnel and carry out experiments at Martian pressures to obtain data for interpretation of Martian eolian processes and to determine aerodynamic flow fields around topographic features, and (4) determine circularity and nonrandom distribution of Martian impact craters to test the tidal fission hypothesis.

W75-70576  
Ames Research Center, Moffett Field, Calif.

**PLANETARY STUDIES**

Dean R. Chapman 415-965-5065

The objectives are to obtain a better understanding of selected problems pertaining to planetary surface phenomena, the composition, structure and evolution of planetary bodies and their satellites, and to understand the origin of the solar system by means of theoretical investigations employing the results of spacecraft and ground based experiments. Theoretical knowledge, physical insight and mathematical modeling techniques are used, together with astronomical and geological data, to construct self-consistent mathematical descriptions of planetary processes and structure. Analysis and interpretation of the results of these models are applied to such topics as: the evolution of Jupiter, wind-blown surface features on Mars, and the calculation of conditions within the early solar system.

W75-70577  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**PLANETOLOGY STUDIES**

D. P. Burcham 213-354-3028
(185-50-73)

The subject of this research is the study of the present occurrence of volatiles in planetary atmospheres, on surfaces of planetary objects, and in meteorites. The objective is to decipher the history of the volatile component of solar system material in terms of: (1) the manner of its initial incorporation into solid solar system material and planetary objects, (2) the mechanism of its release from the interiors of these objects and (3) the subsequent chemical evolution of volatiles condensed on planetary surfaces, or in planetary cometary atmospheres, chemically recombined in regolith material, or present in the gas phase of planetary atmospheres. Current and proposed experimental work includes: (1) ion-counting mass spectrometric analyses of rare gases in appropriate terrestrial rocks and meteorites, (2) experimental studies pertaining to the adsorptive equilibrium on Mars between CO2 and H2O in the atmosphere and regolith, including the effects of variable insolation on atmosphere/regolith exchange, (3) differential scanning calorimetric analyses and simultaneous evolved gas analyses of candidate Martian surface materials and carbonaceous chondritic meteorites, and (4) measurement of the refractive indices of solid CH4 and NH3 as a function of wavelength in the near infrared region of the spectrum.

W75-70578  
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**PLANETOLOGY INSTRUMENT DEVELOPMENT**

D. P. Burcham 213-354-3028
(185-50-73)

The goal of this work is the development of six spacecraft-borne instruments which should be particularly effective in the study of planetary surfaces. Extension beyond present capability for the exploration of Mars is the principal objective in each case, and these specific experiments were selected on their potential for shedding new light on significant questions regarding that planet. However, there also exist potentially important applications for these instruments on other planetary missions. The six instruments are: X-ray diffractometer/spectrometer, differential scanning calorimeter, linear array camera using CCD sensors, radar sounder for Mars stratigraphy, orbiting gamma-ray spectrometer, and alpha/X-ray analyzer using solid state detectors. A complimentary camera development activity to the linear array camera described herein is covered in an Advanced Technical Development (Code 186) RTOP; sensor development is being supported by an OAST task. The alpha/X-ray analyzer task is in
Planetary Geoscience Studies is a program encompassing geology, geochemistry, geophysics, and soil physics which has the broad objective of understanding the genesis, distribution, composition and inter-relationships of the condensed matter in planets, their satellites, comets, asteroids, and other solid materials in the solar systems. The geology of the planets bears directly on three basic aims of lunar and planetary exploration: determination of the origin and evolution of the solar system, determination of the origin and evolution of life, and clarification of the nature of the processes shaping man's terrestrial environment (National Academy of Sciences, 1966). In order to meet these objectives, it is necessary to perform theoretical analysis, instrument development and spacecraft experiments that lead to understanding the nature and properties of the surface, regolith, crust, and core. This knowledge will lead to an understanding of individual planets, the origin of the solar system, planetary physical and chemical properties interactions between the atmosphere and lithosphere interactions of the flux of interplanetary particles and fields with planetary bodies, and will also aid in the discovery and understanding of the origin of extraterrestrial life. One important result of geological exploration of the planets will be increased knowledge of the earth. Very little is known of the first 2 billion years of the earth's history. Mars, Mercury, and the Moon on the other hand have no oceans, and the erosive effects of water are, therefore, virtually absent.

**Planetary Exploration SR&T - Advanced Technological Development**

**W75-70579** 185-50-81
National Aeronautics and Space Administration, Washington, D.C.

**PLANETARY GEOSCIENCE STUDIES**
S. E. Dwornik 202-755-3645

The objectives of this RTOP and OAST RTOP 506-20-22 are to jointly develop microwave radio transponder techniques, components, and subsystem technology required for NASA planetary missions in the period 1977 to 1982. Particular emphasis will be placed on substantially reducing the cost of transponders, while improving performance capability, reliability, and lifetime and reducing size, weight, volume, and power consumption. By the end of FY-74 the technology readiness of the S/X-band multimission transponder in a discrete component-printed circuit board miniature version appropriate for flight missions beginning in 1977 will have been demonstrated. This version has the following advantages over the Viking Orbiter Design: an order of magnitude improvement in differential phase and group delay stability; and reductions of 35% in per unit cost; 80% in power consumption; 72% in volume; and 64% in weight. Key future targets are: (1) in FY-75, demonstrate an order of magnitude improvement in transponder turnaround phase delay stability (through the use of quartz surface wave filters); and (2) by the end of FY-76 demonstrate the technology readiness of the transponder in a micromin version (beam-ledged parts on ceramic substrates) for flight missions beginning in 1979 which has the following advantages relative to the discrete component version: a doubling of mission life potential (adequate for 10-year missions without additional redundancy); and reductions of 56% in weight and volume.

**W75-70582** 186-68-54
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**GUIDANCE AND CONTROL TECHNOLOGY FOR PLANETARY MISSIONS**
R. R. McDonald 213-354-6186 (506-19-14)

The objective of this RTOP is to develop spacecraft guidance and control sensor technology which will be critically needed for the post-MJS missions. The development of a highly reliable, low weight and volume, long-lifetime image dissector tube to replace the currently-used unit will be completed. An accelerated life test in addition to functional and environmental testing will be used to flight qualify the newly designed image dissector tube. The currently used image dissector design has a reliable lifetime too short for usage on the long term missions planned beyond MJS-77. In addition, it is believed that the tube will not be available all after completion of the present VO-75/MJS flight procurement. The advanced image dissector initial development contract (with EMR-Photoelectric in Princeton, New Jersey) has now reached a successful conclusion. Image dissectors meeting the contract specifications in all important aspects have been delivered and full documentation packages have been submitted. This work will complete the development and flight qualify the new image dissector by thorough functional and environmental testing of three tubes, procured from EMR-Photoelectric with firm process and documentation control. Two tubes will be selected for accelerated life tests. Tube qualification will be completed in time to meet an FY-76 technology readiness date.

**W75-70583** 186-68-55
National Aeronautics and Space Administration, Washington, D.C.

**MARS ROVING VEHICLE**
Paul Tarver 202-963-4352

The primary objective of this program is to promote the capability for developing concepts, subsystems, and components for controlling the motion of unmanned planetary surface roving vehicles. The program is a long-term research and advanced development effort and will include analyses, simulations and hardware development for Mars roving vehicle mission. The effort during the next year, will support research contracts at Cornell University and Rensselaer Polytechnic Institute. The benefits derived from these contracts are twofold. First, the results are useful in maintaining and improving the capability of NASA to develop an unmanned roving vehicle for planetary exploration. And second, the student participants are confronted with a practical engineering problem during their course of study. This significantly increases the student’s ability to cope with engineering problems upon his graduation.

**W75-70584** 186-68-55
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**G AND C TECHNOLOGY FOR MARS ROVING VEHICLES**
R. R. McDonald 213-354-6186

The work proposed under this RTOP will provide technical
The objective of this effort is to define and optimize a system and subsystems based on the selected technologies and design concepts and to perform the conceptual design for the spacecraft system required for the proposed Pioneer Venus missions. The approach will take the existing studies as a baseline and perform additional system analysis and tradeoff studies in all spacecraft/probe areas for the purpose of defining the optimum choice for each subsystem and system required to support the mission objectives. The spacecraft and probe areas to be studied include: the definition of the total probe and spacecraft subsystem aerodynamics studies, probe acceleration test studies, low bit rate modulation and coding studies, stable oscillator and transponder designs, communication propagation effects of Venus atmosphere, detail design of critical structural subsystems, mission analysis, and maneuver and navigation studies. The results of these studies will be used to conceptually design the spacecraft systems for the Pioneer Venus Multiprobe and Orbiter Missions.

W75-70586 186-68-61
National Aeronautics and Space Administration, Washington, D.C.
LONG RANGE PLANNING STUDIES FOR SOLAR SYSTEM EXPLORATION
Paul Tarver 202-755-3770

The objective of this effort is to obtain scientific and technical data and to evaluate or develop methodologies that will aid in planning for planetary advanced missions and advanced technology. Mission studies to be conducted will typically cover science objectives, trajectory/payload/launch vehicle analyses and representative spacecraft characteristics and technology requirements. For FY-1975, planned studies are: (1) Titan mission study data base, (2) shuttle impact mission planning, (3) Jupiter orbiter lifetime study, (4) cost estimation research, (5) planetary missions handbook, (6) advanced planning activity. Individual study reports and an annual report will be issued; with interim reports or presentations as appropriate.

W75-70587 186-68-62
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
PROPELLANT COMPATIBILITY WITH MATERIALS FOR LONG DURATION MISSIONS
R. R. McDonald 213-354-6186

The objective of this work is to provide the technology for propellant/material compatibility that will be used on future outer planetary missions. Current objectives include work to determine which materials are acceptably inert for use in the construction of propulsion subsystem components in contact with earth storable liquid propellants for long duration missions. The test program involves continuing actual specimen storage tests in a controlled environment using the compatibility test facility at the JPL Edwards Test Station. Detailed chemical and physical analyses of specimens and propellants will be performed after specific storage periods and a rating assigned for design purposes.

W75-70588 186-68-63
Ames Research Center, Moffett Field, Calif.
PIONEER VENUS SCIENTIFIC INSTRUMENT DEVELOPMENT
J. V. Foster 415-965-5083

The objective of this effort is the development of scientific instruments and theoretical investigations for the Pioneer Venus 1978 Multiprobe and Orbiter missions. The approach to be taken is to conduct vital instrument technology studies, to initiate advanced development of certain instruments requiring long lead planning and feasibility studies to assure readiness to meet program integration and launch schedules, and to initiate conceptual design and interface definition of all instruments selected for development, in support of the system definition design studies.

W75-70589 186-68-65
Ames Research Center, Moffett Field, Calif.
PIONEER FOLLOW-ON MISSION TECHNOLOGY
J. V. Foster 415-965-5083
(186-68-63)

The objective is to develop basic spacecraft and probe configurations, using existing technology, as close as possible to Pioneer F/G, PAET, and Pioneer Venus configurations, respectively, consistent with specific mission requirements. This will provide the basis for the realistic estimates of performance, costs, reliability, and scheduling so vital to project definition and decision making. This can only be accomplished by understanding the required technology, subsystems, and the respective interfaces. Program costs are determined by the ability to define realistic system and subsystem requirements. The approach is to concentrate on the most critical areas first; understand the technology requirements, evaluate alternatives, and investigate the most attractive but unproven concepts. Emphasis will be placed on obtaining experimental data. Evaluation and assessment of existing technology will have the highest priority. All efforts will be primarily hardware oriented and related to specific missions.

W75-70590 186-68-72
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SOLAR ELECTRIC PROPULSION ADVANCED SYSTEM TECHNOLOGY - MISSION AND SYSTEM ENGINEERING
R. R. McDonald 213-354-6186
(186-68-74; 502-24-10)

The broad objective of the Solar Electric Propulsion Advanced System Technology (SEP/AST) Project is to bring solar electric propulsion (SEP) and allied technologies to a state of development where they can be applied to a flight project with a reasonable understanding of related cost, schedule, performance and risk factors. Specific SEP/AST objectives are to: (a) establish mission and spacecraft design requirements, (b) demonstrate the satisfactory operation of a SEP thrust subsystem (TSS) (RTOP 502-24-10), (c) establish power management strategies (RTOP 502-24-10), (d) establish low thrust navigation technologies (RTOP 186-68-74), (e) develop SEP spacecraft attitude control technologies, (f) improve the physical model and ephemeris of the comet Encke. Since development of SEP technology is assigned to JPL, MSFC and LeRC working in mutually supportive roles, this RTOP provides for the necessary coordinative and integration activities as well as for efforts related to the specific objectives identified above. The approach to this effort will be to investigate initially the application of SEP to a comet Encke mission to be launched in December 1978. Using this initial mission and system design information as a baseline, the investigation will gradually be broadened to examine a complete set of planetary missions for which SEP appears attractive. Overlaid throughout this effort is a heavy coordination activity with MSFC to maximize compatibility between the JPL SEP module concept proposed for planetary program purposes and the MSFC SEP stage concept proposed for earth-orbiting and other applications.

W75-70591 186-68-73
Goddard Space Flight Center, Greenbelt, Md.
EPHEMERIDES AND RECOVERY ANALYSIS FOR COMETARY MISSION PLANNING
R. W. Farquhar 301-982-5063

The principal goals of this RTOP are to: (1) initiate cataloging of comet data for proposed target comets of interest for space probes in the 1980's. Particular emphasis will be given to the 1986 return of comet Halley; (2) improve existing ephemerides for target comets by updating orbit determinations with all relevant observations, and investigating alternative methods of mathematically modeling nongravitational perturbations; (3)
Physics and Astronomy - SR&T

conduct statistical error analysis of ephemerides for proposed target comets subsequent to comet Encke's 1980 apparition; and (4) verify and supplement statistical error analyses by utilizing real observations at past apparitions to compare observed and computed ephemerides. The rocket effect due to cometary outgassing introduces significant nongravitational perturbations of the motions of several target comets under consideration for future flyby missions. Appropriate mathematical modeling of these forces in the equations of motion will be determined for comets of interest. Recent observations will then be employed to update existing orbits and ephemerides. Analyses will then be undertaken to determine error ellipsoids for target comets at proposed spacecraft-comet intercept points. To facilitate future cometary mission studies, physical data, ephemerides and error analysis information will be cataloged and made available to all users.

W75-70592 188-68-74
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SOLAR ELECTRIC PROPULSION ADVANCED SYSTEM TECHNOLOGY - NAVIGATION
R. R. McDonald 213-354-6186 (186-68-72; 506-19-21; 508-22-31)

The overall objective of this effort is the development and verification of SEP navigation system technology to ensure flight project readiness. The substantial technology base established in prior years under OR&T support will continue to contribute to the AST objectives. The primary emphasis to date has been on software technology aiming at the development of boardroom software for each of the basic navigation functions: trajectory, orbit determination, and guidance. The boardroom software system will play a key role in the development and verification of a viable navigation system. It is both a prototype for flight software and a versatile analysis tool whereby the effect of spacecraft subsystem specifications, guidance strategies, data accuracies, measurement techniques, filter designs, error models, etc. on delivery accuracy may be evaluated and translated into navigation system requirements. The navigation technology will be paced by the desired application to an Encke slow flyby launching in 1978-79, but also will be largely applicable to a 1984 Encke rendezvous and other planetary missions. The navigation accuracy analyses, orbit determination and maneuver strategy development, and trade studies begun in FY-74 will be continued in FY-75. Software capabilities will be expanded to facilitate the analysis. Navigation requirements will be identified and supplied to the AST in a standardized document. Promising new measurement concepts and processing techniques such as adaptive filtering and the simultaneous interferometer tracking technique (SITI) will be investigated and evaluated with emphasis on the role of these techniques in the total navigation system.

W75-70593 188-36-55
Goddard Space Flight Center, Greenbelt, Md.
MAGNETODYNAMICS - NON THERMAL PLASMAS
K. W. Ogilvie 301-982-5904

The object of this research is to increase the knowledge and understanding of non-thermal plasmas occurring in nature, and also to improve the theoretical description of their properties. This requires a concomitant improvement in measurement techniques, and interpretation of appropriate space and laboratory experiments. The interpretation requires corresponding improvements in numerical techniques.

W75-70594 188-36-55
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
MAGNETODYNAMICS IN SPACE
D. P. Burcham

The vector helium magnetometer is being developed for use on missions to the outer solar system where extremely weak interplanetary or interstellar fields will be measured and where intense planetary fields may also be encountered. Scientists and engineers from JPL will carry out tests and experiments to establish the fundamental principles of the magnetometer operation and design. Improved components are developed, the design is changed to yield improved performance, and new modes of operation are investigated. Selected areas of current scientific interest (interplanetary discontinuities and shocks, spectral analysis of solar wind fluctuations, waves and density fluctuations in the magnetosheath, analytic models of the magnetosphere) are being investigated by a theoretical physicist. Theoretical models are developed and compared with available space data. Field and plasma data acquired with spacecraft are analyzed using sophisticated techniques such as cross spectral analysis. The scientific results are published and presented at meetings.

W75-70595 188-36-55
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTION
Dean R. Chapman 415-985-5065 (385-36-01)

The objective of the RTOP is to provide for investigation of techniques to improve space plasma and magnetic field measurements and to improve understanding of space plasma and magnetic field observations and their relation to the sun and the interstellar medium. Techniques to improve the lifetime, resolution, sensitivity, sampling rate, dynamic range and accuracy of space plasma experiments are studied. Means for improvement of measurement resolutions for the individual plasma parameters, the temperature, density, velocity vector and temperature anisotropy, and investigation of techniques for improvement of calibration procedures and calibration data analysis are included. Theoretical studies provide designs of plasma analyzers for testing in the laboratory. The number and the distribution of flux tubes, position and attitude of particle multipliers, suppression of secondary electrons, shapes for apertures, post-analyzer electric field requirements and optimum electric field configurations for both the energy to charge analyzer section and deflection plates for sampling a range of incident directions are covered. Laboratory sources of simulated space plasmas and calibration beams are prepared. Verification of instrument performance is accomplished using these sources. Computer controlled calibration of flight experiments is performed. The interaction of the moon with the solar wind is to be modeled for a better understanding of the magnetized solar wind and the lunar plasma environment. Theoretical studies of models of the solar plasma have been accomplished.

W75-70596 188-36-55
National Aeronautics and Space Administration, Washington, D.C.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
E. R. Schmerling 202-755-3685

Objectives are to: investigate the processes occurring in the magnetosphere of the earth and in interplanetary space through a study of energetic neutral and charged particles and their interactions with magnetic and electric fields. Areas of investigation include trapped and auroral particles, the magnetopause, geomagnetic tail and solar wind. Investigate ions were also made of the processes which result from the arrival of solar particles near the earth, and the consequences of variations in the incident flux. Instruments were developed for measuring neutral and charged particles from several tens of MeV to below 0.1 gamma to several oersted, electric fields, and VLF wave activity. Theories, needed to understand the magnetosphere, the auroras, the solar wind, the interplanetary regions, and the observed boundary effects, down to the plasmapause, were developed.

W75-70597 188-36-56
Langley Research Center, Langley Station, Va.
MAGNETOSPHERIC PHYSICS
E. S. Love 804-827-2893

The overall objective of this work is to accurately measure the constituent number density of the terrestrial thermosphere (100 to 300 km). The approach centers on the development of a unique molecular beam mass spectrometer system which
virtually eliminates gas-surface interactions and makes possible the accurate measurement of reactive gases such as atomic oxygen. The feasibility of this instrument design for measurement of reactive gases in the atmosphere has been demonstrated by theoretical and experimental work. This work has included design and tests of engineering models of the primary instrument components such as the ion source, mass separator, and ion collector system. Studies of vehicle requirements for flight measurements with this instrument have also been initiated and these preliminary studies indicate that all vehicle requirements can be met by using the third stage of the Scout vehicle or the second stage of a Delta vehicle with only modest modifications.

W75-70598 188-36-56
Goddard Space Flight Center, Greenbelt, Md.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
James P. Heppner 301-982-4797

The objectives are: (1) to conceive, design, develop and test new techniques for space measurements of electric fields, auroral particles, trapped particles, solar-interplanetary particles, plasma waves, wave-particle interactions, photon-particle interactions, plasma composition, ionospheric winds, electron density and atomic and molecular collision processes with particular emphasis on magnetospheric and ionospheric regions, and (2) to analyze problems and conduct theoretical studies in magnetodynamics, plasma physics, and atomic and molecular interactions. The approach includes detector and supporting electronics, design, laboratory and contractor fabrication and testing, and theoretical studies of field and particle phenomena and distributions in space. This effort is expected to produce: (1) flight instrumentation having the capability to make measurements that previously have not been possible, particularly in areas where there are significant gaps in our knowledge as a consequence of there being few or no measurements, (2) accurate models of fields in space which have both scientific and technological utility, (3) indices which describe the instantaneous degree of disturbance in the ionosphere and magnetosphere, (4) advances in the understanding of plasma instabilities, and (5) new techniques for studying the transport of ion and neutral particles in the ionosphere.

W75-70599 188-36-56
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS (AERONOMY)
Dean R. Chapman 415-965-5065 (185-47-67)

Attempts were made to investigate the physics of the earth’s topside ionosphere and plasmasphere and the coupling of these regions with the magnetosphere and solar wind. Theoretical studies of the thermal charged particle composition and temperatures are being performed. Computer programs are being coded based on the continuity, momentum and energy balance equations appropriate to these regions. Data from the Alouette, ISIS and other satellites will be used as boundary conditions. Special correlative studies are also being performed to investigate the global nature of certain anomalous features, e.g., the plasmasphere and ionospheric troughs. The results of these efforts are vital to the understanding of the earth’s charged particle environment, and have application to communications between terminals immersed in these media. The theory and techniques involved are applicable to the studies of atmospheres and ionospheres of other planets. Preliminary efforts are being initiated to investigate the charged particle environment of the Venus and Jupiter ionosphere.

W75-70600 188-36-56
National Aeronautics and Space Administration, Washington, D.C.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
E. R. Schmerling 202-755-3685 (188-36-57)

The objectives are to investigate the absorption of solar photons and particles in the earth’s upper atmosphere, investigate the processes by which the absorption products are dissipated, and investigate the effects which arise therefrom. Included are the collisional, photochemical, and electromagnetic interactions which are found in the upper atmosphere, the ionosphere and the inner magnetosphere. Instruments for the direct and indirect measurement of near-thermal plasmas, electric and magnetic fields were developed. Conducted investigations involved the development of cause-and-effect studies, together with the development of the appropriate theories were discussed. The region covered extends roughly from the lowest ionosphere the plasmasphere.

W75-70601 188-36-57
National Aeronautics and Space Administration, Washington, D.C.
MAGNETOSPHERIC PHYSICS - RADIO SCIENCE
E. R. Schmerling 202-755-3685 (188-36-56)

Objectives are to investigate the interplanetary medium, the environments of the earth, the moon the planets and the sun, as well as celestial mechanics and relativity, by the propagation or scattering of radio waves. Attempts were made to: (1) develop techniques for interpreting the refraction, scattering, polarization rotation, and phase shifting of radio signals occurring naturally or generated artificially in terms of physical properties of the intervening medium, (2) develop instruments for generating electromagnetic waves in space and measuring the effects of the medium, together with the appropriate theory, (3) model, in the laboratory, the plasma interactions and resonances observed in space, and (4) test the theories developed to explain them.

W75-70602 188-38-51
Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
J. F. Osantowski 301-982-5861

The objective of the program is to develop or improve critical technology items principally, but not exclusively, for solar physics research and to supply critical data required by scientists in designing and/or proposing advanced instrumentation for space or ground based observations. Specifically, the development of specialized optical components, the development or improvement of optical instrumentation, and the development or improvement of various techniques or instruments for support of solar observations is included. The approach used to accomplish this objective is by conducting an in-house, coordinated investigation, and contract experimental and theoretical studies in the following technology: (1) design, fabrication, and testing of glancing incidence optical systems for the 8A to 300A spectral region including the problems of increased energy throughput and scattering, (2) diffraction grating technology especially that related to the production of large gratings required for high resolution low light level ground based observations. Other technology areas will be included to support current programs or problem areas identified by the solar physics community. References for identifying key technology include NASA Document SP-213, ‘A Long Range Program in Space Astronomy’ and working group reports such as the Solar Physics Working Group Report.

W75-70603 188-38-51
National Aeronautics and Space Administration, Washington, D.C.
DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
Goetz K. Oertel 202-755-8490

The objective of the work under this RTOP is the development of experiments for space or laboratory application to solar physics research and the development of critical technology items which are needed for solar observations, or which can improve them significantly. Included are the following activities: (1) development of a device for the production of optical components for use in solar and astronomical telescopes, spectographs, etc., on the ground and in space; (2) development of techniques for improving the performance of optical instrumentation in space and on the ground: (3) development of techniques for accurate calibration of solar experiments in space and on the ground in parts of the spectrum where the available accuracy is insufficient for effective
use of data from space; (4) development of novel techniques for increasing the information value of present solar experiments; and (5) development of improved ground-based instrumentation for obtaining solar data in support of spaceflight solar experiments.

W75-70604 188-38-52
Marshall Space Flight Center, Huntsville, Ala.
GROUND-BASED OBSERVATION OF THE SUN
William C. Snoddy 205-453-3103
The real time solar magnetograph (RTSM), built jointly by the Naval Research Labs and MSFC, allows studies of small scale variations of the sun's magnetic field in order to determine their role in solar activity. The system uses a narrow band filter, polarizers, and a SEC vidicon TV system to measure the Zeeman effect in chromospheric absorption lines. An H-alpha brightness distribution analyzing system is being operated in support of the RTSM for active region and flare classification. In direct support of the real time solar magnetograph, a study is being undertaken with the objective to determine the basic phenomena involved in the eruption of solar flares by studying the interactions of the plasma and magnetic fields in the active regions and to analyze basic solar data such as magnetic field and the absorption line profiles and interpret them on the basis of these interactions. Calculated thermal X-ray and mm emissions from the flare volume as functions of various parameters will be compared with ground-based mm and Skylab/ATM X-ray data. The third part of this study is to observe and investigate millimeter emissions from the sun and mm observations of the corona before, during and after solar events and during the quiet sun and to correlate the results with EUV wavelength (OSO 7) on a systematic basis to determine the height and location of mm emission regions during solar activity.

W75-70605 188-38-52
Goddard Space Flight Center, Greenbelt, Md.
GROUND BASED OBSERVATIONS OF THE SUN
J. C. Brandt 301-982-4701
Daily operation of the Zeiss filtergraph previously used to obtain supporting observations for the GSFC OSO-5 wheel experiment and to provide live video H-alpha images to the OSO Control Center and GSFC OSO-7 experimenters has been temporarily suspended. The observatory is being maintained and upgraded for support of OSO-1. Solar Maximum Mission and Sounding Rocket experiments. Photographic spectroscopy of active and quiescent prominences and other solar phenomena are performed with a 24-inch reflector and universal spectrograph at Capilla Peak. A coronal photometry system, intended to obtain brightness maps of the corona during total eclipses of the sun with a high accuracy in relative point-to-point photometry was tested at a site near Charlottesville, Virginia for observation of Comet Kohoutek and will be operated at future eclipses when weather conditions permit. The vidicon system is being used with the McMath Solar Telescope at Kitt Peak to obtain high dispersion spectra of stars. The spectra will be interpreted in a manner similar to that used for solar chromospheric studies to study stellar chromospheres.

W75-70606 188-38-52
National Aeronautics and Space Administration, Washington, D.C.
GROUND-BASED OBSERVATIONS OF THE SUN
K. Goetz 202-755-8490
Ground-based observations of the sun in wavelengths for which the atmosphere is transparent are carried out at a number of suitable observatories and ground stations throughout the United States. The purpose of these ground-based observations is to obtain information on the solar atmosphere, from the photosphere and sun spots, to the chromosphere and the corona, and on the fine and gross structure of the solar atmosphere, and activity in it. This information is then used in correlation with observations from sounding rockets, OSOs, and other spacecraft to determine the physical conditions in the objects, and to understand the physical mechanisms at work in them. The following types of activity are covered under this RTOP (ground-based here refers to aircraft and balloons as well as to fixed installations on the ground): (1) the definition and design of experiments for ground-based observatories; (2) the construction or purchase and operation of such experiments; (3) the observing of the sun, and features in it, from the ground; (4) the analysis of ground-based data in correlation with data from space or from other ground-based observatories; and (5) scientific interpretation in terms of physical conditions and mechanisms.

W75-70607 188-38-53
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENT DEVELOPMENT - LABORATORY AND THEORETICAL SOLAR PHYSICS
J. C. Brandt 301-982-4701
Research toward improved systems for solar observations in the EUV, X-ray and gamma ray regions is being pursued through the development of prototype collimator systems and detectors for these wavelengths. Research into improved hard X-ray detectors emphasizes the objective of extending the energy range of observation to 20 Mev. Use of a passive Li impregnated bismuth shield offers a substantial improvement over existing methods. Electronics are being developed which together with existing crystal and mechanical fixtures, will produce a detector able to record the spectrum of a solar X-ray burst with 100 millisecond resolution. Design of high resolution coronal spectrometer/polarimeters for the wavelength ranges 1-20 A and 1200-1500 A is underway and bench testing will be carried out. COS/MOS type integrated circuits which have reduced power needs, volume and weight have been successfully flown in a rocket experiment and will continue to be environmentally tested in typical space solar experiment electronic units. Developmental work includes an imaging infrared up-converter for use at 5 microns. Development and implementation of imaging detectors for visible-light solar physics includes line profile devices and vidicon techniques. Methods for improved solar observations at radio wavelengths include mm-wave radiometers and interferometry.

W75-70608 188-38-53
National Aeronautics and Space Administration, Washington, D.C.
LABORATORY AND THEORETICAL SOLAR PHYSICS
G. K. Oertel 202-755-8490
Laboratory and theoretical studies are carried out on current problems in solar astronomy and solar physics, and on important areas of atomic and molecular physics which contribute basic information required for the analysis or understanding of solar data from the ground and from space. Theoretical studies of the sun include the following types of activity: (1) the analysis of ground-based and space data to produce models of the solar atmosphere, and to understand the underlying physical conditions and mechanisms; and (2) prediction of future events on the sun, such as predictions of coronal structures from features observable on the disk; of the development of future active regions from magnetic and H-alpha features; and the occurrence of flares from magnetic field complexity and configuration. Theoretical and laboratory studies in atomic and molecular physics include the following activities: (1) the measurement of coefficients for ionization by electron impact for various stages of ionization of elements of astrophysical interest. These coefficients play an important role in the determination of the ionization balance in nonequilibrium astrophysical plasmas such as the solar corona. Elements to be investigated include carbon, nitrogen, oxygen, neon, silicon, and argon, which are also of interest in a large number of laboratory experiments. The theta-pinch facility is uniquely suited for the investigation of
The objective of the effort under this RTOP is the early definition of various types of solar instrumentation, for flight on the space shuttle, required for obtaining data necessary to the pursuit of solar research goals identified for the 1980s. The following activities are among those included: (1) preliminary design of instruments to meet observational requirements, as determined for the shuttle, for improved spatial, spectral and time resolution, covering spectral ranges from gamma-rays and X-rays up through the infrared. Types of instruments include telescopes, photocalorimeters, spectrometers, spectrographs, spectroheliographs, coronagraphs, polarimeters, magnetographs, solid state detectors, spark chambers, etc.; (2) development of methods to exploit fully the advantages and capabilities of shuttle oriented solar observations, by incorporating instrument design concepts which permit maximum utilization of the presence of man as an observer, an instrument operator, and a technician. Implicit in the design would be built-in maintainability and the capability for changeout of the instrument or major modules or components; (3) studies to determine techniques and methodology for application toward developing instruments at significantly lower cost, without sacrificing performance or reliability; and (4) development and in-flight testing of critical areas of concern in instrument design such as optical surfaces, filters, crystals, coatings, gratings, detectors etc.

The laboratory for solar physics and astrophysics and optics branch, Mission Technology Division, GSFC, propose to build a group of instruments to observe solar flares and related solar phenomena from shuttle sortie and free-flier platforms in 1979, 1980, and 1981. The scientific objective of this payload will be to advance our understanding of the nature of the mechanism of a solar flare. This will be done by observing a flare over a wide range of the electromagnetic spectrum from the visible to the gamma-ray region. A number of different instruments will be required to cover this range. They will be selected on the basis of making comprehensive measurements in their specific wavelength regions in a format which is coordinated with and complimentary to the other instruments in the payload. For example, all instruments will operate with the same temporal and spatial resolution to the maximum possible extent. The instruments considered for this payload are: (1) a solar telescope (Photoheliograph) with aperture equal to or greater than cm, (2) a high resolution 1000-2850 A spectrometer used at the focus of the telescope and observing line profiles from the chromosphere and the transition region.
performed using equipment which is mostly already developed and on hand, including photometers, radiometers, spectrometers and an integrating vidicon system. A state-of-the-art integrating vidicon system being developed under another program will also be utilized.

W75-70616 188-41-51
Langley Research Center, Langley Station, Va.
UV AND OPTICAL ASTRONOMY (COMPUTATIONAL PHYSICS)
E. S. Love 804-827-2893

New and improved computer models will be developed to investigate the evolution and structure of various systems of astrophysical interest, such as spiral galaxies, the asteroid belt and Saturn's rings. Galactic related problems that will be studied are how the bar-forming instability can be stabilized to allow formation of normal spirals and the method by which spiral galaxies transfer their angular momentum outwards. Another problem to be investigated is the density wave theory proposed to explain the spiral structure of galaxies. Computer experiments testing the density wave theory without making the approximations required in an analytical treatment will be performed. A threedimensional computer model will be developed to allow investigation of the development of flat or disk systems from originally elliptical or spherical systems. Numerical experiments on the evolution of the asteroids with Jupiter will be investigated. Similar calculations will be made for Saturn's rings. Another problem to be investigated is the particle acceleration and other phenomena occurring in solar flares. It appears that particle acceleration occurs near magnetic neutral points and involves magnetic flux annihilation in solar flares, in laboratory experiments, such as the plasma focus and possibly also in phenomena on a galactic scale.

W75-70617 188-41-51
Lyndon B. Johnson Space Center, Houston, Tex.
ULTRAVIOLET STELLAR SPECTROMETER DEVELOPMENT FOR SPACE SHUTTLE
Y. Kondo 713-483-6487

The objectives are to develop astronomical space-UV instrumentation for use in shuttle sortie missions, which will demonstrate state-of-technology detector and tracking performance, flexibility of interfacing instrumentation with a general purpose telescope platform, and versatility of man's real-time operational involvement. The development of the ultraviolet stellar spectrometer for space shuttle is performed through the flights of the balloon-borne ultraviolet stellar spectrometer (BUSS) payload as well as through other concurrent laboratory-based developments. The BUSS payload performs high resolution spectrophotometry of astronomical objects in the mid-ultraviolet. The first version of the BUSS payload has been developed and flown successfully twice. It comprises a pointable telescope (40 cm aperture, f/7.5 modified Ritchey-Chretien) to which a variety of instrumentation can be attached. Payload functions are commanded from the ground in real time, and the data are telemetered to the ground in real time, where they are monitored in real time and recorded. Further development of the payload is planned in conjunction with the proposed collaborative program with the Space Research Laboratory, Utrecht, the Netherlands. In this collaborative program, we shall jointly investigate stellar UV objects in the range 2000-3400 A with a resolution of 1/10 A, employing an echelle spectrograph in combination with an image intensified, storage vidicon detector. Subsequent flights will develop the star tracing system for targets as faint as 10th magnitude and for improved spectral resolution.

W75-70618 188-41-52
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
RADIO ASTRONOMY
D. P. Burcham 213-354-3028

This RTOP uses the unique facilities of NASA's Deep Space Instrumentation Facility (DSIF) to find microwave spectral lines of interstellar atoms and molecules at X-band (8 GHz) and K-band (15 GHz), regions in which NASA's receiving capabilities are the best in the world. Concurrently, a laboratory microwave spectroscopy program is carried out to measure frequencies, absorption coefficients and linewidths for presently known interstellar molecules and for other molecules whose presence in the interstellar medium is strongly predicted by theory. The DSIF equipment to be used includes: the 64m Goldstone antenna; K-band and X-band wideband low noise feeds, masers, and receivers; a wideband digital correlator spectrum analyzer; calibrated noise sources; and programmable local oscillators. This DSIF equipment either already exists or is being developed for programs supported by the Office of Tracking and Data Acquisition. The spectrometer system to be used in the laboratory investigations includes a Stark modulation spectrometer and associated programmable digital data handling and control equipment. Fundamental questions in stellar and galactic evolution to be answered by interstellar microwave spectroscopy include the galactic molecular and isotope distribution and the isotopic abundance ratios; the velocity distribution of interstellar material; and the causes of anomalous interstellar molecular spectral line intensities. Of particular interest is the location and abundance of complex interstellar molecules, because the mechanism that allows the creation and retention of such molecules is presently unknown.

W75-70619 188-41-52
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED RADIO ASTRONOMY
R. G. Stone 301-982-4631
(161-05-03; 369-05-03)

The objective of the Ground Based Radio Astronomy Program is to provide a better understanding of the dynamics and composition of astrophysical plasmas in objects such as radio galaxies, quasars, supernovae, pulsars, and solar system sources such as the Sun and Jupiter through the high angular and time resolution observations of radio emission from these objects. Radio astronomy has provided new insight into such problems which could not have been gained from observations in other parts of the spectrum such as the visible or UV region. The interpretation of source spectral and spatial distribution in terms of our knowledge of plasmas and high energy processes leads to knowledge of the evolution of the source and the magnetic fields, energetic particle composition and dynamic processes within the source. The approach taken involves the use and development of high resolution radio telescopes which permit remote observations of phenomena occurring in extensive and inaccessible regions.

W75-70620 188-41-54
National Aeronautics and Space Administration, Washington, D.C.
RELATIVITY
N. G. Roman 202-755-3649

The primary objective is to make experimental tests of the theory of relativity and thereby elucidate the interrelationship among space, time, and gravity. In particular, the test of Einstein's General Theory of Relativity is paramount. This formulation is fundamental and of high scientific interest. Experimental verification is difficult but the ability to orbit large, complex, and extremely precise apparatus, shielded from deleterious perturbations should obviate them. In addition to the scientific goals, improvements and innovations in the technological areas of cryogenics, gyroscope design, and precision clocks are expected. Specific objectives include the development and operation of a flight qualified cryogenic gyroscope, complete systems error analysis, and the consideration of various theoretical formulations of relativity and their subsequent experimental implications. Possible future benefits apart from the scientific ones include improved timing for navigation, communication and geodesy as well as cryogenic systems capable of extended operation in space.

W75-70621 188-41-54
Marshall Space Flight Center, Huntsville, Ala.
RELATIVITY AND CELESTIAL MECHANICS
R. A. Potter 205-453-3431

The objective of this activity is to develop, through a coordinated program, the technology and research required to support the flight of the gyro-relativity experiment. This experiment
will be a fundamental and unique test of the general theory of relativity. The feasibility of this experiment centers around the development of gyroscopes of several orders of magnitude more precise than any existing, and the ability to maintain these gyroscopes and record their precessions, while in earth orbit, over a period of twelve months or more. The work will be accomplished by continuing the technology development programs being carried out in the laboratories of the Marshall Space Flight Center (MSFC) supported by the work on the gyro development at Stanford University and the University of Alabama at Huntsville and the Dewar development work at Ball Brothers Research Corporation. A Phase A study will be accomplished which will determine the most economical and scientifically rewarding flight program. A well coordinated, experimental, theoretical and engineering program in which Stanford University and MSFC effort complement each other is well under way. These activities are oriented toward a satellite flight that will establish the validity of the General Theory of Relativity.

**W75-70622**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

RELATIVITY AND CELESTIAL MECHANICS

D. P. Burcham 213-354-3028

(385-41-01)

The astrophysical consequences of missing matter in the universe will be studied, first by formulation of general models with conducting plasma matter content, and then by introducing inhomogeneities through perturbation techniques. This research will support interpretation of data on intergalactic matter, its composition, excitation and ionization history, which will result from far ultraviolet quasar spectra taken with the forthcoming IUE satellite. We will formulate selected anisotropic cosmological models and study their observational consequences. The simplest models of interest will be so-called Bianchi type 7 sub O big bang universes, with incoherent matter content. These have recently been shown by Hawking and Collins to be the only set of non-zero measure, among non-collapsing models, which tend toward isotropy. Consequences for observational cosmology will also be considered, especially experiments in space for the detection of anisotropy in the universal microwave background radiation. Advances in techniques of nonlinear applied mathematics will be applied to selected problems of relativistic gravity, in particular to the calculation of fields of axisymmetric spinning sources, and to cylindrical gravity waves.

**W75-70623**

National Aeronautics and Space Administration, Washington, D.C.

INFRARED ASTRONOMY

N. W. Bogess 202-755-3688

The objective is to advance stellar and galactic astronomy in the spectral region between 1 and 1000 microns through observational and theoretical programs. Observations in the infrared portion of the electromagnetic spectrum are particularly important for an understanding of the early and late stages in stellar evolution, interstellar matter, galaxies and quasistellar objects and the energy mechanisms associated with them, and the residual radiation of the universe. A balanced program including observation, technique and instrumentation development, and theory is required to insure the advances needed for full utilization of future platforms in space. The approach includes the following elements: (1) support observational programs using ground-based telescopes, balloons, and airplanes; and (2) promotion of the development of infrared techniques and apparatus. Special emphasis is placed on far IR narrow band filters, spectral interferometers, modulation techniques, and multiple detector arrays in order to enhance the information content of an observation; and more recently, on development of cryogenic and low-background telescopes.

**W75-70624**

Ames Research Center, Moffett Field, Calif.

INFRARED ASTRONOMY

Dean R. Chapman 415-965-5065

The broad objectives of this program are to obtain and interpret astronomical data in the far infrared region of the spectrum and to develop and evaluate improved platforms and instrumentation for far infrared. A 28' balloon-borne telescope has been measured for observing in the far infrared. Engineering test flights have verified that repeated launchings can be performed with turn-around times of only a few days. An offset tracking capability has been developed for the telescope to permit prolonged observations of infrared sources that do not have bright visible counterparts. Broad-band photometric observations are planned for early flights and special structured flight tests later in this program. Specific objectives include planets, HII regions circumstellar dust clouds and extragalactic objects.

**W75-70625**


MILLIMETER-WAVE AND FAR-INFRARED ASTRONOMY

Patrick Thaddeus 212-866-3618

(176-31-53)

The main scientific purpose is to observe interstellar molecules at millimeter and submillimeter wavelengths, in order to study the dynamics of dense interstellar clouds, the process of star formation, isotopic ratios, interstellar chemistry, and other astrophysical topics, and (2) to obtain laboratory data on molecular spectra in order to interpret these observations, and in order to search for new molecules in space. The main technical purpose is to extend radio frequency techniques into the far infrared for use on aircraft and space vehicles.

**W75-70626**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

INFRARED ASTRONOMY

D. P. Burcham 213-354-3028

The objective of this research is to develop an improved type of detector of radiation in the microwave and far infrared region from 100 microns to 3mm, for use in both earth- and spacecraft-based astronomical observations. The detector is expected to have a sensitivity on the order of 10 to the minus 15th power W/Hz, a response time of 10 to the minus 9th power sec or better, and to be narrow-band and tunable. The program proposed here is the development of the Notary-Mercereau form of superconducting weak-link structure as a practical infrared detector. The N-M structure provides reproducibility, stability and reliability difficult to achieve in Josephson tunneling junctions and weak-link point-contact junctions. The major problems to be faced in applications are the improvement of the sensitivity at millimeter and submillimeter wavelengths, and the improvement of coupling of electromagnetic radiation to the detector. The first of these will be approached by decreasing the size of the weak-link section to sub-micron dimensions. The second will be approached by fabricating the devices in arrays, which will increase impedance and sensitivity. In both cases, fabrication to high accuracy at sub-micron sizes is necessary. It is proposed to do this by use of the scanning electron microscope (SEM) as a machining tool. The effort in this fiscal year will be devoted to the application of an already available SEM to the task of fabrication of the necessary structures and to testing of the resultant devices. Preliminary work in FY-74 has proven the feasibility of this approach.

**W75-70627**

Lyndon B. Johnson Space Center, Houston, Tex.

INFRARED SPECTROSCOPY OF COOL STARS AND PLANETARY NEBULAE

Andrew E. Potter 713-483-2071

Infrared spectra of planetary nebulae and cool stars are measured using a Michelson interferometer using infrared with photomultiplier tube detectors and the 107 in McDonald Observatory telescope. Analysis of the spectra yields information on the composition and structure of nebulae gases and stellar atmospheres. Principal objectives of the work are to clarify the nature of Wolf-Rayet stars, omission features in B-type stars, and composition of planetary nebulae.

**W75-70628**

Goddard Space Flight Center, Greenbelt, Md.

X-RAY ASTRONOMY

Elihu A. Boltz 301-982-5853

OFFICE OF SPACE SCIENCE
X-ray production is a necessary consequence of energetic charged particles in space. Hence, by studying the X-ray emission from stellar objects, nebulae, the interstellar medium, and extragalactic space we get direct information on energetic processes over a broad range of physical conditions and astronomical scales. Observations of hard X-rays are made with mechanically collimated proportional gas counters of advanced design or a large array of cooled solid state detectors (Ge and Si). The technical goals are large effective area, broad spectral coverage, optimum resolution, and efficient rejection of extraneous events (e.g., caused by gamma rays, electrons, radioactivity). These goals, coupled with a detailed knowledge of detector response, are being achieved via laboratory tests, balloon, and rocket flights. Observations of soft X-rays may be made with small specialized detectors at the focus of grazing incidence optics. Cooled solid state detectors and gas X-ray filters are being investigated.

W75-70629 188-41-59
National Aeronautics and Space Administration, Washington, D.C.
X-RAY ASTROPHYSICS
N. G. Roman 202-755-3649
The objective is to investigate and understand the nature of sources of X-ray emission. The number of such sources detected has been increasing by about 50% per year. These detections have been made by large arrays of detectors built into space-borne observatories. The general topics of interest include: the study of galactic and extragalactic X-ray sources in terms of the history of the formation and evolution of the galaxy and the universe; the detection of new sources of X-ray emission from the interstellar medium and the intergalactic medium; and the search for X-ray sources from novae, X-ray binaries, and quasars. The objectives of this research include: (1) the detection of additional sources, spatial mapping of the background, accurate positional determination, and correlation with optically identifiable objects. These objectives are met by supporting laboratory studies, flight programs, and theoretical work. Research and development of advanced detectors, shielding systems, and focussing optical systems are being conducted. Data processing methods are being refined.

W75-70630 188-41-64
Goddard Space Flight Center, Greenbelt, Md.
X-RAY SPECTROSCOPY FOR SHUTTLE
Elihu A. Boldt 301-982-5853
X-ray production is a necessary consequence of energetic charged particles in space. Relativistic electrons radiate X-rays characteristic of their interactions with magnetic fields, ambient electromagnetic waves, and interstellar grains. Subrelativistic suprathermal charged particles, including cosmic ray nuclei as well as electrons, generate X-rays characteristic of collisions with ambient gas (e.g., bremsstrahlung continuum radiation and characteristic line emission resulting from electron charge exchange between highly stripped nuclei and ambient atoms). Hot plasmas generate X-rays characteristic of thermal electron-ion interactions. Hence, by studying the X-ray emission from stellar objects, nebulae, the interstellar medium and extragalactic space we get direct information on energetic processes over a broad range of physical conditions. X-ray astronomical observations are being achieved using laboratory and flight research using experimental and theoretical results is a second aim. A third aspect involves observations from space craft to obtain new data. The last phase uses ground based telescopic observations. Molecular beam and laser techniques are being used for measuring productions of atoms, radicals and ions from planetary, cometary or interstellar molecules by impact of photons, electrons and ions. The optics, spectroscopy and chemistry of species appropriate to the study of interstellar molecules and grains will be investigated. The possible relation of cometary and interstellar molecules to star formation chemical evolution and the origin of life will be examined. In support of other research use of image intensifiers to study comets and interplanetary matter will be investigated. Part II of the Atlas of Cometary Forms, illustrating dust and plasma tail phenomena will be prepared.

W75-70632 188-45-51
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
COMETS AND ASTEROIDS
D. P. Burcham 213-354-3028
The Apollo missions to the Moon and Mariner missions to Mars have shown that these bodies have been subject to extensive modification since their origin. Only small bodies may still preserve evidence information on the original formation of the solar system. Asteroids, meteorites, and fireballs are all small bodies in the solar system. The long-term evolution of gravitational forces can be studied with common techniques. The intent is to study the origin and evolution of all three classes of small bodies in a similar manner. The work in this RTOP over the past two years has resulted in the development of a mechanism which transports material from the asteroid belt into the orbit of the earth in a length of time (and amounts) consistent with the evidence from stoney meteorites. Until recently, proposed transport mechanisms failed to satisfy the time and mass constraints. The specific objectives for FY-75 are as follows: (1) it now seems likely that some meteorites can come from the asteroid belt by secular resonances. The dynamics of individual asteroids near these resonances will be studied to pick the most likely sources; (2) update the asteroid belt and family study as new asteroid data becomes available. Do special studies of families where useful; and (3) investigate the long-term orbital evolution of special objects by numerical integration.

W75-70633 188-45-52
Langley Research Center, Langley Station, Va.
METER ASTROPHYSICS - OBSERVATION, SPECTRA AND DATA ANALYSIS
E. S. Love 804-827-2893
The primary objective is to obtain trajectory, orbit, and spectral data of chemically differentiated meteoroids, and of meteors of special interest. Additional objectives include radiation studies, and studies of earth-orbital, far-UV meteor spectroscopy. Airborne UV observations of nebulae and comets as part of the Fall 74 ASSESS II mission in preparation for far-UV meteor photometry and spectroscopy from space shuttle launched platforms (LDEM) and (ATL) will be performed. (Contract) The objectives of the Smithsonian Astrophysical Observatory (SAO) research are to further investigate orbital distributions of sporadic meteors and meteor streams within the SAO radar meteor sample, and to determine the selection effects of fragmentation in space on orbit distributions. The research will be accomplished by expanding and refining the two-station, direct-photographic meteor data. Statistical studies of data in hand and detailed reduction of selected data will continue. Radiation studies will continue. An engineering model of a far-UV meteor photometer will be developed for intended use on the Long Duration Exposure Module (LDEM), i.e., on the first space shuttle deployed experiment-module. (Contract) The SAO synoptic year radar data will be further reduced and analyzed. Particular attention will be directed to selection effects of meteoroid collisions in space and to characteristics of meteor streams. Theoretical studies of meteor phenomena will be performed to aid analysis of the meteor data.

W75-70634 188-45-53
Ames Research Center, Moffett Field, Calif.
COSMIC DUST MEASUREMENTS
The objectives are to perform chemical analyses of extraterrestrial material (involving major element, trace element, and isotope determinations) enabling interpretation of the nature and origin of cosmic dust and meteorites. A laser microprobe is used in this work to excite spectral emission from cosmic dust grains, and electron probe technique will also be applied to determine isotope ratios of cosmic dust and meteorites. Laser-mass spectrometer and electron probe technique will also be applied to determine isotope ratios of terrestrial and extraterrestrial material, and pollution particles. The laser microprobe continues to prove an ultrasensitive method for trace element study. The elements Zn, Cu, Cr, Mn, Si, Ni and Fe have been analyzed in atmospheric aerosol material and found to be present, even though they would have been detected if present at exceedingly low levels. A laser-to-mass spectrograph hookup is nearing completion. This will enable determination of radical groups and perhaps isotope ratios in unknown particles. An electronprobe may also be used to help detect light (Z < 8) elements.

Goddard Space Flight Center, Greenbelt, Md.

COSMIC DUST RESEARCH
Charles C. Schnetzler 301-982-2282

The objective of this research is to understand the nature and history of condensed matter in the solar system. The multidisciplinary approach will involve the analyses of meteorites by the following techniques: (1) chemical analyses: major, minor and trace element composition by conventional wet chemistry, X-ray fluorescence and high precision atomic absorption; (2) non-destructive gamma-ray analyses: naturally-occurring K, U and Th, and cosmic-ray-produced radionuclides (such as A1-26) by low-background gamma-gamma coincidence spectrometry; (3) major, minor and trace element analyses in individual mineral grains and grain boundaries by electron microprobe, and ion microprobe microanalyzer; (4) cosmic-ray and fission track analyses by track etching techniques; and (5) mineralogical and petrographic analyses.

Goddard Space Flight Center, Greenbelt, Md.

PARTICLE ASTROPHYSICS
F. B. McDonald 301-982-4801

The objective is to measure the energy spectra, charge and isotopic composition of the primary cosmic radiation and of solar cosmic rays. Supported by this objective is the development of new detector systems for the study of the properties of cosmic radiation, and the associated development of theoretical studies related to these experiments. The results will be used in astrophysical considerations concerning the origin, acceleration and propagation of cosmic radiation. Specific goals are enumerated as follows: (1) measurements of the high energy composition of the cosmic radiation, including spectral, charge and isotopic studies from electrons up through the heaviest elements; (2) development of detectors to study the low energy composition of solar and galactic cosmic rays, with the goal of measuring the intensity of cosmic rays at great distances from the sun on deep space missions; and (3) improved measurements of the positron ratio from 20 MeV to 20 GeV. Detectors will be designed, constructed, and tested in our laboratories. Detector behavior will be explored using particle accelerator beams and other devices. Balloon flights will be carried out both for the purpose of detector development and for obtaining new scientific information. New measurements will be made of the properties of cosmic radiation available for study at balloon altitudes.

National Aeronautics and Space Administration, Washington, D.C.

PARTICLE ASTROPHYSICS
Albert G. Opp 202-755-8493 (188-46-57)

The objective of this RTOP is to study the isotopic and charge composition and energy of galactic and solar cosmic rays. The primary galactic radiation represents the direct penetration of material from the galaxy into the solar system. The study of the nuclear composition and energy of this material provides direct evidence that the galaxies are responsible for the cosmic ray and information on the interstellar material transited by the cosmic ray. The observation of solar cosmic rays provides information on the abundances of different elements in the sun and information on the solar processes that accelerate energetic particles to their observed energies. The design, construction and test of cosmic ray detectors is the prime activity supported by this RTOP. Solar, magnetic spectrometers, scintillators, Cerenkov counters and ionization spectrometers are typical instruments developed and tested under the support of this RTOP. Research balloons are employed extensively in high energy astrophysics. Balloon flights are used both to test new instruments and to obtain new scientific information on the properties of cosmic radiation. New instrument concepts are also tested at particle accelerations and from mountain top laboratories.
This describes the JPL program in X- and gamma-ray astronomy, part of which is a cooperative effort with UCSD. The primary objective of the program is to observe nuclear gamma ray line spectra from extraterrestrial sources in the 0.2 to 10 MeV energy range. Such observations could provide important information on nucleosynthesis, galactic history and the physical nature of various celestial objects including cosmic X-ray and gamma-ray sources, both constant and transient. Under this program, a high resolution gamma ray spectrometer balloon system will be used in a series of astronomical observations. Additional activities will be the development of advanced concepts in instrumentation and data analysis. The specific objectives for this program for FY-75 are to reduce, analyze, and publish the data from the FY-74 balloon flight series; conduct two observational balloon flights in the spring of 1975; and develop a gamma ray burst detector.

W75-70641 188-46-57
Goddard Space Flight Center, Greenbelt, Md.

GAMMA RAY ASTRONOMY
C. E. Fichtel 301-982-1910

The technical objective is to develop the most appropriate detector systems for the observation of the astrophysical sources of very energetic photons. The approach has been divided into several different parts. The first approach to the general problem of gamma-ray astronomy was the development of a large telescope using digitized spark chambers to be tested on high altitude balloons and then flown on satellites. Other approaches to detector systems are now being pursued both for the high energy gamma rays and intermediate gamma ray studies. A medium energy gamma ray detector has been designed and built. A unique feature of this system is its high time resolution which will permit the tagging of several gamma rays during a short (microseconds) pulse as might be expected from a supernova outburst. Additionally, the theory of shaped scintillation detectors for measurement of medium energy gamma rays on small satellites is being studied, and design work of a detector system will be in the near future. Improvements in the spark chamber systems are continuing, and methods for accurate timing are being developed for a search for discrete source emission of gamma rays at pulsar periodicities. Special attention in the digitized chamber research is now being directed at designing and building a low cost chamber of significantly larger size. At the same time several different approaches are being explored to improve angular resolution, as well as sensitivity for future gamma ray telescopes.

W75-70642 188-46-64
Goddard Space Flight Center, Greenbelt, Md.

SHUTTLE DEFINITION STUDIES FOR HIGH ENERGY ASTROPHYSICS
F. B. McDonald 301-982-4801

The objective of this program is to develop a variety of new detector systems for high energy astrophysics research, including cosmic-ray, X-ray and gamma ray astronomy. Meaningful new experiments in these fields presently require the development of several new devices, incorporating new improvements in energy, charge and isotope resolution, in temporal resolution and directional resolution, and in data shaping and handling. The objective is to measure the energy distribution and the charge and mass composition of the several components of the primary cosmic radiation. These components include both electrons and nuclei from hydrogen to iron, lead, uranium, and beyond. Beyond 10 to the 12th power eV, no information is presently available, primarily because particles in this range are very rare. In this range, spectra fall steeply with increasing energy requiring large area detectors and long exposure times. This large exposure must be obtained while maintaining the resolution of much smaller detectors. Energy measurements in this highly relativistic range are currently being done using ionization spectrometers. Development of new techniques such as transition radiation detectors, large area gas filled counters, magnetic spectrometers, etc. will be required to extend existing measurements to beyond a TeV/nucleon. The properties of charge measuring devices, direction detecting devices, and total ionization spectrometers will be calibrated on the ground and studied at balloon altitudes.

W75-70643 188-48-51
Marshall Space Flight Center, Huntsville, Ala.

INTERDISCIPLINARY SPACE RESEARCH
E. Stuhlinger 205-453-3033

The objective is to conduct space research in various scientific and technical disciplines with a capability of directing quick reaction efforts toward significant problems or promising areas of research and with the overall purpose of enhancing in-house scientific capabilities of the MSFC. Such research is related to the physics and astronomy programs of NASA. Under the direction of Professor D. J. Miller, research is initiated in scientific and technical areas which influence the scientific missions of the center. Research projects are selected that, within available resources, contribute significantly to in-house scientific capabilities and state-of-the-art advancement. These projects are then funded from the Interdisciplinary Space Research discretionary funds.

W75-70644 188-48-52
Goddard Space Flight Center, Greenbelt, Md.

BASIC THEORETICAL RESEARCH
A. Temkin 301-982-4441

The objective is to develop techniques for the solution of basic (prototype) atomic collision problems involved in processes occurring in planetary and stellar atmospheres, and in other plasmas: also for collision processes that may be used as diagnostic tools in atmospheres. Specific work implementing the above objective falls into the following general categories: (1) study of electron impact ionization; (2) development of techniques and calculations of autoionization states of atomic systems; (3) calculation of electron molecule scattering techniques; (4) charge exchange of iron nuclei with cosmic gases; (5) study of electron-atom scattering methods; (6) investigation of atomic matter-antimatter annihilation and its cosmic significance; and (7) study of photoionization processes.

W75-70645 188-78-51
Goddard Space Flight Center, Greenbelt, Md.

ADVANCED TECHNOLOGICAL DEVELOPMENT. GENERAL: SIGNAL AND DATA PROCESSING ELECTRONICS: SOLID STATE NUCLEAR DETECTORS
J. H. Trainor 301-982-6282

The technical objectives of this research project are to develop and test new on-board signal handling, data processing, storage, computing and auxiliary electronics circuitry for use in energetic particle and astrophysics experiments on Pioneer, HEAO, Helios, shuttle missions, explorers, outer planet missions, rockets, balloons, etc., as well as special test and analysis equipment applicable also for both ground and shuttle usage. The growing complexity of experiments and the often corresponding increase in the volume of data obtained have made signal handling, data processing and data transmission capability limiting factors. To reduce the transmission of unnecessary data, it is necessary to increase the experiment's on-board signal handling and data processing capability. This program is approached through (1) the investigation and development of new techniques for signal shaping and handling, data processing and auxiliary circuitry and (2) the modification of existing techniques by the application of advanced technology and materials including bipolar integrated circuits, MOS/LSI technology, thick film techniques, micropower circuitry and multiple chip techniques. Special techniques must also be devised in order to accurately and efficiently evaluate and test new flight systems at low cost. The use of u-processors and minicomputers will be pursued both for ground testing and in-flight data systems.

W75-70646 188-78-51
Marshall Space Flight Center, Huntsville, Ala.

LOW GRAVITY SUPERFLUID HELIUM ADVANCED TECHNOLOGY DEVELOPMENT
R. A. Potter 205-433-3431
Several experiments are currently being developed which will require a low temperature environment for their proper operation in space. Superfluid helium will undoubtedly be used for many of these applications. Immediate applications to experiments are to be found in cosmic ray, relativity, and infrared astronomy. The purpose of this task is to investigate theoretically and experimentally, where possible, the properties of superfluid helium to be expected when liquid helium dewars are flown into space. The properties of superfluid helium in this near zero gravity environment will be assessed and methods will be investigated whereby problem areas may be resolved or controlled.

W75-70647 188-78-51
National Aeronautics and Space Administration, Washington, D.C.
ADVANCED TECHNOLOGICAL DEVELOPMENT, GENERAL; CRYOGENICS
M. J. Aucrane 202-755-3676
Physics and Astronomy experiments are being developed which will require a low temperature environment for their proper operation in space. Superfluid helium will undoubtedly be used for many of these applications. The purpose of this work is to investigate theoretically and experimentally, where possible, the properties of superfluid helium to be expected when liquid helium dewars are flown into space. Properties of superfluid helium and other cryogens for application in IR astronomy, cosmic ray physics and relativity will be assessed and methods to deal with problems will be developed.

W75-70648 188-78-56
National Aeronautics and Space Administration, Washington, D.C.
INSTRUMENTATION TECHNOLOGY - IMAGE TUBE AND DETECTOR DEVELOPMENT
M. J. Aucrane 202-755-3676
Development of Large Space Telescopes are fundamental to the objectives of the Astronomy Research Program. It is essential that normal incidence image forming systems operating with maximum spatial and spectral resolution in the IR, visible, and ultraviolet regions be evolved. These instruments will be required to detect and present astronomical data in extreme fidelity. In order to accomplish this it will be necessary to develop a series of instruments that both accomplish their scientific objectives and at the same time provide technological data to permit a burgeoning capability. In order to fully utilize such advanced telescopes it will be necessary to concurrently develop suitable electronic image sensing system.

W75-70649 188-78-56
Goddard Space Flight Center, Greenbelt, Md.
SCIENTIFIC INSTRUMENT DEVELOPMENT FOR THE LARGE SPACE TELESCOPE
G. M. Levin 301-982-6688
The long range goal of the LST project is to build and operate a large, diffraction limited optical telescope, exploiting the capability for detection of faint sources, high angular resolution studies of all sources and measurement over a wide wavelength range. The broadest expertise in astronomical instrument design and consequently the best definition of instrument needs lies with the body of ultimate users, the astronomical community, which must be brought into LST activity. This will be done through the Instrument Definition Team organization developing scientific instrument definitions and identifying science and engineering tradeoffs between potential instruments and through contracts to develop supporting technology based on the recommendations of the Instrument Definition Teams. Contracts for supporting technology will be let by GSFC.

W75-70650 188-78-60
National Aeronautics and Space Administration, Washington, D.C.
ADVANCED MISSION STUDIES
M. J. Aucrane 202-755-3676
The objective of the Advanced Mission Studies is to initiate studies both in-house and on contract for the Explorer Series, and for the disciplines represented in Physics and Astronomy Programs. This RTOP will permit studies to be initiated for those disciplines outlined in the recent announcement of flight opportunities. The need for observations in the disciplines of physics and astronomy has been expressed by the National Academy of Sciences (NAS). Endorsement of the Explorer Series has been provided by the NAS in their summer studies and by others in the scientific community. The purpose of this RTOP is to expedite preliminary and conceptual studies by the appropriate field centers. If OSS is to continue to meet the goals of this agency, then it is imperative that we initiate the studies required to meet our scientific commitments to the nation. The technical objectives of the planned effort include: (1) support activities in definition studies; (2) the review of prior projects, such as SAS; (3) to ascertain whether existing subsystems, systems and hardware can be used in a minimum cost approach to designing the basic spacecraft; and (4) the resources required to conduct the missions.

Planetary Biology

W75-70651 192-55-61
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION
H. P. Klein 415-965-5094
(192-55-62)
Chemical evolution encompasses the study of the evolutionary path of carbon and its compounds from the primordial fireball, through interstellar dust clouds, to formation of galaxies, solar systems, and planets, to the beginnings of life on the earth. In the laboratory, the syntheses of organic compounds related to terrestrial biochemicals are explored in experiments which simulate the putative environments of interstellar dust clouds, cooling solar nebulae, and primordial and extant planetary atmospheres and surfaces. The study is relevant to understanding the prebiological chemistry of the solar system which led in the case of earth to the formation of organic compounds and the origin of life, but which on extraterrestrial bodies and environments, may have taken divergent paths. The study provides an experimental basis for the hypothesis that the origin of life on earth, and possibly elsewhere, was preceded by a period of organic chemical evolution in which simple compounds containing the organogenic elements C, N, O, S, P, and H were converted by abiotic processes into the complex organic molecules which are direct precursors of the macromolecules essential to life.

W75-70652 192-55-61
National Aeronautics and Space Administration, Washington, D.C.
PLANETARY BIOLOGY
Dr. R. S. Young 202-755-3732
(192-55-62)
Chemical evolution is the laboratory study of the non-biological synthesis of biologically significant organic molecules under conditions presumed to have existed on the primitive earth, or any primitive planet before the event of life. The study is relevant to understanding the origin and evolution of life. Experiments relevant to prebiological organic chemistry can, in principal, explain the processes by which primitive cells could have originated on the earth. The greatest of evolutionary puzzles, the origin of life, takes on a new immediacy in light of recent laboratory advances and experiments which have a different approach but have the same common denominator, i.e., pathways by which biologically significant molecules arose prior to life.

W75-70653 192-55-62
Ames Research Center, Moffett Field, Calif.
ORGANIC GEOCHEMISTRY
H. P. Klein 415-965-5904
(192-55-61)
The principles and practices of organic geochemistry can be applied in any cosmological study wherein a solid matrix is investigated for the presence or absence of organic compounds.
Thus, not only are geological materials from earth candidates for study, but also included in organic geochemical investigations are extraterrestrial samples such as meteorites, lunar materials, and in the future, samples returned from planets. The main focus of organic geochemistry here is to study the occurrence, distribution and fate of organic compounds in terrestrial substances, such as contemporary organic compounds from ancient sediments (including Precambrian rocks), and fossils. The methods and results of these studies are applied to the interpretation of the significance of organic substances in extraterrestrial materials. By using the earth and its geochemical processes as a model, information about extraterrestrial processes can be better interpreted. Highly refined analytical techniques are used in organic geochemistry to separate organic compounds from mineral matrices. These compounds form the basis for understanding geological processes including diagenesis. From these studies, chemical criteria can be developed to distinguish between organic matter of biological and nonbiological origin. These criteria are essential for understanding the mode of origin of extraterrestrial organic materials.

W75-70654  192-55-62
National Aeronautics and Space Administration, Washington, D.C.

PLANETARY BIOLOGY
Dr. R. S. Young  202-755-3732
(192-55-61)

Organic geochemistry is the study of ancient terrestrial rocks for organic molecules and inclusions of biological origin. The development of techniques for the isolation of organic matter and distinguishing organic matter of biological origin from that of non-biological origin is discussed along with the applications of such technology to returned extraterrestrial samples.

W75-70655  192-55-63
Ames Research Center, Moffett Field, Calif.

LIFE DETECTION
H. P. Klein  415-965-5094
(192-55-66)

Those attributes of life which can be used for the remote detection of life are being studied. Techniques are being developed for the detection of active extraterrestrial life, for the detection of organic molecules unequivocally related to life, and for the determination of the nature of extraterrestrial life.

W75-70656  192-55-63
National Aeronautics and Space Administration, Washington, D.C.

PLANETARY BIOLOGY
Dr. R. S. Young  202-755-3732
(192-55-61)

The development techniques for the detection of extraterrestrial life and life related molecules, including evidence of life, past, present or future is discussed. The search for organic molecules of biological or non-biological origin, metabolic activity, growth and reproduction, and visual identification is also described.

W75-70657  192-55-64
Ames Research Center, Moffett Field, Calif.

BIOLOGICAL ADAPTATION
H. P. Klein  415-965-5094

The objective is to study terrestrial microorganisms which have adapted to life under environmental extremes. Models for organisms which may be found on other planets, possible terrestrial contaminants of other planets, and examples of organisms which may be present in samples returned from Mars in the future are considered. There are microorganisms which live in conditions of high and low temperatures, low humidity, high radiation flux, acidity, alkalinity, and salinity which are environments found on one or more of the other planets. The enzymes, structural components, and genetic systems of these organisms are being studied to determine how they have been modified during adaptation to such conditions. The information will suggest whether it is reasonable to expect that life forms resembling terrestrial life could have evolved on a particular planet, and what characteristics might be present in those forms. If it appears that a terrestrial type of life has a low probability of existing there, the study will suggest what properties may be present in the native life. In addition, there will be information important to the questions of forward contamination of another planet, and back contamination of earth.

W75-70658  192-55-64
National Aeronautics and Space Administration, Washington, D.C.

PLANETARY BIOLOGY
Dr. R. S. Young  202-755-3732

The study of the ability of microorganisms to survive and grow in environmental extremes approaching those of the planetary environments is discussed in terms of temperature and pH extremes, water availability, and salt concentrations. This is relevant to an understanding of biological processes in environments very different from those usually considered as being typical of the earth.

W75-70659  192-55-65
Ames Research Center, Moffett Field, Calif.

BIOINSTRUMENTATION
H. P. Klein  415-965-5094

The broad objectives of this effort are to develop instrumentation and techniques for the detection and characterization of life on other planets. The primary emphasis of the program is directed toward the planet Mars, but consideration will be given to application of the instrumentation to other planets. The work projects involve the continued development of operational breadboard models of the unified biology experiment and the wet-chemical amino acid analyzer, which are being developed as candidate post-Viking experiments. In addition, instrumentation feasibility studies are planned for other biological experiments in order to ready them for later potential planetary missions. Development of operational breadboards for the unified biology and the wet chemistry analyzer experiments will be continued with emphasis on test programs, to insure that the current designs will adequately perform the scientific goals of the experiments, and to identify engineering problems which will require further design and development efforts.

W75-70660  192-55-65
National Aeronautics and Space Administration, Washington, D.C.

BIOINSTRUMENTATION
Dr. R. S. Young  202-755-3732

The broad objective of the effort is to develop instrumentation and techniques for planetary exploration in the field of exobiology. The primary emphasis of the program is directed at the exploration of Mars, but consideration will be given to application of the instrumentation to other planets. The work ranges from the continued development of a complex wet-chemical processor for the isolation and identification of soil compound such as amino acids, to feasibility studies of experiments involving the in situ study of soil gas evolution, microscopy, and calorimetry, and gas chromatography/mass spectrometry. The approach is to: (1) develop, fabricate, and test, in breadboard form, specific critical components of the wet-chemical processor; (2) establish feasibility and perform preliminary design of in-situ gas exchange experiment; (3) establish feasibility and perform preliminary design studies of remotely operated microscope systems; and (4) determine feasibility of combining gas chromatograph/mass spectrometry with wet-chemical analytical systems.

W75-70661  192-55-66
National Aeronautics and Space Administration, Washington, D.C.

PLANETARY ENVIRONMENTS
Dr. R. S. Young  202-755-3732

Analytical methods will be developed for the determination of biologically important planetary environmental characteristics, such as composition of the atmosphere, presence or history of water, and occurrence of organic emissions. The methods and instruments developed for planetary exploration will be useful in assessing a planet's ability to sustain a biota.
W75-70662 192-55-66
Ames Research Center, Moffett Field, Calif.

PLANETARY ENVIRONMENTS
H. P. Klein 415-965-5094
(192-55-63)

Scientifically justifiable methods of analyzing biologically
important parameters are being studied for instrumental
implementation in order to assess the extent of a planet's biological
habitability based on the planet's atmosphere and water history,
and for selecting biologically enriched areas based on water
availability and organic emissions.

W75-70663 192-55-68
National Aeronautics and Space Administration, Washington,
D.C.

SUPPORT ACTIVITIES
Dr. R. S. Young 202-755-3732

The AIBS Advisory Panels for OSSA are established to perform
the following functions: (1) to evaluate the scientific merits of
research proposals submitted by OSSA Program Chief(s) and to
advise Program Chief(s) on the scientific merits of said proposals;
and (2) to plan, conduct and coordinate meetings of the panels,
providing necessary secretarial service, including minutes of the
meeting.

Planetary Quarantine

W75-70664 193-58-61
National Aeronautics and Space Administration, Washington,
D.C.

PLANETARY QUARANTINE ADVANCED STUDIES
Lawrence B. Hall 202-755-3760

It is NASA's policy to avoid contaminating the planets with
viable terrestrial life and to avoid negation of life detection
experiments by contamination with terrestrial life. This can be
accomplished by: (1) avoiding contact with the planet; or (2)
landing only space flight hardware that carries limited life on
board. The research will result in sterilization methods specifically
tailored to the spacecraft. The technology that is being developed
in the use of dry heat may have limited application to other
fields, but alternative methods being developed to supplement
dry heat may have widespread and economically important use
in the sterilization of foods, pharmaceuticals, surgical supplies,
and other fields in which biological contamination cannot be
tolerated. The major approach to the sterilization of spacecraft
has centered on dry heat. Other methods have been examined
and found wanting on the basis of reliability, cost, safety, and
other factors. In dry heat heavy emphasis has been, and will
continue to be, placed on the definition of the amount needed
to accomplish the purpose. Concurrently, a search is being made
for acceptable alternative methods of sterilization that may be
used for specific applications in which dry heat is not acceptable
because of materials degradation. Included in this approach are
studies of the lethal effect of the space environment encountered
during the period of interplanetary cruise.

W75-70665 193-58-61
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PLANETARY QUARANTINE ADVANCED STUDIES
C. W. Craven 213-354-5322

Planning and analytical studies will be carried out which
support the evolution of defendable requirements in planetary
quarantine, and which develop basic analytical techniques for
their effective implementation in flight programs. Potential
contamination events of future missions will be evaluated.
Specifically, these studies will include: (1) an evaluation of the
impact of planetary quarantine constraints on Jupiter Saturn
flyby missions, satellite, and Saturn rings encounters. Jupiter
orbiter and probe missions to both Jupiter and Saturn; and (2)
studies to determine the effects of the natural space environment
on the survival of microorganisms. These studies are to be
carried out to identify planetary quarantine constraints for planned
missions to better understand the requirements and to develop

W75-70667 193-58-62
National Aeronautics and Space Administration, Washington,
D.C.

MICROBIAL ANALYSIS
Lawrence B. Hall 202-755-3760

The research program on microbial analysis stems primarily
from the need to sterilize space flight hardware by the application
of some form of stress to the organisms. As the organisms are
stressed, they die, not all at the same time, but progressively in
what is termed the 'logarithmic order of death.' Thus, the more
organisms that are present, the more stress (usually dry heat)
must be applied. Acting in the opposite direction, however, is
the need to keep the stress to the essential minimum so that
hardware reliability will not be degraded. For these reasons the
number distribution, and types of microorganisms must be known
in order that the optimum sterilization cycle may be applied.
The applications of this technology are being and will be applied
largely to spacecraft but the methods will also spill over into
the hospital, food preparation, pharmaceutical and surgical
supply fields. The approach being taken includes: (1) the
development of precise methods for the removal, enumeration,
and identification of all the bacteria from a representative surface;
(2) the recovery of a representative sample of the organisms
that are buried in solids; (3) the propagation of bacteria in aerosols;
and (4) the estimation by mathematical and computer tech-
niques of the total bioload on, and in, a spacecraft. Concurrently,
field applications are being carried out to provide experience
with the technology and the base line data on missions that
have been or will be landed.

W75-70668 193-58-63
National Aeronautics and Space Administration, Washington,
D.C.

CONTAMINATION
Lawrence B. Hall 202-755-3760

The probability of contaminating a planet by a flyby or
orbiter spacecraft and the difficulty of achieving sterility of a
landing spacecraft is related directly to the amount and
characteristics of the biological contamination on the spacecraft.
Therefore, the probability of contaminating the planet and the
difficulty of sterilizing a landing vehicle can be reduced by
controlling the amount and kind of viable contamination that
gets on, and in, the spacecraft during manufacture, assembly,
test, and launch. The concepts and procedures resulting from
this effort provide the pressures used to keep a spacecraft

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biologically clean. The dissemination of these biological cleanliness procedures is of major importance to industry, particularly pharmaceutical and surgical supply industries. In the former, the procedures developed for contamination control are saving millions of dollars a year by preventing false positives that result in the needless destruction of large batches of product. The approach to this problem centers largely in the evaluation, dissemination, and application of ultraclean techniques and in the gathering and recording of planetary quarantine publications.

W75-70670 193-58-64
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
PLANETARY BACK CONTAMINATION
C. W. Craven 213-354-5322
The objective of this technical work package is to develop methodology and procedures for the reduction of microbial burden on an assembled spacecraft at the time of encapsulation or terminal sterilization or during flight. This technology is required for: (1) determination of the sterilization process for a planetary lander or probe; and (2) the reduction of excessive microbial burden on spacecraft components for the purposes of either decreasing planetary contamination probabilities for an orbiter, or minimizing the duration of the sterilization process for a lander. The work will provide needed information concerning cleaning techniques that could significantly reduce microbial burden on spacecraft hardware. This technical work package contains two work units which provide for activities at the Planetary Quarantine Laboratory at the Air Force Eastern Test Range. This laboratory's research is directed at improving and evaluating assay techniques, enumeration estimates, sterilization procedures and rapid identification of microorganisms associated with spacecraft and their environments. This technical work package also contains a work unit to study the impact of planetary quarantine on shuttle launched spacecraft.

W75-70671 195-20-01
National Aeronautics and Space Administration, Washington, D.C.
EARTH BASED OBSERVATIONS
F. I. Roberson 202-755-1602
Continued study is planned of the lunar surface using earth-based instruments. Studies of broadband reflection spectroscopy are used to determine the chemical and mineralogical composition of the lunar surface. Study is also planned of the moon in terms of composition, surface processes, and regional geology using data from telescopic spectral reflectivity. Using telescopic measurements of minute color differences, studies will be conducted on separating lunar maria into chemical and stratigraphic units and dating these units.

W75-70672 195-20-02
National Aeronautics and Space Administration, Washington, D.C.
THEORETICAL STUDIES

F. I. Roberson 202-755-1602
Development of scientific concepts about the composition, structure, stratigraphy, origin, and history of the moon and its constituent features requires an iterative process of data acquisition, synthesis, and theory. The evolving theoretical models of the moon have been constantly refined through testing and modification in this series of studies. Major areas of research include temperature-pressure studies, cosmo genesis, seismology, electrical conductivity, geologic mapping, interactive of lunar materials with energetic particles, and thermodynamics of lunar processes.

W75-70673 195-20-03
National Aeronautics and Space Administration, Washington, D.C.
LABORATORY SIMULATION
F. I. Roberson 202-755-1602
The objective is to study the moon by experimentation in the laboratory. This includes: study of the lunar surface by laboratory observations of the effect of various types of solar radiation on silicate glass; study through models, the lunar interior structure and evolution as constrained by the physical and chemical properties of the same minerals found on the moon; study the shock effects, in the laboratory, of rock-riding minerals and the synthetic materials under a wide range of temperature and pressures; and study shock metamorphism effects and cratering phenomena to impact parameters of meteoroids using the laboratory facilities.

W75-70674 195-20-04
National Aeronautics and Space Administration, Washington, D.C.
EXTRATERRESTRIAL MATERIALS
F. I. Roberson 202-755-1602
The objectives of extraterrestrial materials program are to improve and extend scientific and technical knowledge of meteorites in order to increase our understanding of the composition and history of the solar system, give detailed information on present and past conditions of cosmic radiation in interplanetary space (space probes), and supplement studies of the chemical, physical, and geological properties of the lunar samples. The wide variety of experimental techniques available for meteorite study, including measurements in crystallography, mineralogy, radioactivity, particle tracks, chemical and isotopic composition, etc.-serve to give us detailed information on the origin, age, and history of these extraterrestrial objects.

W75-70675 195-20-05
National Aeronautics and Space Administration, Washington, D.C.
ANALOGUE STUDIES
F. I. Roberson 202-755-1602
Studies of terrestrial features that have been formed by similar processes to those that are believed to have shaped the moon's surface provide the data needed to interpret lunar history. The type of features being extensively studied are: terrestrial meteorite impact structures, terrestrial volcanoes, mass waste erosion, lava ridges, ash flows and ejecta flows. These are the type of features that appear to be dominant on the lunar surface.

W75-70676 195-20-06
National Aeronautics and Space Administration, Washington, D.C.
SCIENCE EXPERIMENT CONCEPTS
F. I. Roberson 202-755-1602
Experimental concepts are conceived, developed, and demonstrated that pertain to the lunar orbit and surface which require perfection of techniques of data reduction and analysis, and interpretation as well as investigation of concepts, instruments and hardware including testing and calibration. These experiments emphasize geophysics and geochemistry.

W75-70677 195-21-02
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF THE MOON AND METEORITE PARENT BODIES
The objectives are to obtain better understanding of the structure, origin, and evolutionary history of the moon by means of theoretical investigations employing the results of lunar and ground based experiments. Theoretical and experimental knowledge of physical processes, and mathematical modeling techniques are used, together with astronomical and geological data, to construct and analyze mathematical descriptions of lunar and meteorite processes and structure. The results of these calculations are interpreted in terms of such topics as: composition, material properties, and thermal history of the moon; solid state convection in the lunar interior; the interpretation of rare gas studies of meteorites and lunar samples; lunar cratering and the tidal fission of lunar orbiting bodies.

**THEORETICAL STUDIES**

John A. O'Keefe 301-982-4445  
(195-22-03; 195-22-04)

This work consists of diverse theoretical studies on the structure and history of the moon. Included are: (1) backward calculations of the orbit of the moon to find out where it was in times past; (2) chemical calculations aiming to explain the absence of nickel and precious metals from the moon's surface; (3) dynamical studies of the mechanics of splitting the earth; and (4) studies of tektites, testing the hypothesis that they are actually a kind of inexpensive and abundant lunar sample. Work so far suggests that the moon may have formed by fission of the earth so most of the effort is being channelled along this line. The question of possible lunar volcanism (in our times) is also being carefully studied.

**IMPACT CRATERING IN GEOLOGIC MATERIALS**

D. R. Chapman 415-965-5065  
(383-21-02)

Scars of large ancient terrestrial impact events are being recognized at a steadily increasing rate and this unfolding record, together with evidence of impact craters on Mars as well as those on the Moon and probably on Mercury, serves to emphasize that meteoroid cratering has been an important geological process in planetary evolution. For most atmosphere-free bodies such as the moon, impact has been a major geologic agent for erosion and metamorphism (shock). Appreciation and thorough understanding of the effects of impact at all scales are, therefore, essential in unraveling lunar (and planetary) history. Moreover, knowledge of cratering processes and the influence of variables controlling crater formation and geometries provide invaluable means for interpreting physical properties and structural details of the surfaces exposed to the meteoroid environment. Impact studies using the Vertical Gas Gun (VGG) Range already carried out have contributed significantly to the interpretation of planetary geology. The most recent publications in which these studies played a major role are: V. Oberbeck and R. Morrison. Laboratory simulation of the herringbone pattern associated with lunar secondary crater chains, The Moon. 1974 (In Press) V. Oberbeck and R. Morrison, The Lunar Herringbone Pattern, Apollo 17 Prelim Science Report NASA SP, 1973 (In Press).

**CHEMICAL AND ISOTOPIC STUDIES OF METEORITES AND ABLATION PRODUCTS**

D. R. Chapman 145-965-5065  
(195-42-51; 385-45-01; 879-10-00; 188-45-53)

Chemical analyses via the electron microprobe permit determination of coexisting mineral compositions in meteorites, terrestrial analogs, and lunar samples. Knowledge of mineral compositions, together with textural studies, is needed to determine more precisely the physicochemical conditions of their origin, post-solidification thermal histories and shock events. On-going experiments are being utilized to determine the feasibility of forming meteorites from a cold beginning. Concentrations of volatile and nonvolatile elements in high temperature inclusions and minerals of carbonaceous chondrites, together with O18/O16 will be determined to test the condensation vs. extrasolar system origin for carbonaceous chondrites. In addition, several other meteorites, consistent in composition with the high temperature condensation theory will also be examined. This portion of the task will be conducted by ion probe analyses. Characterization of reactions and fractionated products will define the types of material being ablated from bodies during entry into the earth's atmosphere. This will enable new criteria to be developed for identifying debris ablated from sources such as meteoroids. Hence, it will be possible to identify extraterrestrial debris ablated from meteoroids and fine balls from glacial ice sediments. Analyses to be conducted on specimens will include optical mineralogy, petrography, density, X-ray diffraction, X-ray fluorescence, electron microprobe, ion microprobe and scanning electron microscopy.

**CHEMICAL AND ISOTOPIC STUDIES OF METEORITES AND ABLATION PRODUCTS**

Goddard Space Flight Center, Greenbelt, Md.  
(195-22-06)

The overall objective is the development of improved systems for lunar orbital X-ray and gamma ray spectrometry. Three efforts involved in this are: (1) adapting a central data system for a lunar orbital vehicle; (2) solid state detectors; and (3) determining the system's radiation background. The central data system will improve data handling by consolidating the data accumulation, acquisition, and transmission for multiple input detectors such as proportional counters, scintillation counters and solid state detectors. This will simplify the detector spacecraft interface. Solid state detectors will give improved resolution of characteristic line radiation used for elemental identification of the lunar surface. The development of such detectors for space flight use will be encouraged. Studies of their response over the energy range of interest will be performed using neutron irradiation of extended media. Background radiation in the detector and surrounding
OFFICE OF SPACE SCIENCE

EARTH BASED LUNAR OBSERVATIONS
D. P. Burcham 213-354-3028

We propose to conduct ground-based observations of the moon using several techniques. Two dimensional observations in the visible and near infrared will be made using the Silicon Imaging Photometer System (SIPS). These observations will yield two dimensional images of spectral reflectance which can be used to define compositional and stratigraphic units. The Image Processing Laboratory facilities will be used to optimize data for comparison with other data sets obtained under this program.

Two types of radar investigations are also planned: (1) the mapping of polarized and unpolarized radar echoes to facilitate correlation with Apollo bistatic radar results and existing ground based radar maps; and (2) topography measurements along great circles using Arecibo Observatory 70 cm radar. These measurements will be tied to Apollo topography data to obtain accurate topographic control over a large lunar area. The results from all of the investigations will then be correlated along with other data sets (such as gravity) to investigate: (1) the source of gravity anomalies in irregular mare; (2) large scale roughness variations; and (3) age stratigraphic relationships among mare units.

THEORETICAL STUDIES
D. P. Burcham 213-354-3028

We propose to solve a series of boundary value problems appropriate to the moon which relate the deformation of the surface under prescribed loads of finite mass distribution to other observed geological parameters. The time-dependent problem will be considered in which viscosity at depth is allowed to vary in response to variation in subsurface temperature. The subsurface temperature is in turn determined by appropriate models of the thermal history. The ultimate aim is to solve the inverse problems, i.e., what the history of the temperature profile is under a given load or mass distribution and a given deformation. The formalism of the inverse problem is the subject of a current lunar synthesis proposal. Here we seek to solve and make usable the forward problem of surface deformation resulting from various possible distinct lunar models, and through the sensitivity of the differences in deformation to initial assumptions implied by such models at the present time. From such calculations a framework can be provided to study: (1) various structural models of the upper part of the moon; and (2) early near-surface temperature distributions. The former may help distinguish between various models of lunar formation; in fact the method of analysis proposed here may be the only direct means of attacking the difficult questions of the paleotemperature distribution within the moon. The latter way aids in solution of the still unsettled question of locating anomalous masses, i.e., the mascons.

ADVANCED EXPERIMENT CONCEPTS
D. P. Burcham 213-354-3028

Advanced gamma ray spectroscopy is investigated in anticipation of an opportunity to chemically map the entire lunar surface from a spacecraft placed in a close lunar polar orbit. Reference points will be the results of the Apollo 15 and 16 gamma ray experiment, and the scientific potential-design requirements of a high purity Ge detector instrument. Particle track cosmochronology is also investigated to develop fast neutron thorium mapping methods and expand particle track methods in preparation for more detailed chronology studies of ancient rocks. These studies answer questions about fractionation of the heat producing elements on a mineralogical and whole-rock scale. Support for application of these methods to lunar samples will be sought. When the results of these tasks are applied to the moon, valuable information will be gained on the nature and processes of the lunar surface. Application of this large and small scale information will enlarge our understanding of the moon's chemical and thermal history.

Planetary Astronomy SR&T

W75-70687 195-25-03
Lyndon B. Johnson Space Center, Houston, Tex.

LABORATORY SIMULATIONS
L. A. Haskin 713-483-4484

The conditions of origin and formation for naturally occurring geological materials can be experimentally determined through the production of synthetic analogs in the laboratory combined with geochemical and geological analysis of the products. The Planetary and Earth Sciences Division of JSC conducts such experimental work using controlled atmosphere furnaces and hydrothermal and gas high pressure equipment to produce synthetic minerals and rocks and a 20 mm flat plate accelerator capable of performing controlled shock loading experiments of up to 700 kb peak pressure in geological materials.

EXTRA TERRESTRIAL STUDIES (METEORITES)
L. A. Haskin 713-483-4484

Meteorite studies are performed to generalize our knowledge from lunar and terrestrial studies to other parent bodies in the solar system, to investigate the commonality or uniqueness of processes involved in the primary accretion and differentiation of bodies in the solar system, and to decipher the record of subsequent processes that is preserved in surface samples. Research involves the use of a variety of analytical geochemistry methods of analysis.

W75-70688 195-25-05
Lyndon B. Johnson Space Center, Houston, Tex.

LUNAR ANALOG STUDIES
L. A. Haskin 713-483-4484

Selected areas of the earth bear considerable similarity to areas of the moon and are chosen for detailed geological analysis so that the information derived can be used in interpreting the scientific findings from the lunar science program. Certain large scale impact structures and other terrestrial occurrences are chosen to provide information on ejecta blankets surrounding impact craters, strontium isotope ratios as important parameters in determining the petrogenesis of plutonic rocks, origin and evolution of basaltic and gabbroic rocks, melt-derived versus non-melted fragmental products of large terrestrial impacts, and Precambrian anorthosite complexes.

W75-70690 195-25-06
Lyndon B. Johnson Space Center, Houston, Tex.

ADVANCED EXPERIMENT CONCEPTS
L. A. Haskin 713-483-4484

The objective of this plan is to develop the ion microprobe microanalyzer as a high resolution instrument for the determination of trace elements in geochemical research. The development program consists of three parts: (1) analysis and evaluation; (2) electronic system development; and (3) data reduction methods development.

W75-70691 196-41-50
Goddard Space Flight Center, Greenbelt, Md.

GROUND-BASED INFRARED ASTRONOMY
R. A. Hanel 301-982-4528

The scientific objective is to determine information on the atmospheres and surfaces of the planets from ground-based infrared measurements, obtained with high spectral resolution.
of planet thermal emission spectra. A double-beam Michelson interferometer has been used to obtain high-quality spectra of Venus in the regions of the terrestrial atmospheric windows at 450-500/cm, and 1100-1200/cm with a spectral resolution of 0.2/cm. Evident of the spectra are numerous CO2 molecular absorption lines and several diffuse absorption features in the 850-1200/cm region. Interpretation of the diffuse features with homogeneous model atmospheres strongly indicates a 75%-85% 800-1200/cm region. Evident of the spectra are numerous CO2 molecular interferometer has been used to obtain high quality spectra of Venus. Attempts to measure the thermal emission spectrum of Jupiter have not been successful to date due to its very low infrared signal. Improvement of the present instrumentation will allow further valuable planetary observations to be obtained. These observations would initially be concentrated on measurements of Jupiter at approximately 1/cm spectral resolution in the 10 and 20 micron terrestrial atmospheric windows.

W75-70692  196-41-51
Goddard Space Flight Center, Greenbelt, Md.
RADIO AND RADAR PLANETARY STUDIES
J. K. Alexander  301-982-5461
The objective of this study is to obtain information on the nature, extent, and dynamical behavior of planetary magnetic fields, trapped radiation belts, and magnetospheres by studying the nonthermal radio emissions from the planets. The three major approaches to this investigation are: (1) synoptic observations of Jupiter's decametric radiation via a five-station network of monitoring instruments; (2) observations of Jupiter and Saturn at radio and decameter wavelengths with a very long baseline interferometer (VLBI); and (3) theoretical analyses of the generation and propagation of nonthermal radiation in a planetary magnetosphere. The Jupiter Monitor Network is providing unique data relative to the rate and stability of the magnetic field rotation, and the physics of satellite-plasma interactions in the magnetosphere, and correlative data for fly-by in situ measurements. The VLBI measurements may provide the first positive detection of a Saturnian magnetic field.

W75-70693  196-41-52
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED OPTICAL SOLAR SYSTEM ASTRONOMY
S. P. Maran  301-982-4703
This RTOP provides for the operation of two small observatory facilities, the principal one being a high-altitude observatory, and the other a mobile, expedition-type facility for qualitative and quantitative observations and measurements of solar system phenomena. These include imaging research on comets and their interactions with solar radiation and the solar wind, as well as photoelectric photometry and spectroscopy of atmospheres of comets, planets and natural satellites of the planets. In addition, if a suitable bright comet appears radio observations will be made.

W75-70694  196-41-67
Ames Research Center, Moffett Field, Calif.
PLANETARY ASTROMETRY AND SUPPORTING LABORATORY STUDIES
R. D. Chapman  415-965-5065
The abundance, temperature, and pressure of certain constituents of planetary atmospheres can be determined by spectroscopic observations from ground-based and from airborne observatories. Such data are necessary for the preparation of model atmospheres that are needed to evaluate the possibilities of life on the planets and to design systems for exploratory missions. The objectives of this work are to study airborne and ground-based observatories of planetary spectra, to obtain in the laboratory the spectroscopic parameters needed to analyze the observatory spectra and to develop the analytical and computational techniques to interpret the spectra in terms of real planetary atmospheres. Spectroscopic parameters, such as absorption line and band intensities and absorption line half-widths as well as their dependence on pressure and temperature, will be obtained for molecules of planetary interest using long path gas cells, cooled and heated gas cells, and high resolution spectrometers and interferometers operating primarily in the infrared.

OFFICE OF SPACE SCIENCE
W75-70695  196-41-71
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
GROUND-BASED OPTICAL ASTRONOMY
D. P. Burcham  213-354-3028
The general objective of this task is the comprehensive study of solar system bodies through ground-based astronomical observations. Specific emphasis is placed on high-resolution spectroscopic observations of the outer planets, Jupiter, Saturn, and Uranus. The principal instruments used in this effort are the Table Mountain Observatory 24-inch telescope with its high-resolution coude interferometer, the McDonald Observatory 82 and 107 inch telescopes, and the Mount Wilson 60-inch telescope. A laboratory spectroscopy program is operated in conjunction with the astronomy program in order to provide molecular data necessary for the interpretation of the astronomical data. Specific objectives for FY 75 include: (1) a program of observation of the spatial and temporal variations of H2, CH4, and NH3 on Jupiter, and H2 and CH4 on Saturn and Uranus. Analysis of these data in terms of abundance, temperature and pressure structure, and dynamics of the planets' atmospheres; (2) observation and analysis of temporal variations of the recently discovered sodium-emission region around the Jovian satellite Io; (3) a systematic program of photometry and spectroscopy of comets, with emphasis on comet P/Encke; (4) a program of multicolor photometry to investigate the colors and light curves of selected minor planets, with emphasis on those for which the least amount of observational data are available; (5) laboratory spectroscopy to provide molecular parameters required to analyze observations of planetary atmospheres; (6) evaluate the performance of recently developed breadboard Transform Camera by imaging Jupiter in wavelengths of the reflected solar spectra and in wavelengths close to 5 microns. This spectral region is a region in which the principal atmospheric constituents of Jupiter are highly transparent and in which J. Westphal has detected localized 'hot spots'.

W75-70696  196-41-72
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
GROUND-BASED INFRARED ASTRONOMY
D. P. Burcham  213-354-3028
The objective is to obtain and analyze high resolution infrared spectra of the planets in the 1.5 micron region in direct support of ongoing and planned planetary missions. The primary approach employed is the analysis of spectra produced with a Coudé-type Fourier spectrometer at the 107' telescope, McDonald Observatory, University of Texas. Ancillary approaches involve the use of laboratory infrared spectroscopy and data compilations for the analysis of spectra, together with significant operational efforts in the fields of radiative transfer and model atmospheres. Interpretation of the data also feeds back to the development of instrumentation to support both potential spacecraft missions. For instance a spatial/spectral multichannel scanner for the investigation of the temperature profile and cloud morphology in the upper Jovian atmosphere using the 5 micron CH3D bands discovered in 1971 is being constructed.

W75-70697  196-41-73
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
RADIO AND RADAR PLANETARY STUDIES
D. P. Burcham  213-354-3028
The objective of the radio astronomy task is to conduct a comprehensive ongoing program in earth-based planetary radio astronomy. Primary interest is focused on Venus and the four major planets and their satellites. Studies of the properties of the atmospheres, magnetospheres and surfaces of these bodies are conducted with radio astronomical observations providing valuable input to theoretical models. The observational work of this task is conducted at JPL's Table Mountain Observatory (TMO), Goldstone Tracking Stations, Caltech's Owens Valley Radio Observatory (OVRO) and other observatories as required by specific radio astronomy program. Research programs at these facilities are planned in order to take full advantage of the various unique capabilities of the individual systems, especially the new 36 GHz interferometer at TMO and the 64-m antenna and advanced low-noise receivers at Goldstone. The objective of the Deep Space
The Office of Space Science (OSS) astronomy task is to obtain radar data on the planets for determining properties of their surfaces, orbits, and spins, with Venus, Mercury, Mars, and Saturn's rings as prime goals. This work employs the unique facilities of the OSS, and exploitation of synthetic aperture techniques. The microwave radiometer development effort is supportive of the Radio Astronomy task. The objective is to design, develop, construct, test and maintain advanced microwave radiometer systems for use at the Table Mountain, Goldstone, Owens Valley and other radiotelescope facilities. During FY-75, the specific objectives are to maintain and upgrade the existing equipment and to expand the operation of the 36 GHz interferometer to the two-baseline capability.

W75-70698 195-35-01
Goddard Space Flight Center, Greenbelt, Md.
**LUNAR POLAR ORBITER DESIGN STUDY**
W. D. Hibbard 301-982-4474
(888-20-00)

The objective of this RTOP is to provide the necessary technical, scientific and management information to justify and initiate the design and fabrication of a Lunar Polar Orbiter payload and its support functions. The approach is to conduct a detailed mission definition study, including mission and payload system engineering studies, cost/weight/risk trade-off analyses, experiment definition studies, resource estimates, implementation plans, and other activities required. The major products will be a system design report, a procurement package covering all major contracts, and a project implementation plan. Supporting reports will be issued as required. It is anticipated that the payload will be Delta-launched and will comprise two lunar satellites: (1) a low-altitude polar orbiter carrying the primary scientific instruments; and (2) a high-altitude, low-inclination relay satellite that provides a precise tracking link to the far side of the moon.

W75-70699 195-35-01
Lyndon B. Johnson Space Center, Houston, Tex.
**S AND AD SUPPORT FOR SUPPORTING RESEARCH AND TECHNOLOGY TASKS**
L. A. Haskin 713-483-4464
(195-25-03)

This plan provides the institutional type support for S and AD in-house geoscience supporting research and technology tasks. Typical support is provided in the form of analytical and experimental instrumentation design and fabrication, instrument maintenance and repair, instrument up-grade as state-of-art improvements become available from vendors or are developed in-house, liquid nitrogen storage and remote terminal computer rental, purchase of technical publications, analytical instrumentation operation, in-house computer maintenance and repair, purchase of thin sections and rocks samples, and purchase of computer programs.

W75-70700 195-40-02
Langley Research Center, Langley Station, Va.
**NEW TECHNIQUES FOR THE ACCURATE DEFINITION OF THE LUNAR GRAVITATIONAL FIELD**
E. S. Love 804-827-2893

The objective of this work is to develop new techniques for analyzing the data from lunar missions so as to better define the physical properties of the moon. Lunar gravity analyses have been hampered by the absence of direct measurements of the lunar farside gravity environment, by the considerable roughness of the lunar gravity field, and by the limited data situation. These factors require the estimation of a large number of coefficients which are highly correlated. Emphasis this year will be in two areas. The first area will be science optimization for future lunar missions. Specifically, parametric studies of satellite-to-satellite Doppler tracking will be made to determine the efficiency of these data for very high degree, intermediate degree, and low degree gravity field determination. The second area involves development of a theory for combining available satellite tracking data with lunar retroreflector data. In order to do this, various methods will be evaluated, the optimum method selected, and finally, the detailed theoretical development will be performed.

**OFFICE OF TRACKING AND DATA ACQUISITION**

**Tracking, Orbit Determination & Ground Base Navigation**

W75-70701 310-10-22
Goddard Space Flight Center, Greenbelt, Md.
**MISSION SUPPORT COMPUTING SYSTEMS AND TECHNIQUES**
D. S. Woolston 301-982-5571
(310-10-26)

The major objectives of this RTOP are to provide generalized, flexible and economical mission support and mission analysis computing systems to meet the operational needs of forthcoming spacecraft missions. Many of the effort will be directed toward finding the most effective and most efficient combination of techniques for a given application. New statistical filtering techniques which decouple orbit and model parameter estimation have been developed under this RTOP and will be evaluated and extended to permit the use of newly available data types. A further objective will be to explore the possibility of reducing ground based tracking and orbit determination requirements by examining new and unique ways of determining a spacecraft's orbit. The information content of on-board attitude data and/or landmark data, for example, should be useful in orbit determination and could reduce the need for tracking. In a task picked up from a companion RTOP, halo-orbit stationkeeping technique will be explored with the objective of determining the proper magnitude, direction, and timing of orbit adjust maneuvers.

W75-70702 310-10-26
Goddard Space Flight Center, Greenbelt, Md.
**ATTITUDE/ORBIT ANALYSIS**
E. J. Lefferts 301-982-5508

The objectives of this RTOP are to increase the efficiency and decrease the resources needed to meet the requirements for forthcoming spacecraft missions by: (1) the use of new data types from telemetry to decrease the quantity and usage of tracking data for orbit determination and guidance control; (2) the provision of generalized and flexible computing systems using on-board sensors and computers along with small ground computers to reduce the demand upon the central computer facility; and (3) providing standardized sensor combination and telemetry software interfaces to effect a reduction in the attitude determination development cost. The approach involves the development of computational software to permit the analysis of the coupled attitude/orbit determination process. An error analysis program will be developed to examine the sensitivity of sensor combinations in the combined model. Cost models for the mix of on-board, ground based mini-computers and large central computers will be developed. Simulations of the attitude and orbit determination process will be performed using on-board computer systems and small ground-based systems (PDP-11).

W75-70703 310-10-42
Goddard Space Flight Center, Greenbelt, Md.
**FREQUENCY STANDARD SOURCES**
H. E. Peters 301-982-5946

This RTOP is to develop improved atomic hydrogen frequency and time standards for critical NASA applications: optical and microwave tracking (2 microsecond time stability required); very long baseline interferometry in geodesy and astronomy; experimental requirements for Spacelab Applications Facility (ranging, timing, relative goals); and precise time and frequency dissemination or basic standard reference. The objective of task A, Operational Atomic Hydrogen Maser Standards, is to complete tests with new hydrogen masers built in FY 1974, test new teflon high line Q bulb configuration, develop improved synthesizer, and complete advanced cavity auto-tuner system. The objective of task B, Hydrogen Maser Basic Calibration Standard, is to design and construct variable volume hydrogen maser for evaluation of operational maser inaccuracy effects. A
new design, capable of 1 x 10 to the minus 14th power accuracy, will be completed and tests will start in FY 1975. The objective of task C, Atomic Hydrogen Beam Standard, is to design a new device based on free atom resonance for absolute accuracy capability of 1 x 10 to the minus 14th power or better. Resident Research Associates, now on-board, will follow earlier successful work.

Spacecraft-to-Ground Communications, Telemetry and Command

**W75-70704** 310-20-20
Goddard Space Flight Center, Greenbelt, Md.

**TRACKING AND DATA RELAY SATELLITE TECHNOLOGY DEVELOPMENT**

George Q. Clark 301-982-6331
(310-20-46)
The objectives are: (1) to provide for the simulation and system design of a Tracking and Data Relay Satellite System (TDRSS) to be used for support of NASA missions, and (2) to provide for the orderly development of the technology required for implementing a first-generation TDRSS by 1979. Various studies, simulations, and model fabrications will be performed to establish the parameters for a TDRSS, while other studies will identify and provide solutions to problems inherent in the system. In addition, technology will be developed as required for the improvement of a first-generation TDRSS.

**W75-70705** 310-20-27
Goddard Space Flight Center, Greenbelt, Md.

**NETWORK TIMING AND SYNCHRONIZATION TECHNOLOGY**

A. R. Chi 301-982-2502
The objectives of this research are to: study and develop techniques for time synchronization; coordinate time determination methods and dissemination formats to meet NASA needs and network requirements; apply known technology to planned or existing systems which may or may not be solely NASA supported programs; initiate and review development programs which meet present and future needs of the network including hardware and software development where appropriate; and conduct theoretical investigations and experimental tests for network applications. A single worldwide time synchronization reference system using the Navy's OMEGA navigation system as a carrier was investigated. Receiver hardware for time extraction from the carrier signals was developed. A field test of the receiver and system capability is ready and planned for FY-74. Construction of OMEGA transmission format as presently constituted includes two side frequencies which are separated by 250 hertz for time transmission. The system precision is 90 microseconds at cycle identification level and 1 to 5 microseconds after a carrier cycle has been identified.

**W75-70706** 310-20-31
Goddard Space Flight Center, Greenbelt, Md.

**A GROUND ANTENNA FOR WIDEBAND DATA TRANSMISSION SYSTEMS**

L. R. Dod 301-982-5319
Future advanced spacecraft system will transmit data to the ground at rates much higher than that of current operational systems. The Earth Observation Satellite (EOS) will transmit high resolution color TV either directly to a ground station or via a Tracking and Data Relay Satellite (TDRS). The TDRS will transmit signals from EOS and other satellites which required total TDRS bandwidths approaching 1 gigahertz. Existing NASA ground stations are not equipped for such data rates. Future wideband communication by TDRS, EOS and other projects, require use of frequencies at which the necessary bandwidth can be allocated. A wideband (approximately 1 gigahertz) system requires high performance ground antenna system. Emphasis on overall system efficiency will be essential to an economically feasible ground station. In particular, techniques and components will be developed which yield high efficiency antenna systems, feed systems and low noise preamplifiers. In addition, dichroic subreflector techniques permitting simultaneous and efficient operation of an antenna at different frequencies without degradation of overall performance or flexibility will be refined. Analytical procedures and design tools will be further developed to support the specific requirements of these advanced antenna systems and the general antenna development program.

**W75-70707** 310-20-32
Goddard Space Flight Center, Greenbelt, Md.

**HIGH RELIABILITY CONTROL SYSTEMS FOR ANTENNAS**

N. A. Raumann 301-982-6579
The objective is the development of a high performance servo and control system for large tracking antennas. There is a trend in the networks toward higher RF frequencies, switching from S-band to Ku-band of operation. This switch will require an improvement in tracking accuracy of the antennas from a present 0.9 mrad to 0.2 mrad. At the same time there is a requirement for increased link reliability due to concentration of data acquisition responsibilities and increasing data bandwidths resulting from reduction in the number of network stations. Thus link downtime has to be minimized by providing a high reliability control system and by reducing routine alignment and maintenance requirements. These objectives are met by use of a small digital computer in the antenna tracking loop. An experimental system, the computer controlled antenna system, has been developed under this RTOP and is in operation in the Network Test and Training Facility. The capabilities of this system will be extended by development of control algorithms to improve the tracking accuracy and by providing high reliability control system to minimize antenna downtime.

**W75-70708** 310-20-46
Goddard Space Flight Center, Greenbelt, Md.

**R.F. TECHNOLOGY FOR TDRSS USER SPACECRAFT**

F. J. Logan 301-982-4901
The objective of the work under this RTOP is to achieve technological advances in R.F. and antenna systems in order to satisfy the future requirements of spacecraft projects that require the near global real-time coverage of the Tracking and Data Relay Satellite System (TDRSS). The program: (1) identifies the basic operational requirements of these missions (2) investigates R.F. components and types of antennas that are available to attain the required parameters, and (3) develops system designs incorporating the optimum subsystems to permit the spacecraft projects to obtain proven reliable flight hardware within a reasonable time frame. These advances will be utilized in the development of S-band and Ku-band spacecraft systems, including the antenna, transponder, transmitter and receiver. These systems will be capable of direct communications to ground stations or to the TDRSS.

**Network Operations and Control Theory**

**W75-70709** 310-30-21
Goddard Space Flight Center, Greenbelt, Md.

**ADVANCED PROJECTS SUPPORT STUDIES**

F. L. Stetina 301-982-5730
The objective is to provide detailed analysis of advanced spacecraft mission interfaces with the STDN and the most efficient utilization of existing and projected NASA Spaceflight Tracking and Data Network (STDN) capabilities, including TDRSS, in the field of telecommunications and related data systems. Advanced projects are those in the mission and systems definition phases; such as, Large Space Telescope (LST), shuttle, spacciob, Interior Observation Satellite (IOS), Earth Resources Satellite Operational System (EROS), Earth Observation Satellite (EOS), Tracking and Data Relay Satellite, etc. Studies will be performed to optimize spacecraft link to ground RF link and data system. Studies will be used to identify new technology and support capability that can be used to upgrade or augment existing network capabilities. Consideration will be given to trade-offs made between spacecraft
Data Handling and Processing

W75-70711 310-40-25
Goddard Space Flight Center, Greenbelt, Md.
AUTOMATIC COMPUTER PROGRAM DOCUMENTATION
E. P. Damon 301-982-6868

The purpose of this project is to extend the capabilities of the Automatic System for Computer Program Documentation Software System, which is now under development for the IBM 360, to operate on the UNIVAC and CDC computers. Furthermore and more significantly, the purpose of this project is the investigation into the existence, availability, and applicability of automated verification tools, and the evaluation of current approaches to software modeling.

W75-70712 310-40-36
Goddard Space Flight Center, Greenbelt, Md.
AUTOMATIC DATA HANDLING
J. C. Rodgers 301-982-4189

Improvements to meet the large increases in support requirements demanded by NASA's future space programs specifically include a higher level of automation for Goddard Space Flight Center (GSFC) facilities resulting in increased data and information exchanges between the various GSFC facilities. This RTOP shall study methods of handling data and information and shall result in two end products: (1) the design and development of the Data Accountability System with the necessary capability to monitor, coordinate, and account for the data messages transferred between the remote ground stations and the GSFC facilities; and (2) the design and development of a prototype Integrated Telecommunications Distribution System providing a communications network between the operational M and DOD computers. The Data Accountability System shall interface with the M and DOD computer facilities and NASCOM concentrating on the particular problems inherent data coordination, and accountability when data is automatically transmitted between ground stations and GSFC by computer to computer transfers. The Integrated Telecommunications Distribution System will permit any computer on the telecommunications network to communicate with any other computer on the network.

W75-70713 310-40-38
Goddard Space Flight Center, Greenbelt, Md.
COMPUTATIONAL REQUIREMENT DEFINITION
A. Goodson 301-982-5308

A continuing need exists to reassess the functional capability of the M and DOD computer facilities in the light of present and future mission support requirements, advances in computer technology, and cost-effectiveness considerations. The purpose of this RTOP is to find practical answers to different aspects of this problem. Emphasis is on determining the practical guidelines which limit productivity on large computers operated in a multiprogramming environment.

W75-70714 310-40-39
Goddard Space Flight Center, Greenbelt, Md.
IMAGE PROCESSING FACILITY PERFORMANCE EVALUATION AND IMPROVEMENT
J. Y. Sos 301-982-2841

In the future several new Office of Applications (OA) projects, such as Nimbus-G, SEASAT, will require image data processing capabilities. It is planned to augment the existing GSFC image processing facility (IPF) to support, in addition to ERTS, the above projects. This plan proposes to conduct studies leading to the development of specifications for new IPF equipment, to define operational concepts for the facility, and to continue the development of efficient image processing algorithms. To assure achievement of high performance it is necessary to develop efficient performance monitoring techniques, parameters to characterize product quality, and obtain instruments to implement the techniques in conjunction with existing IPF hardware. It is also necessary to study methods for generating image products that could be less expensive and more useful to the investigator, and to eliminate un-needed and expensive products. This plan proposes to develop efficient and accurate methods for monitoring and controlling performance of equipment, and assuring the quality and usefulness of products generated in the IPF. Higher time resolution will be required on future spacecraft consistent with more sophisticated experiments and with the desire to correlate data from one spacecraft with data from another. It is necessary to study several spacecraft systems with different types of timing problems.

W75-70715 310-40-40
Goddard Space Flight Center, Greenbelt, Md.
PROJECT OPERATIONS CONTROL CENTER COMPUTATIONAL SYSTEM OF THE 1980'S
Richard desJardins 301-982-6222

The goal of this RTOP is to develop a control center computing system concept (hardware/software) for the shuttle era, embodying the following features: ultra reliable, fail-safe/hardware/software design; high visibility of systems implementation status; flexibility and ease of reconfiguration; simplified integration and test; reduced development time and cost; special attention to human interfaces; and high visibility of systems operational state. The effort will be distributed among three areas: (1) identification of probable computational requirements on GSFC project operations control centers anticipated in the shuttle era; (2) identification of probable system hardware/software capabilities and applicable technologies; and (3) to develop system hardware/software configuration concepts, including any models needed to prove feasibility or select system parameters.

W75-70716 310-40-41
INCREASING COMPUTER EFFICIENCY
Paul B. Schneck 212-966-3800

The objective is to develop and apply techniques for increasing computer efficiency. Specific objectives are to: (1) derive operating system designs which minimize idle CPU time; (2) develop preprocessing programs capable of analyzing and optimizing an input program to decrease its running time; and (3) develop preprocessing programs capable of transforming a program to a form suitable for parallel or vector processing machines of the type being introduced. A design philosophy, embracing the GISS operating system structure, will be extended to include effects of virtual memory, multiprocessing, and interactive processing. A FORTRAN to FORTRAN optimizing compiler employing all conventional optimizations will be used as the basis of investigations into additional common subexpression detection, code motion, interprogram optimizations. A preprocessor, performing global topological analysis will restructure
The actual reliability of data storage systems used for long-term storage affects both performance and cost of ground data handling equipment. Current work under this RTOP is directed to improved magnetic tape system reliability and performance evaluation. Cost savings can be achieved by improving the efficiency and reliability of magnetic tape systems used in data interchange. Means for full standardization of the ground instrumentation tape record/playback process are not available, and the error-producing mechanisms arising in computer tape have not been well evaluated. This RTOP implements two key studies needed to obtain quantitative data for computer tape failure mechanisms and to establish the specifications for an international standard reference tape system. A data flow rate of approximately 10 to the 12th power bits per year from the STDN network through computer data processing to the experimenters is carried by instrumentation and digital magnetic tape. Planned modifications to the ground data handling facilities will decrease or modify somewhat current tape system use, but magnetic tape will remain a major NASA cost and performance factor in the next decade. The work under this RTOP has no environmental impact.

OFFICE OF MANNED SPACE FLIGHT

Advanced Development

OFFICE OF MANNED SPACE FLIGHT

Advanced Development

W75-70718 909-81-08
Goddard Space Flight Center, Greenbelt, Md.

CONTROL COMPONENTS FOR EARTH ORBITAL SYSTEMS
H. E. Evans 301-982-5194

This task covers design, development and evaluation of prototype drive motors speed reducers, and ultra low friction systems for manned earth orbital systems support. Goals for this program are component and systems design that will be cost effective and meet 10 years operating life in the space environment. Initial efforts cover design, development and evaluation of components for CMG spin motor and gimbal torquers utilizing electronic commutation and unique speed reducing assemblies. Electronic circuitry required to provide control over the duty cycle range will also be designed and evaluated. Component studies will also include the integrated power and attitude control system elements such as ultra low friction rotor suspension and motor-generator design. Close coordination will be maintained with related efforts at LaRC, MSFC and JSC to insure program compatibility.

W75-70719 909-04-04
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ATTITUDE CONTROL PROPULSION
P. J. Meeks 213-354-2546
(506-21-21)

The objective of this plan is to design and test a flight weight ignition device based on the resonance tube concept for hydrogen/oxygen propellants at reduced temperatures. Empirical data gathered during the previous FY will be correlated analytically. Using this information a flight weight resonance ignition device will be designed and fabricated. The device will be made to fit into a hydrogen/oxygen engine. The final effort during this FY will be to experimentally optimize this unit with reduced temperature propellants and revise the analytical model if necessary.

W75-70720 909-44-02
Lyndon B. Johnson Space Center, Houston, Tex.

THERMAL CONTROL
W. E. Ellis 713-483-4941

The objective of the proposed effort is to (1) develop a modular, self-contained, inflatable radiator system that can be easily deployed in orbit from standard docking ports in order to minimize radiator area availability problems of future spacecraft, (2) develop a modular, heat pipe radiator system which would replace conventional pumped-fluid radiators in order to improve performance capabilities, reduce system complexities, and possibly reduce weight, and (3) develop a radiator system that can operate as a condenser in a vapor compression cycle where it can reject heat at much higher temperatures and, thus, operate in very severe external environments with a minimum area. The approach in developing the inflatable, deployable radiator concept will include an analytical investigation and a feasibility test of candidate inflatable radiator concepts followed by the development of prototype hardware. A modular, wide heat load range capability heat pipe radiator system will be developed by extending an on-going Grumman effort initiated in FY-72 in order to develop a more flight representative panel design configuration leading to a three-panel modular heat pipe radiator system test in a thermal-vacuum environment.

W75-70721 909-44-03
Lyndon B. Johnson Space Center, Houston, Tex.

SPACE SYSTEMS PROPULSION
Charles W. Yadez 713-483-4924

The objective of the first task is to generalize design criteria for acoustic resonator configurations and experimentally verify for the control or elimination of combustion instability without the aid of injector baffles. The end product is the design and test verification of acoustic cavities capable of simultaneously damping the basic and higher modes of combustion instability. The objective of the second task is to understand the mechanisms that cause reactive stream separation for hypergolic propellants. A basic understanding of the problems associated with unlike elements operating with hot fuel is necessary if advanced high performing engines are to be developed at a reasonable cost. The objective of the third task is to investigate new solutions to valving problems of propellant compatibility contamination, dynamic stability, and vibration sensitivity. The program will emphasize; (1) design approaches to minimize sliding friction (2) optimization of ceramic and elastomer materials; and (3) modeling techniques for sealing and dynamic valve performance. The objective of the fourth task is to develop technology for a nonintrusive flowmeter which can be used as a method of gauging cryogenic and earth storable propellants. The program will develop methods of measuring to 1% accuracy or less, the dynamic as well as steady state flow of liquid propellants in both one g and zero g. The objective of the fifth task is to investigate feed system/combustion chamber coupled instabilities. Passive devices for suppression of low frequency oscillations as well as the capability of operating with a low pressure drop injector will be designed and tested. The objective of the sixth task is to develop design criteria for a large continuous propellant acquisition system using earth storable propellants. Emphasis will be placed on successful operation under adverse g loading.

W75-70722 909-44-05
Lyndon B. Johnson Space Center, Houston, Tex.

SPACE SYSTEM ELECTRICAL POWER
David Bell, Ill 713-483-5361

Various in-house and contracted analytical and test programs will be performed to: provide advancements in solid polymer fuel cell technology to take advantage of associated inherent characteristics of long-life, invariant performance, low specific weight and low cost.

W75-70723 909-44-07
Lyndon B. Johnson Space Center, Houston, Tex.

COMMUNICATIONS
Jack G. Sheppard 713-483-6301

This RTOP will improve the productivity of communication and tracking systems to support Spacelab, payloads and
subsequent programs. Improvements will be achieved by taking advantage of advances in solid-state electronics, particularly in LSI (Large Scale Integration). Other gains will be achieved by transmission system improvements at new frequencies (high microwave and optical). Television will be important in future programs. It will gather experiment data, control payloads, assist docking operations, inspect damage and provide information to users on the ground. These diverse uses require a family of cameras, monitors, and controls. It is highly desirable that these components be solid-state. This RTOP continues the design of required systems and development of key components. RF spectrum crowding and data increases place a burden on communication signal processing. Careful selection and design can maximize throughput within system constraints (frequency, power, gain, and noise figure). LSI reduces size, component count, and interconnections by orders of magnitude, giving an attendant gain in reliability and reduction in program costs, making techniques previously ruled out by such factors practical. This RTOP continues the LSI implementation of key signal processing components. RF spectrum crowding and data rates are driving systems to higher frequencies—both microwave and optical. These new systems offer greater performance, but require careful implementation. In particular, the integration of electronics and antennas must be investigated to ensure that system performance required techniques do not negate the advantages of operation at high frequencies. Likewise, hardware demonstrations of optical (laser) systems are required to ensure that the projected unique capabilities of such systems are realizable.

W75-70724  909-44-13
Lyndon B. Johnson Space Center, Houston, Tex.

INSTRUMENTATION
Dave H. Owen, Jr.  713-483-4407
The Space Environment Simulation Laboratory at JSC represents the state of the art in advanced thermal-vacuum test (space simulation) facilities. Continuing efforts are being made to reduce required manpower and total operating costs, while, at the same time, maintaining the high standards of test posture and capability of the facilities. This required techniques and predict operational characteristics as they apply to actual thermal-vacuum chambers, payloads, and spacecraft. This is to include molecular migration and sticking coefficient, condensation, re-evaporation, corona phenomena, test articles geometric shapes and surfaces; and to develop methods and systems for identification, measurement, control and improvements. The following tasks are proposed: (1) Task 32 - computer simulation of system (continuing effort); (2) Task 33 - molecular flux math model development (continuing effort); and (3) Task 52 - development of low cost techniques for optics refurbishment and fabrication.

W75-70725  909-44-21
Lyndon B. Johnson Space Center, Houston, Tex.

MANUFACTURING AND INSPECTION
Evans C.  713-483-2941
The objective of this program is to further develop methods of electrical termination techniques. These electrical termination techniques are to be utilized on the proposed Advanced Aircraft Avionics Systems, Earth Resources Program, Department of Defense applications, unmanned and manned space efforts, and deep-sea oceanographic studies. This is to necessitate improved materials and hardware integrity due to their intended extended usage on these programs, as well as the planned numerous flights. This program will identify the techniques which have the potential for joining, reworking, and inspection of various electrical conductors (copper, nickel, Kovar) in such configurations as the following: Stranded copper with various platings to stranded, stranded to solid round with various platings, stranded to flat, flat to flat, flat to round, and round to round. The electrical conductors and terminations will be of various standard aerospace and commercial metals, platings, and dimensions. Under this program techniques will be developed which will expand existing techniques and give consideration to new methods in order to accomplish the above purposes. An additional task under this RTOP will be to complete a series of tests on hydraulic/pneumatic fittings. The fitting are separable, or permanent type of 11 different designs procured from aerospace suppliers. The sizes to be tested are 3/8", 5/8" and 1" on titanium and stainless steel tubing.

W75-70726  909-44-25
Lyndon B. Johnson Space Center, Houston, Tex.

ADVANCED SCHEDULING
R. H. Brown  713-483-4346
This RTOP continues the language development initiated with RTOP 909-44-25. An extension of Phase I, the language definition phase, and Phase II, the prototype implementation phase, of the development are supported by this RTOP. The functional specification of the basic Plans language, the support and algorithm modules of the language library, and the data structure are the end products of Phase I. Phase II will implement these specifications on a specified computational system. The detailed design specification of the language, the formulation of the specific routines, the final coded deck, and associated documentation will be produced by Phase II.

W75-70727  909-44-26
Lyndon B. Johnson Space Center, Houston, Tex.

ALGORITHM DEVELOPMENT
E. Dupnick  713-483-4431
Task 41 - Resource Allocation Algorithm Study. This study will continue investigating the applicability of certain mathematical programming procedures to a special class of resource allocation problems. The basic problem to be solved is development of an algorithm for use in allocating limited resources to competing activities. Task 51 - Development of an Advanced Variable Metric Iterator. This study will develop an advanced variable metric iteration trajectory shaping that combines the best features of several known techniques, achieving improvements in computational speed and cost. The resulting algorithm will be widely usable in various special purpose trajectory optimization programs and in general mission design and analysis programs. Task 52 - Explicit Guidance Algorithm Development for Third Stage Guidance. This study will develop the capability for explicit computation of guidance commands that will allow a space vehicle to achieve all required orbital transfers with minimum propellant expenditure. A specific required application of the algorithm is the unique situation of long powered maneuvers performed by a space vehicle having very low thrust-to-weight ratio propulsion capability.

W75-70728  909-44-27
Lyndon B. Johnson Space Center, Houston, Tex.

ADVANCED SOFTWARE DEVELOPMENT
Bond V.  713-483-4581
Task 32 - Development of Mission Design Tools Using Linear Transformation Orbit Theory. This study will produce new techniques for the calculation of precision trajectories based on a theory recently introduced by Drs. Kustaanheimo and Stiefel. This theory, named K-S theory, involves linear transformation of classical orbital elements. Recently the K-S theory has been extended from its numerical domain into generalized Delaunay elements. This study will continue that development so that it can be applied in low altitude earth orbit simulations. Task 51 - Development of an Interactive Computer Program to Provide Software Structure Analysis and Test Design Aid. This study will continue the development of an experimental technique to aid software verification. The basic concept is to design a computer program which can analyze the code of other programs and generate data useful in verifying these programs. It is proposed that this program be made interactive so that the software programmer may provide information about his software, and may receive information developed about the structure of that software, and thus be able to make that software more easily testable and more error-free.

W75-70729  909-44-28
Lyndon B. Johnson Space Center, Houston, Tex.

SOFTWARE PROCESSES (GENERALIZED DATA MANAGEMENT SYSTEM TOOLS)
L. R. Kirbie  713-483-3281
The objective of this RTOP is to perform research in data management system techniques leading to the development of
tools to aid JSC personnel in implementing new applications, selecting among data management system approaches and evaluating the performance of the applications on the host system. Research is also being performed on new data structuring techniques. One tool is a Math Model Simulator which will simulate various data base structures and access techniques for various host computers and background loads to provide data concerning resource utilization and response time for a particular application. The second tool is a piece of software called the Real Time Simulator which will interface actual Data Management Systems to permit the creation of actual data bases on an actual host computer system to provide instrumentation data for use in calibrating and validating the Math Model Simulator and user requirements.

W75-70730 909-44-29
Lyndon B. Johnson Space Center, Houston, Tex.
COMMUNICATIONS/NAVIGATION/TRACKING SYSTEMS ENGINEERING APPLICATIONS (AVIONICS COST/SYNTHESIS MODEL)
Dr. B. H. Batson 713-483-2981 (909-44-29)
This RTOP provides for development of prototype hardware for an all-digital television processing and transmission system. Much effort has been directed towards the study of TV digitization, compression, coding, and modulation techniques, but only recently (with the advent of large-scale integrated circuit technology) has an all-digital system appeared truly competitive with conventional analog techniques. It is now felt that an all-digital approach to picture transmission is not only feasible for the shuttle operational era, but that such an approach will have very significant advantages, such as low cost, high reliability, light weight, low power consumption, small volume, and high performance.

W75-70731 909-44-31
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE OPERATIONS TECHNIQUES
Walter Scott 713-483-3458
Task 32 - Task 2 of the Consumables Management Requirements for Space Shuttle. For this study, a four part statement of work has been written; the first part (Task 1) has been completed. This, the second part (Task 2), will define the ground support system that complements the onboard consumables management baseline concept defined in the previous RTOP; will evaluate this ground system with respect to other candidate onboard consumables management concepts also defined in the previous RTOP; and define a system that performs the complete consumables management function. Task 41 - Development of Cryogenics PVT Algorithm for Space Applications. This study will resume and complete the study of the equations-of-state for hydrogen. It will provide in computerized form the thermodynamic properties of slush oxygen and hydrogen; will provide a computer program of a density explicit equation-of-state for hydrogen, oxygen, and nitrogen which will be 100 times faster and at least 1/3 smaller in core storage size than any presently existing; and will provide data on properties of ammonia at pressures less than one atmosphere.

W75-70732 909-44-32
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED TECHNOLOGY/SUBSYSTEMS (DEVELOPMENT SEMICONDUCTOR MEMORY TECHNOLOGY)
Saverio Gaudiano 713-483-4061
An activity will be undertaken to upgrade two technical areas critical to the performance of electronic memories used in earth resource programs, shuttle, and spacecraft avionics. This effort will consist of a program to develop a non-volatile (information is retained if power to the device is lost) semiconductor memory and a second program to evaluate a memory employing a peristaltic charge coupled device (CCD). (1) A study will be conducted to define the design requirements for a nonvolatile semiconductor memory with respect to performance, cost, reliability, and data storage requirements. The memory chip will be designed, fabricated, and tested to determine the feasibility of using non-volatile semiconductor memories in spacecraft systems. (2) A study will be conducted to determine the current status of peristaltic charge coupled devices to define the requirements for a fast general purpose CCD mass storage aerospace memory system. The CCD memory will be designed, fabricated, packaged, tested, and documented. This program will result in a further development of CCD memories and a careful evaluation of their potential application to aerospace hardware.

W75-70733 909-44-35
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE SYSTEMS ENGINEERING APPLICATIONS (AVIONICS COST/SYNTHESIS MODEL)
Humboldt C. Mandell, Jr. 713-483-4551 (908-44-35)
The objective of this plan is to improve JSC and NASA capability to use costs and schedules as parameters in avionics system design and development. The approach is to: (1) develop an avionics data base of historical cost, schedule, and technical performance; (2) to use the data base developed for each subsystem in determining relationships between cost, schedules, and readily-known parameters, such as desired technical performance characteristics; (3) to perform cost and schedule sensitivity analysis over state-of-the-art and advanced (expected) performance ranges for each subsystem; (4) to verify the validity of cost and schedule estimating techniques developed with an example from each subsystem family, within the relevant performance ranges mentioned in (3); and, (5) to determine the influence of cost related parameters on advanced avionics system designs. Special studies will be performed to investigate low cost approaches to avionics development. These will include investigations of the use of previously-developed subsystems, and the relaxation of NASA specifications to ARINC standards and the use of commercial fabrication and testing techniques. Investigations will include the study of least costly lot sizes for the purchase of NASA avionics equipment.

W75-70734 909-44-36
Lyndon B. Johnson Space Center, Houston, Tex.
MECHANICAL SYSTEMS
Richard F. Smith 713-483-3491
This RTOP will develop and fabricate seals for evaluation which will not adhere/cohere to mating seals under simulated docking conditions of future spacecraft missions. It will be the added objective that the techniques used to prevent seals adhering/cohering will in no way compromise scaling integrity or seal compression requirements. This RTOP will perform design, fabrication, and verification testing of a sufficient number of windows to evaluate proposed methods of pressurizing in terms of reliability and weight savings.

W75-70735 909-44-37
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE SYSTEM CRYOGENICS
R. K. Allgeier 713-483-6771
The summary of this effort consists of two subprograms, one, an advanced insulation concept employing optically thin dielectric layers, the second, on testing evaluation of an 8'' x 22'' hydrogen thermal test article (HTTA). (1) The preceding contractual effort was partially successful in demonstrating feasibility. This effort will explore the feasibility of optically thin film stacks for cryogenic insulation when applied to a suitable substrate which theoretically will provide a substantial improvement in insulation performance. Prototype samples will be fabricated and tested with the early samples containing several layers and subsequent samples containing dozens of layers. A vessel with conventional insulation will be tested and then reinstalled with the dielectric insulation and retested. (2) FY-74 funds in the amount of $62K were allocated for testing evaluation of the HTTA. Due to leakage encountered in final checkout prior to test, an additional $45K is needed on this task. The test evaluation funds above would be utilized as intended following correction of the problem leakage. It is desirable to fund enough of the repair and corrective work to permit implementation of the funded test program.
This RTOP covers the development of improved nonmetallic materials for furnishing spacecraft interiors. The materials developed for previous programs (Apollo, Skylab) were optimized for maximum flame resistance in oxygen-rich environments at the expense of long term durability. Retest aircraft interior materials either fail to meet NASA flammability requirements or produce copious quantities of vision-impairing and toxic smoke. The objective of this RTOP is the development of durable nonmetallic materials which are capable of meeting spacecraft habitability and engineering requirements while meeting NASA flammability requirements and generating little or no smoke, and to advance the state of the art in the development of durable, flame resistant fibrous materials to satisfy long duration and reusability requirements. The significant pace of advancement made in fibrous materials from Mercury through Skylab programs must be continued in to the future mission configurations.  

Marshall Space Flight Center, Huntsville, Ala.  

COMMUNICATIONS  
D. O. Lowrey 205-453-1578  
The objective of this effort is to develop active electronically steerable microwave phased array systems operating in the S-band and Ku-band frequency regions for space communications and tracking purposes. These systems will provide high data rate, telecommunications capability with simultaneous or separate transmit, receive and tracking functions. Considerable system advancement and performance with decreased size and weight will be realized over conventional systems using separate transmitters, receivers, antenna, transmission lines, control and driving motors, and associated supporting structures. This is a continuing effort that will produce active electronically steered phased arrays that are light weight, highly redundant, have low dc power drain, uses 100 percent microwave integrated circuitry and utilizes a modular building block construction concept with standardized modules for maximum design versatility at minimum cost. The study of application of active electronic modular techniques to the Ku-band electronically steered phased array will be continued.  

Marshall Space Flight Center, Huntsville, Ala.  

MANUFACTURING AND INSPECTION (NDT)  
R. M. Henrette 205-453-1426  
The objectives of this effort are to develop and demonstrate the capability of a system using TV and fiber optics to permit visual inspection of space hardware in areas usually inaccessible to such inspection techniques and to extend and demonstrate the applicability of holography to nondestructive testing. A low light level color TV camera will be equipped with coherent fiber optic and appropriate light sources and filters will be provided to permit illumination and viewing of generally inaccessible areas of space hardware. This system will be modeled after, and extend the capability of an existing black and white system. Holographic techniques and systems previously developed to permit nondestructive testing of specific items of space hardware in response to testing problems encountered in specific development programs will be further developed and configured to provide a more broadly applicable testing capability. An integrated program consisting of contracted and in-house tasks will be pursued.  

Marshall Space Flight Center, Huntsville, Ala.  

INFORMATION MANAGEMENT SYSTEMS (SUMC AND TUG)  
H. Garrett 205-453-4070  
The objective of this SUMC effort is to develop advanced space computer hardware, software, and peripheral devices. Also the development of computer/scientist languages and interactions will be performed. This effort will lead to the development of advanced space computers, multiprocessors, and multicompurer systems, and the associated software; development of advanced computer peripheral devices; development of advanced computer displays, history plotters, keyboards, hardcopy devices, and mass storage units; and development of high level computer/scientist languages to
facilitate man-machine interaction. The objective of this tug effort is to define, develop and space qualify an onboard information management system which can best accomplish the requirements of the space tug mission. Aspects of this work that are being accomplished in-house and contractual efforts are being used to investigate power generation and control capability of IPACS; to develop requirements for critical hardware components to develop IPACS configurations and control laws; and to define multimission applicability of IPACS. Viability of the IPACS concept will be verified through integration of critical hardware components into a laboratory IPACS and thorough evaluation of this unit in a realistic mission and dynamic environment using LRC static and dynamic test facilities. Associated development programs will be directly coordinated with LeRC, GSFS, JSC, and MSFC. Preliminary problem areas include the impact of reliability, maintainability, failure modes and system integration on IPACS performance and multimission usage capability; performance limits of composite materials under cyclic stresses and extended-duration vacuum; development of bearings, seals, and lubrication systems capable of long-life at high speeds and under large cyclic loads; development of high power, high efficiency motor generators units for operation at high speeds; development of high power, long-life, low friction slipping assemblies for operation in a vacuum. Solutions to these problems will be verified through hardware tests and simulations, which will determine power generation capability, control effectiveness, and spinup, spindown cycling effects on system performance. Successful and timely completion of this program could result in significant cost savings resulting from large weight and volume savings and multimission usage of an IPACS module.

W75-70745
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL CONTROL (TUG)
J. L. Vaniman 205-453-3821
Thermal control of the tug is the maintenance of thermally sensitive tug equipment and structures within specified critical temperature limits through the control of heat flow to and from such equipment. Equipment includes such items as electronics components, fuel cells, batteries, APS systems, and hydraulic systems. It excludes thermal isolation and conditioning of main propellant tanks which is covered under a separate RTOP. Current studies have analyzed thermal control concepts for the worst case tug orbital environment. These studies show that long-life, low cost and semi-passive thermal control methods are required to maintain satisfactory thermal conditions under the environmental extremes encountered by the tug. The objective of continuing effort is to design the necessary thermal control hardware and to demonstrate its application and feasibility through breadboard development and testing. This demonstrated technology, optimized for weight and power critical to the tug, is to then be used for design of the NASA tug.

W75-70746
Marshall Space Flight Center, Huntsville, Ala.
PROPELLATION
A. L. Worlund 205-453-3853
The objective of this effort is to develop an RL-10 O2 heat exchanger that will provide mixture ratio control during tank head idle mode operation, and G02 for the tug vehicle tank pressurization.

W75-70747
Marshall Space Flight Center, Huntsville, Ala.
GUIDANCE AND NAVIGATION
D. O. Lowrey 205-453-1578
(502-23-42; 909-51-33)
This RTOP describes the program of research and technology development planned in the guidance and navigation area to establish an adequate technology base for the design and development of the space tug. The objective of this effort is to provide advances in the state-of-the-art in the inertial measurement unit and the scanning laser radar sufficient to support the design and development of the space tug mission requirements. The approach is the inhouse performance of specific improvements in operational characteristics, weight, cost and reliability of the guidance and navigation systems and components. This program takes advantage of other ongoing development programs at MSFC, such as the SUMC computer funded by OMSF and the laser gyro funded by OAST.

W75-70748
Marshall Space Flight Center, Huntsville, Ala.
CRYOGENICS
A. L. Worlund 205-453-3853
(909-55-03)
The basic program objective is to provide an integrated technology base to enable realistic trade studies involving cryogen propellant management subsystem options for the full capability tug. Preliminary studies, environmental parameters and component development will be combined to establish design data on performance and reusability. Operational constraints and interface design criteria will be a principal output of the subsystem and system testing. Subsystem concepts will be integrated and tested to identify system interface problem areas and the maintenance/cost relationship. Advanced concepts developed under prior technology programs which have not been applied to flight vehicles but already have a hardware development history will be utilized.

W75-70749
Lyndon B. Johnson Space Center, Houston, Tex.
MATERIALS (TUG)
W. R. Morgan 205-453-5313
Thin gauge Al 2219-T87 is proposed for propulsion tanks in the tug to minimize weight. Although much data exists on fracture properties of this alloy, it is on thicker sections. Thin gauge Al 2024-T6 is well characterized in thin sheets with stringer support for aircraft fatigue. Thin gauge Al 2219-T87 fatigue and fracture data are required. This program will provide design data not currently available. Fatigue crack propagation and toughness at cryogenic temperatures of thin parent metal and welded sheets unsupported by stringers will be determined.

W75-70750
Lewis Research Center, Cleveland, Ohio.
ADVANCED H2-O2 ENGINE COMPONENT TECHNOLOGY
J. W. Gregory 216-433-6849
The objective is to provide improvements in component technology applicable to advanced, high performance reusable hydrogen-oxygen rocket engines. Such engines must operate reliably in space for long periods of time and provide many restarts during a minimum of 20 missions. Included in this program are efforts on components such as: bearing and seals for turbopumps, complete turbopump assemblies, and thrust chambers. Technology will be developed for long life, small, high speed bearings for liquid hydrogen turbopumps. Both rolling element and hybrid (fluid film) bearings of 20mm size (shaft diameter) will be evaluated. Bearing design and fabrication will be provided under contract, and bearing testing will be performed in-house at LeRC. Effort will also be applied to the design, fabrication, and testing of controlled fluid film seals for small, high speed liquid oxygen turbopumps. This effort will evaluate seals of 30mm diameter capable of 10 hours operational life and 300 start/stop cycles at shaft speeds up to 90,000 rpm.
Space Life Sciences

W75-70751 970-21-11
Ames Research Center, Moffett Field, Calif.
NEUROPHYSIOLOGY
H. P. Klein 415-965-5094
The objective is to determine the effects on the nervous system of the unusual environmental factors encountered in space. This information will be applied in the evaluation, prediction, and control of adverse effects resulting from exposure, for example, to high and low g forces and unusual linear and angular forces. Particular attention will be paid to (1) vestibular, visual, and proprioceptive systems, (2) their anatomical substrates, (3) their interactions, (4) their roles in motion sickness, and (5) their relationships with the arousal mechanisms underlying sleep and wakefulness. Descriptive studies will define the influences of altered gravity on neurophysiological functions, orientation, sensorimotor coordination, postural control and locomotion. Analytical studies will be devoted to the understanding of the neural processes involved in the reception of gravitational stimuli, thresholds for detecting changes in acceleration and rotation, and the rate and level of adaptation to chronic exposure to altered gravity. In addition, studies will address the mechanisms which underlie changing levels of sleep and arousal, attention, alertness, and motivation in the presence of the gravitational and accelerative forces encountered in space flight. Other sensory systems such as those serving auditory and cutaneous (tactile, thermal and pressure) sensibilities will be investigated, as necessary, in support of flight experiments and in developing basic information relevant to remotely operated systems.

W75-70752 970-21-12
Ames Research Center, Moffett Field, Calif.
CARDIOVASCULAR PHYSIOLOGY
H. P. Klein 415-965-5094
The objectives are to describe and understand the mechanisms underlying the cardiovascular changes observed with space flight and the course of adaptation with readjustment upon return to unimpaired conditions. Studies will be directed towards an understanding of the cardiovascular changes associated with bedrest and their relationship to the cardiovascular changes observed with space flight. Cardiovascular responses to gravitational stresses (LBNP, tilt, and centrifugation) will be determined before and after varying durations of bedrest simulation of weightlessness. Human studies will be accomplished using primarily non-invasive, non-destructive testing methods. Animal studies will involve the use of chronically instrumented preparations and will be tested for their potential in future biomedical spaceflight payload definition studies.

W75-70753 970-21-13
Ames Research Center, Moffett Field, Calif.
RESPIRATORY PHYSIOLOGY
H. P. Klein 415-965-5094
It is predicted that pulmonary function changes significantly in weightlessness. The objective of this program is to determine the magnitude of certain of these changes and determine their effects on the ability of man to adjust successfully to long duration spaceflight and to adjust to normal gravity subsequent to such a mission. In addition, the part played by gravity in determining pulmonary function on earth in health and disease will be examined on subjects and patients to obtain baseline data and improve the prediction which can be made regarding the changes expected in weightlessness. The functions being measured are lung volumes, carbon dioxide washout, regional perfusion, regional ventilation, total ventilation, ventilation/perfusion ratio for whole lung and different regions, pulmonary diffusing capacity, mixed venous CO2 tensions, pulmonary blood volume and cardiac output. The effort includes: (1) investigations to determine the effects of gravity on normal human lungs with particular reference to mechanical deformation and its effects on pulmonary function; (2) continued work on baseline data on patients with early pulmonary disease; (3) feasibility demonstrations for hardware systems for testing pulmonary function.

W75-70754 970-21-14
Ames Research Center, Moffett Field, Calif.
METABOLISM AND NUTRITION
H. P. Klein 415-965-5094
Metabolism and nutrition studies conducted during, and subsequent to, space flight have shown transitory changes in several body functions. The objective of this RTOP is directed towards obtaining a greater understanding of the regulatory mechanisms associated with physiologic adaptations and readjustments to altered gravity levels. Work is to be performed using both experimental animals and human test subjects. Approaches are oriented towards a determination of gravity influenced subsystems and their mechanisms of response with a view to contributing towards future space flight science experiments definition. Animal studies are being conducted to develop a maintenance system for long term study on unattended instrumented monkeys; to determine the biochemistry and physiology of muscle, bone and red blood cell mass changes during simulations of hypodynamic environments; and to evaluate the metabolic implications associated with the gravitational accelerations and upon return to normal environments. During human bed rest studies, newer methods are being applied to evaluate variations in lean body mass and fluid compartments, as well as renal mechanisms pertinent to the regulation of plasma electrolytes, volume, and blood pressure. Carbohydrate metabolism is being studied with emphasis on the metabolic role of fat, and neuronal and urinary excretion is determined. Basic studies are being conducted to develop non-invasive measures of liver function and factors regulating body fat depletion/mobilization.

W75-70755 970-21-16
Ames Research Center, Moffett Field, Calif.
ENDOCRINOLOGY
H. P. Klein 415-965-5094
The general objective is to define more precisely the endocrine mechanisms which mediate the physiological responses and adaptations encountered in prolonged space flight. Research will be primarily directed to the analysis of the endocrine mechanisms regulating protein, lipid and mineral metabolism. Emphasis will be placed on the development of biochemical methods for assessing the endocrine status of subjects exposed to prolonged space flight with particular reference to the effects of real or simulated weightlessness and of variable g-forces. The specific approaches to be employed are as follows: (1) the quantitative determination of the levels of circulating pituitary and other peptide hormones in plasma; (2) the analyses of the spectrum of tissue peptidases involved in the conversion of peptide hormone precursors into biologically active hormones as well as their involvement in the regulation of the biologically active concentrations of pituitary and other peptide hormones; (3) the effect of variable g-forces on the plasma concentrations of peptide hormones and their resultant effects on protein, lipid and mineral metabolism; (4) evaluation of radiorespirometry as a tool for assessing the endocrine-dependent metabolic status of the whole animal; (5) analysis of endocrine-dependent enzymes involved in lipid metabolism and transport, and (6) the elucidation of the effect of varying brain serotonin levels on responsiveness of the pituitary-adrenal system to stress.

W75-70756 970-21-17
Ames Research Center, Moffett Field, Calif.
COUNTERMEASURES
H. P. Klein 415-965-5094
The objectives are to develop effective countermeasures to counter the altered physiologic responses demonstrated to accompany...
The objective is to describe and study the potential microbial, immunological, and biochemical problems of manned space flight and to describe the cellular and tissue response of the human body to prolonged exposure to the space flight environment. Studies will include the early (preclinical) detection of disease, microbial shock immunity to infection, measures to prevent or limit infectious disease, induction of latent viruses and the infectivity of large particle viruses. Tissue studies will investigate the effects of space flight factors on vascular permeability. Emphasis will be placed on the determination of the basic mechanisms involved at the cellular and tissue levels in the production of undesirable or harmful effects during prolonged space flight. This effort will be carried on by an integrated program of university grants and in-house research.

The objective is to determine effects of various environmental factors in relation to human performance and health in spaceflight. Cellular consequences as well as physiological effects will be studied. Design limitations predicated that crew and passengers on space vehicles will be subjected to weightlessness for considerable periods of time during spaceflights. Tolerance of humans after varying periods of simulated weightlessness will be determined under medically controlled conditions. The effects of weightlessness and reentry profiles from the weightless state will be ascertained in a variety of subjects as may be candidates for passengers in the shuttle. Correlations are also being made between morphological alterations and physiological changes caused by altered environmental factors such as altered G levels. Extent of damage and extent of reversibility are being ascertained using ultrastructural morphology as an endpoint.

The objectives are to assess the interference of prescribed drugs with routine physiological and biochemical measurements used for biomedical assessment of man in space, to study environmental influences on the efficacy of specific drugs likely to be used during manned space flight, and to develop selection criteria for candidate passengers aboard shuttle utilizing standard and advanced physiological monitoring techniques and provocative tests. Selected drugs from those available to the crewmen during Skylab and those planned for shuttle missions will be studied for their interference with routine biomedical determinations. These basic approaches will be used: (1) the evaluation of interference of the drug or its metabolites with the analytical procedures used; (2) the interference of the drug with physiological and biochemical responses used for the biomedical assessment of health status; and (3) the interference of the altered biomedical status on the effectiveness of the drugs used. Initially, work will involve the antimotion sickness drug combinations used, decongestants, analgesics and antibiotics. Work will be done primarily on man but animals will be used wherever necessary. Work on the aspirin/CO2 interaction will be completed this year. In order to develop a checklist on which the selection of candidate shuttle passengers can be based, work will continue to establish distribution of physical and emotional fitness for shuttle flights for categories of individuals of different age, race and sex. A package of biomedical tests derived from various ground-based research efforts will be evaluated for predictive value of physiological and psychological tolerance to human shuttle re-entry acceleration profiles after G-force exposures of short periods of time.
and depressed) will be explored as a potential simulator of weightlessness.

W75-70763  970-21-62
Ames Research Center, Moffett Field, Calif.

DEVELOPMENTAL AND GENETIC BIOLOGY
H. P. Klein  415-965-5094

The objective is to determine the effects of spaceflight on genetic integrity, differentiation, growth, development, maturation and senescence of living systems. Research will be performed on the role of gravity, from high g to weightlessness, in the maintenance of cellular integrity, cellular spatial relationships and in biochemical and biophysical reactions that control differentiation, growth, development and maturation of embryonic systems (plant and animal). Of general importance is the determination of any subtle or gross effects of altered gravity on the organization of living matter during a complete life span in the space environment and its subsequent readaptation to earth's gravity. The quantitative comparative differentiation between gravity-dependent and gravity-independent systems will be evaluated critically. Experiments have been selected which can be developed into flight experiments to investigate the genetic effects of the space environment. Laboratory tests will be required to develop procedures and establish baseline genetic data. Improved techniques will be used to measure specific endpoints such as the use of electron microscopy in analyzing spindle malfunctions in plants. Radiation sources will be developed for in-flight use to detect synergism of radiation and weightlessness in producing genetic damage. The effect of high Z cosmic ray particles will be determined.

W75-70764  970-21-63
Ames Research Center, Moffett Field, Calif.

RADIATION BIOLOGY
H. P. Klein  415-965-5094

A comprehensive study addressed to the space radiation problem for manned flights will be accomplished for the purpose of establishing realistic and exposure limits and developing protective and preventative procedures and techniques against hazards of space radiation. Emphasis will be placed on studies concerned with biological effects and relevant dosimetry of galactic cosmic ray particles, and combined effects of radiation and dynamic spaceflight factors. Both ground-based and spaceflight studies will be accomplished. The program plans are: (1) conduct intensive ground-based work utilizing a variety of biological materials and end-points and existing or modified particle accelerators for irradiation to establish and understand the mode of action and the biologic effectiveness of energetic, heavy ions (HZE) at the molecular, cellular, and organism levels; (2) assess the acute and chronic biologic effects of radiation, vibration, and compensation of gravity; and (3) establish the rate of production and energy spectra of high-LET recoil particles in tissue equivalent nuclear track detectors and develop capability to identify track, energy and charge of particle impacting biologic targets.

W75-70765  970-22-21
Ames Research Center, Moffett Field, Calif.

AIR REVITALIZATION
H. P. Klein  415-965-5094
(970-22-30)

Ames Research Center will conduct a program to perform research and advanced technology development in air revitalization. The areas to be investigated are: (1) advanced academic life support research, (2) static-feed water electrolysis, (3) nitrogen generator development, (4) electrochemical oxygen concentration, (5) electrolysis CO2 concentration, (6) trace contaminant control, and (7) solid electrolyte oxygen regeneration system development.

W75-70766  970-22-23
Ames Research Center, Moffett Field, Calif.

WATER AND WASTE MANAGEMENT
H. P. Klein  415-965-5094

Ames Research Center will conduct a program to perform research and development in water and waste management. The areas to be investigated are: (1) reverse osmosis-membrane development; (2) urine pretreatment - chemical, enzymatic, electrochemical; (3) vapor diffusion water (VDR)-membrane development; and (4) an analytical assessment of reverse osmosis membrane and module technology.

W75-70767  970-22-30
Ames Research Center, Moffett Field, Calif.

CREW EQUIPMENT SYSTEMS
H. P. Klein  415-965-5094
(970-22-21)

Ames Research Center will conduct a program to perform research and advanced technology development in crew equipment systems. The areas to be investigated are: advanced space suit and glove development, advanced liquid-cooled garment (and LCG thermal control), regenerable portable life support system (RPLSS) CO2 control, and RPLSS-thermal control.

W75-70768  970-23-20
Ames Research Center, Moffett Field, Calif.

TELEOPERATOR MANIPULATOR AND END EFFECCTOR TECHNOLOGY
H. P. Klein  415-965-5094

Ames Research Center will conduct a program to perform research and advanced technology development in remote manipulator systems for space exploration. The teleoperator manipulator and end-effector work will include: (1) improved manipulator arms and dexterous end-effectors; (2) advanced visual sensing and display systems to provide 3-D view of the remote scene to a human operator; (3) predictor displays based on hybrid computer mapping, storing, and manipulating stereo pair information obtained from the stereo camera system; (4) study of man-machine integration problems associated with various levels of manual and automatic control; and (5) development and evaluation of advanced sensory aids and associated displays to provide relevant information of the remote scene to the human operator.

W75-70769  970-23-30
Ames Research Center, Moffett Field, Calif.

ADVANCED BIOINSTRUMENTATION
H. P. Klein  415-965-5094

The objective is development of bioinstrumentation techniques to enable the measurement of biological, physiological and psychological responses of man and/or selected animal species to actual or simulated space flight conditions. Non-invasive, non-destructive testing procedures will be utilized for obtaining data wherever possible and feasible. Approaches will be directed towards development of instrumentation associated with measurement of central and peripheral cardiovascular function, bone mineral content, deep body physiological and physical functions, new and unique biochemical measurement techniques and methods of sample preservation. Techniques involved in cardiovascular function testing will lead to development of implantable telemetry systems. Miniaturized multi-channel discrete part units will be developed techniques will be investigated utilizing ultrasound and microwave transducers as means for obtaining information from the body surface. Bone mineral content will be obtained from a dual beam radioisotope scanning approach. Advanced biochemical measurement techniques will be developed utilizing ion-specific electrodes and new miniaturized gas chromatographs.

W75-70770  970-23-40
Ames Research Center, Moffett Field, Calif.

INTEGRATED BIOINSTRUMENTATION SYSTEMS
H. P. Klein  415-965-5094

The objectives are to integrate presently available NASA cardiovascular bioinstrumentation measurement systems, and identify those methods presently under ground-based investigation which have potential applications for determining cardiovascular adaptive mechanisms during space flight. Those methods which need further research and development are also identified. Various methods for measuring cardiovascular function will be documented and assessed against methods being used for similar purposes at the bedside or during cardiac catheterization. Noninvasive,
nondestructive methods will be emphasized. Accuracy will be assessed against clinical standards. Efforts will be coordinated with JSC.

**W75-70771**
Flights Research Center, Edwards, Calif.

**SHUTTLE PILOT REQUIREMENTS**
L. R. Carpenter 805-258-3311 (970-23-10; 970-53-10)

This RTOP will establish requirements for a cost effective and reliable man/machine system for aircraft type landing of aerospace vehicle using indirect viewing. Outside visibility requirements for landings have been established by previous work accomplished under this RTOP, and it has been learned that limited visibility will cause the pilot's workload to increase significantly. Helicopter work at Langley has indicated that television does not provide the pilot with good altitude knowledge for landings. Therefore, the approach to this study shall be conducted in two parts. The first phase will include flight experiments in a PA-30. These flights shall establish base line data and explore the feasibility of using external altitude cues painted on the runway. For example, a series of diamonds may be painted on the center line of the runway to help facilitate altitude knowledge to the pilot when approaching and landing.

**W75-70772**
Lyndon B. Johnson Space Center, Houston, Tex.

**NEUROPHYSIOLOGY**
J. L. Homick 713-483-4731

The overall objective is to investigate and evaluate the effects of space flight on the central nervous system of man. In view of past experiences and the implications for future manned flights, primary attention will be given to the study of those neuro-sensory and related physiologic mechanisms responsible for the space flight 'motion sickness' syndrome. In this regard a broad-based program of studies will be undertaken which has as its goal the elucidation of mechanisms underlying this syndrome in 0-g, the development of techniques for reliably predicting on an individual basis who is prone to this problem in 0-g and, finally, the development of effective countermeasures. Additionally, research will be continued to determine overall central nervous system function as it influences man's performance during space flight. Particular emphasis will be given to understanding neurophysiologic correlates of behavior and critical visual and auditory processes. With regard to underlying mechanisms, appropriate studies will be performed to investigate semicircular canals and ototh organ interactions, fluid shift/vestibular response interrelationships, biochemical alterations, visual influences, and the role of idiosyncratic psychophysiological or behavioral responses to 0-g. The development of predictive techniques will be difficult; however, planned approaches include the investigation of motion sickness susceptibility and adaptation for future space flights. Extrapolation to sub-gravity states would have validity and ground-based correlational studies with non-astronauts as well as astronauts who have flown space flight missions.

**W75-70773**
Lyndon B. Johnson Space Center, Houston, Tex.

**CARDIOVASCULAR PHYSIOLOGY**
G. W. Hoﬄer 713-483-5554

The objectives are: (1) to design, implement, and conduct experimental programs and studies which will determine the nature of cardiovascular system responses and/or adaptations to the various environmental factors associated with manned space flight; (2) to provide from the foregoing data necessary to formulate integrative concepts for understanding man's total physiological adjustments to space flight, and such inputs to vehicle and habitat design as may be required for preventative/therapeutic measures; and (3) to support ground-based operations attendant flight crew selection, training, and readiness preparations from a clinical cardiological perspective. Particular attention will be given to the physiological responses to weightlessness and mission-like workloads. Emphasis will be placed on investigations pertaining to those factors which affect, and the mechanisms which control, the orthostatic responses to gravitational fields following exposure to long-duration weightlessness. Ancillary effort will be directed towards other factors and physiologic systems affecting cardiovascular function such as heat and metabolic loads, water and electrolyte balance, renal and endocrine control. Ground-based programs will include use of: (1) space habitats (especially head-down tilt), study of regulatory mechanisms and related physiologic systems and responses, development of measurement techniques, hardware, and data management and analysis capabilities, conduct of pre- and postflight evaluations of space crews; data from inflight medical experiments.

**W75-70774**
Lyndon B. Johnson Space Center, Houston, Tex.

**METABOLISM AND NUTRITION**
J. A. Rummel, Ph. D. 713-483-5156 (970-52-20; 970-51-13)

Metabolic mechanisms which store and liberate heat and energy are the most basic processes in living systems. In supporting this scientific discipline, into three overlapping areas: (1) nutrition - the supply of adequate energy sources, (2) respiratory/Metabolic - the transformation of energy sources to useful body processes and the resultant external work of the organism, and (3) thermal - the effect of the environment on the organism's ability to regulate the loss of the heat produced by metabolic processes. The specific objectives and approach in each of these areas is as follows: (1) Nutrition - this program has, as its end point, the development of criteria for optimum foods and packages. It approaches this goal through two major categories of effort: the derivation of nutritional and metabolic requirements and the design of foods and packages to meet those requirements. (2) Respiratory/metabolic - the objective of this program is to obtain an understanding of the homeostatic mechanisms involved in the adaptation of man's energy transforming processes to the spaceflight environment. This will be accomplished by conducting basic research to evaluate the effect of abnormal and proposed environmental conditions on respiratory/metabolic function in order to determine human effects, threats to life and protective/preventive requirements. (3) Thermophysiology - the physical effect of the spacecraft environment on thermoregulation has been included in a model of thermoregulation in man. Although no direct physiologic effect of the spacecraft environment is expected there may be interactions of the pulmonary and...

**W75-70775**
Lyndon B. Johnson Space Center, Houston, Tex.

**HEMATOLOGY**
S. L. Kinsey 713-483-4086 (970-51-16; 970-51-25; 970-21-25)

Data collected in support of manned space flight missions indicate significant alterations of selected hematologic and immunologic functions as a consequence of the space flight environment. A primary objective of this program is to provide information to elucidate the etiology and mechanisms of the observed changes in hematologic processes, and to establish the significance of these changes in limiting man's participation in space flights. The overall objective is to assess the physiological costs of manned space flight relative to the hematologic and immunological systems. Advanced biochemical analytical techniques are being applied for: (1) detection and characterization of disease states prior to their clinical expression; (2) quantitative and qualitative analysis of cellular chemical constituents of the formed elements of the blood, and (3) computerized cell identification and functional classification based upon pattern recognition and association routines. Studies are being conducted to perfect procedures for inflight acquisition and preparation of microsamples of blood for inflight and postflight physicochemical analysis.

**W75-70776**
Lyndon B. Johnson Space Center, Houston, Tex.

**ENDOCRINOLOGY**
C. S. Leach 713-438-5458

The overall program is designed to further elucidate and define those physiological mechanisms which are operative in adaptation of the man to the space flight environment and in his readaptation to the earth environment following extended...
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duration missions. In general, these investigations will be directed toward the identification of hormonal and neurohumoral agents which are active in the readaptive process and will be concerned with describing the relationship between these compounds and those organ systems which are affected by the space flight environment. Research emphasis will be placed on quantitation of endocrine compounds and their effects within the total system, as well as principally to the regulation of fluid and electrolyte balance, acid-base equilibrium, cardiovascular alterations, protein and carbohydrate metabolism, and musculoskeletal changes. Additional studies will utilize ground-based weightlessness simulation techniques to correlate Skylab urine and plasma endocrine data with fluid, electrolyte, circulatory, and other observed changes. Improvement and validation of endocrine measurement techniques used on Skylab will also be addressed. Additional endocrine studies, such as thyroid function, may be included to further clarify the total endocrine response. The endocrine control of major system responses will include, but not be limited to, such areas as stress response, physiological cost and reserve, and nutritional effects. The effects of stress induced endocrine/metabolic processes will be examined in reference to the interrelationship of the hormonal system with the metabolic process to identify those which are of importance in man's overall adaptation to environmental change.

W75-70777 970-51-17
Lyndon B. Johnson Space Center, Houston, Tex.

COUNTERMEASURES
Malcolm C. Smith, Jr., D.V.M.  713-483-5056

The objectives of investigations undertaken within the countermeasures shall be to define, develop and evaluate preventive and/or remedial measures for mitigating the deleterious effects of prolonged weightlessness on crew and/or passenger personnel. These deleterious effects may appear during flight, but are apt to be more evident on return to force fields (1-g). Countermeasures may range from pharmacological, or dietary (nutritional) in character and shall relate to the known biomedical problem areas of space flight, viz., cardiovascular deconditioning (postflight orthostatism), bone demineralization, muscle mass loss, decreased exercise tolerance, deconditioning of ligamentous, tendinous, or other supportive skeletal structures, and vestibular disfunction. Methods shall be largely empirical but not to the exclusion of defining mechanisms of action in more basic studies. Finally, countermeasures will be validated by appropriate stress testing, which may include centrifugation, zero-g flights, and other less elaborate verification techniques. Particular emphasis will be placed on maintaining the integrity of the cardiovascular and musculoskeletal systems, as well as the general physical fitness of representative candidate crew and passenger populations. Rest will be the weightless analog utilized to simulate zero-g either inhouse or at contractor facilities. Such studies are now in progress at the USPHS Hospital, San Francisco in the mineral metabolism, fluid, electrolyte, and cardiovascular areas.

W75-70778 970-51-35
Lyndon B. Johnson Space Center, Houston, Tex.

ENVIRONMENTAL FACTORS EFFECTS
D. J. Horrigan 713-483-5156
(970-51-14)

This effort is concentrated on both inhouse and contractor work in the acts of conditions in the environment on human performance. It includes spacecraft atmosphere and decompression evaluation, studies of inert gas and 100% oxygen effects, thermal physiology, and life support system evaluation. The approach is to seek out experts within universities, industry, and government to carry on required work in these areas; and to continue an in-house capability in the area of thermal physiology and life support system evaluation.

W75-70779 970-51-45
Lyndon B. Johnson Space Center, Houston, Tex.

MEDICAL SUPPORT
P. Buchanan 713-483-4021

The objective is to formulate programs, protocols and specifications for medical support of long duration space flight; to develop a data bank of space medical, physiological, and aphrophomorphic data in a readily usable and easily updatable handbook format; to review Skylab health monitoring techniques and those factors of spacecraft habitability which affected crew health and performance and formulate responsible recommendations for future techniques and designs. Continuing effort will be focused on the identification of those endocrine and other determinants for incorporation into a total history, psychological and physical examination protocol to be used for shuttle crew and passenger selection and other space flight requirements. Computer assisted health maintenance programs and required man/machine interface is the essence of the continuing search for better methods of medical support of aerospace personnel: The accumulation of available aerospace data on a readily usable human standards data book format will be of immeasurable assistance in future planning toward attainment of the above goals. An expansion of current MEDICS/MEDATA capability into a flight hardware configuration for eventual inflight use by a crew physician and a computer-assisted diagnostic program for use where real-time consultation is not available, will be a part of this effort. This problem is primarily aimed at utilization in long duration space flights, but its terrestrial spinoff value will not be ignored.

W75-70780 970-51-62
Lyndon B. Johnson Space Center, Houston, Tex.

DEVELOPMENT AND GENETIC BIOLOGY
J. A. Mason 713-483-3169

The developmental biology program utilizes selected plant and animal systems to explore the problems and possibilities inherent in the space environment. Primary objectives are to evaluate dependency of plant growth upon specific (space related) environmental factors; to assess and to understand the mechanisms involved in the effects of reduced gravitational and geomagnetic forces on growth and development of plants and animals to evolve concepts for use of biological systems in a space for fundamental research or support of spaceflight capabilities. The general approach employed to accomplish these objectives is to cooperate closely with academic researchers using the unique resources of the JSC as a funnel for directing university research into the specific needs of the space program, concentrating the JSC efforts upon space-specific aspects of the problem. Approaches to the study of space environments involve the use of biological systems in which response to alteration of gravity, geomagnetism, or other space related factors is reflected in obvious modification in function or form. Several systems currently considered worthy of investigation are in various stages of experimental development. These include aromatic amino acid metabolism, responses in plants, including sleep (biorhythms) and movements and the bioelectrical activity associated with these various responses. One animal system Fundulus heteroclitus is being used as a model for studies of embryogenesis and the adaptation of sensory behavior in null gravity. Intimately associated with ongoing basic studies are efforts to evaluate and develop practical uses for plant systems in space and to develop the laboratory facilities necessary for support of future inflight experimentation.

W75-70781 970-51-63
Lyndon B. Johnson Space Center, Houston, Tex.

RADIATION BIOLOGY
R. A. Hoffman 713-483-3419

This research program is designed to investigate and further define the biological hazards of the space radiation environment to manned space missions. Although experimental animals comprise the major source of information, human response data resulting from radiation therapy and accidental exposures are included. Investigating the response to and mechanism of action of high energy high Z (HZE) cosmic particles is emphasized. Also emphasized is further definition of effects resulting from low dose, low dose-rate, and fractionated dose exposures. Determining whether significant physiological changes have occurred even though gross responses may not be evident is of major importance throughout these studies. Considerably more data is needed in this area to more accurately specify safe and reasonable radiation safety criteria for manned space programs.
Although not included in current experimentation, studies planned to guide the selection of optimum subsystem combinations, the analysis, fabrication and testing efforts toward solving problems associated with the integration of life support system hardware. The basic approach involves the use of analytical studies to guide the selection of optimum subsystem combinations, the implementation of the results of these studies into hardware programs and the confirmation of the validity of these efforts through a coordinated ground test program. Specific programs involve the development of system level computer programs for analysis of shuttle and potential shuttle payload environmental control and life support systems, and the continuation of the development of a representative spacecraft environmental control system.

The objectives of this RTOP are to provide advanced life support technology for components and subsystems for: air revitalization, atmosphere storage and generation and control techniques for carbon dioxide, humidity and trace contaminants of manned spacecraft cabins. The general approach is to advance the subsystem technology through to the design and verification of reliable hardware for shuttle and near term space missions, and for the development of flight experiments in support of the Life Sciences Payload activities. Performance data on subsystems and components will provide a basis for selection of critical subsystems to make them adaptable to flight type hardware.

The objectives of this RTOP are to provide advanced life support technology for components and subsystems for cabin atmospheric control of such parameters as pressure, composition and temperature as well as required environmental control subsystem sensors. The general approach is to advance the subsystem technology through to the design and verification of reliable hardware for shuttle and near term space missions. Performance data on subsystems and components will provide a basis for selection of critical subsystem to make them adaptable to flight type hardware.

The objectives are to provide advanced life support technology for components and subsystems for water management, including water purification and the management and control of manned spacecraft wastes. The general approach is to advance the subsystem technology through to the design and verification of reliable hardware for shuttle and near term space missions, and for the development of flight experiments in support of the life sciences payload activities. Performance data on subsystems and components will provide a basis for selection of critical subsystems to make them adaptable to flight type hardware.

The objective is to develop food systems having maximum palatability and nutrition with minimum in-flight food preparation time, and minimum cost, volume, weight and power requirements. Food technology, food sciences and food engineering will be used to support research and development of food systems. Emphasis will be on food systems, preservation techniques, packaging and storage. Particular attention will be given to those techniques which are judged to be most likely to aid in achievement of space food systems engineering design goals. Emphasis will be placed on specialized technical areas neglected by the commercial food industry. These efforts will be complemented by tasks to select and adapt commercially developed food technology and food engineering techniques. Priorities will be given to development of overall concepts for advanced food systems by tradeoff analyses, optimization of space food preservation techniques, optimization of packaging, and development of efficient in-flight food storage, preparation, and delivery systems, and subsystems hardware. Food will be developed to meet mission needs prior to development of food system hardware design specifications. System components will be to mission requirements rather than compromised to fit commercially available foods.

The objectives are to (initiate component technology design, development, fabrication, and testing of a shuttle related EVA life support system; (2) continue the testing of the prototype advanced IV and EVA technology suits for application in the space shuttle program; and (3) continue development of an elastomeric polymer material that will be flame resistant in an O2 enriched environment (70/30 ration of N2 and O2). Material will also be capable of molding and extruding while maintaining resiliency and elasticity. EVA life support components to be developed include those that exhibited design deficiencies in prior life support system application or require specific modifications as a result of unique shuttle related requirements. Continued design, development, and testing of the prototype advanced IV and EVA suits as well as the development of the flame resistant elastomeric polymer material will be conducted through an increase in scope and follow-on efforts to existing contracts.

The activity outlined involves two major tasks: (1) a study to determine the applicability of using a combination of the EVA crewman and man-rated Shuttle Attached Manipulator System (AMS) to accomplish on-orbit shuttle/payload maintenance and servicing tasks: and (2) by utilizing and expanding current studies, and documented EVA capabilities (Skylab, etc.), develop a set of detailed ‘payload task’ completion plans. Task 1 will include: (1) feasibility and benefits of using the AMS for transporting crew and cargo to shuttle/payload worksites; (2) identification of shuttle payload operations that would economically benefit from the EVA/AMS combination; (3) development of operational requirements for the AMS attached EVA workstations; and (4) define operational requirements of an AMS attached EVA control panel and a plug-in AMS control panel for use at the EVA workstations. Task 2 will include: (1) a definition of the Orbiter EVA System. The EVA system and capabilities defined should provide for the complete range of possible shuttle EVA missions; (2) development of a preliminary set of task sequences and timelines that show how payload mission objectives may be satisfied by using the shuttle EVA System for specific payloads and classes of payloads.
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Louis E. Livingston 713-483-4966
This activity is a progressive buildup of an in-house manipulator test article more nearly duplicating the performance of the orbiter system. This simulator will be utilized to develop techniques of operation and mechanical interfaces between payloads and the manipulator system. Results of these efforts will be used to verify the Shuttle manipulator system preliminary design being performed by JSC. Another segment of investigation is the preliminary design of a manned maneuvering unit (MMU). This effort is related to MMU tasks conducted under RTOP number 975-50. The total tasks under these two RTOP's will be controlled by JSC's MUWG (maneuvering unit working group) and will contribute toward and directly support the mission modeling and hardware design for a shuttle manned maneuvering unit, which could be used as early as the first manned orbital flight to conduct thermal protection subsystem inspection and repair, if necessary.

W75-70790 970-53-30
Lyndon B. Johnson Space Center, Houston, Tex.

INTEGRATED BIOINSTRUMENTATION
S. L. Pool, MD 713-483-4211
The Life Sciences Directorate at the L. B. Johnson Space Center has under development several items of bioinstrumentation in support of advanced space missions. These advanced bioinstrumentation developments include the GO (Gravity-Zero) Analyses the MLM (Microbial Load Monitor), MEMS (Microbiological and Ecolological Measurement System), APEAS (Automated Potentiometric Electrolyte Analysis System), zero-G IV fluid administration, and others. A comprehensive program to support life sciences investigations and clinical support for advanced manned missions is being developed by NASA, but several items of advanced bioinstrumentation have already emerged as viable candidates for the program and hold great promise for use on future space missions. The objective of the advanced bioinstrumentation program being conducted at JSC is to develop and test space-applicable bioinstrumentation. The advanced bioinstrumentation program is a multi-disciplinary effort; included are efforts in microbiology, cardiology, and engineering. The programs in this area usually start as study efforts, although several have now reached the ground-based hardware product phase and/or testing phase. The overall objective of the Advanced Bioinstrumentation effort is to perform research and clinical/health care instrumentation associated with cardiovascular and circulatory function, pulmonary function, laboratory analysis, early detection of disease—

W75-70791 970-53-30
Lyndon B. Johnson Space Center, Houston, Tex.

INTEGRATED BIOINSTRUMENTATION SYSTEMS
N. Belasco 713-483-4211
(970-53-30)
The objective is to develop and prove a system to provide remote health care delivery to crewmen and passengers in spaceflight, and provide the instrumentation support for space medical research. This effort will include formulation of engineering requirements and medical systems design requirements and procedures, and verification/evaluation of their effectiveness in ground-based simulations and actual clinical situations. A secondary objective of the effort will be to promote NASA bioinstrumentation technology applications. This effort is directed toward development of remote health care techniques utilizing a ground-based IMELMS (STARPAHC) concept. It also includes tasks to integrate and evaluate advanced bioinstrumentation technology within the IMELMS/STARPAHC and within shuttle/ spacelab verification tasks for the purpose of applying resulting procedures and requirements to the definition and development of manned spaceflight mission payloads (including instrumentation and procedures to support inflight medical research and to provide an inflight clinical capability for shuttle, spacelab, and beyond). The following tasks are proposed: (1) Development of remote health care techniques (IMELMS) - The assembly and test, installation and operation of a ground-based remote health care delivery system using the IMELMS concept. The system test bed accommodates advanced bioinstrumentation developments to improve the efficiency or enhance the total capability of the system—

W75-70792 970-53-50
Lyndon B. Johnson Space Center, Houston, Tex.
MAN-MACHINE SYSTEMS DESIGN
Robert L. Bond 713-483-4966
The objectives are to: (1) review data from Orbiter Maintainability Program to establish tool kit requirements; (2) utilize commercial types of tools for the basic tool kit with necessary modification for on-orbit environment; both IVA and EVA; and (3) provide design for handling and packaging of tools. Specifications and drawings necessary to produce flight hardware suitable for Orbiter and its payloads will be provided.

W75-70793 970-62-40
Marshall Space Flight Center, Huntsville, Ala.
FLIGHT EXPERIMENTS DEFINITION AND DEVELOPMENT
Dr. J. W. Littles 205-453-3831
One objective of this RTOP is to provide the technology required for flight test of regenerative life support systems. Experiment concepts will be established, hardware designed, built and tested with a view of eventual orbital flights. The second objective is to accomplish, in cooperation with the NASA Life Sciences elements, the engineering design and development of habitats (Common Holding Units) for Life Sciences Specimens.

W75-70794 970-63-20
Marshall Space Flight Center, Huntsville, Ala.
TELEOPERATOR CONTROL AND REMOTE MANIPULATION
W. G. Thornton 205-453-5530
This RTOP proposed to further develop the technology applicable to earth orbiting teleoperator such that design criteria and the requirements are available in the 1976 time frame and for subsequent applications. The principal technical areas of concern are: manipulative devices including the end effectors and their control, visual and other sensors, remote control of the manipulator unit, man-machine interface, and system integration. Objectives are: (1) to define experimental and prototype free flying teleoperator systems and operations for applications in shuttle, tug, and earth orbiting payload applications; and (2) to establish component and integrated system technology, design criteria and requirements for free flying teleoperators in the areas of manipulative devices and end effectors, sensory systems, applications analysis and interfaces with shuttle, tug and payloads. Objectives are: (1) to define experimental and prototype free flying teleoperator systems and operations for applications in shuttle, tug, and earth orbiting payload applications; and (2) to establish component and integrated system technology, design criteria and requirements for free flying teleoperators in the areas of manipulative devices and end effectors, sensory systems, mobility unit control, and the control and display station. Using prior system studies as a baseline and utilizing current design efforts in shuttle, tug, payloads, system definition investigations for specific applications of free flying teleoperators will be conducted. Feasibility studies and design investigations will be conducted on remote manipulators, end effectors, visual systems, displays, and remote control: man-machine invention methodology for remote, free flying teleoperators will be evaluated.

W75-70795 970-83-20
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
REMOTELY MANNED SYSTEMS: DISPLAYS AND SUPERVISORY CONTROL
Ewald Heer 213-354-3060
(970-23-20; 970-63-20; 112-30-14)
The objective is to develop technical information about Remotely Manned Systems (RMS) and teleoperator/robots so that space missions requiring the use of such systems can be planned and implemented with the required reliability, performance, and economy. Specific objectives are to identify requirements, develop conceptual designs and breadboards, and determine the machines and man's complementary roles in the operation of RMS and teleoperator/robots, including time delay requirements with emphasis on sensor/display and supervisory control aspects. The approach is to use technical studies to identify the scientific and operational mission requirements, and to develop the resultant necessary RMS and teleoperator/robot functions. From the implied capability requirements for man and machine, the necessary technology developments for teleoperator/robot systems and subsystems will be derived. Required develop-
functions to be performed by man or machine or both for remote explorations and operations. Function allocations will be made between man and machine for various communication time delay requirements, so that optimum system performance can be achieved, and critical technology development requirements can be identified. New concepts of teleoperator/robot systems and subsystems will be developed when appropriate and related feasibility studies will be conducted. Man - machine system performance evaluations will be conducted and performance criteria will be established. This work will be coordinated with related work at JPL, ARC, JSC, and MSFC.

Payloads

W75-70796 975-50-01
Langley Research Center, Langley Station, Va.
STS USER COMMUNITY DEVELOPMENT
E. S. Love 804-827-2893

The objective is to help identify and develop space transportation system (STS) utilization in the 1980's. Potential STS users will be identified and briefed on the capabilities of the shuttle missions using space laboratories (SL), and free flying multipurpose satellites such as the Long Duration Exposure Facility (LDEF). Potential users will be stimulated with limited financial support to identify and study experiments in their particular fields which may be compatible with shuttle. The experiments will be studied in sufficient depth to define the cost and potential return. The program will be implemented in geographical areas which have high concentrations of potential STS users. Small contracts will be awarded to individuals in each selected area to identify potential users in the area, to assemble the users for briefing on the shuttle capabilities, and to work with the users after the briefings to stimulate and help develop their ideas for SL and LDEF usage. LRC personnel will participate in these shuttle briefings.
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**FISCAL YEAR 1975**

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- Fire Resistant and Laser Countermeasure Materials for Military Programs
- Chemical and Isotopic Studies of Moleculines and Ablation Products

### ACOUSTIC MEASUREMENTS
- Basic Noise Research
- Noise Technology
- Noise Footprint Prediction
- Aircraft Aerodynamic Performance, Dynamics and Noise

### ADHESIVES
- Basic Noise Research
- Adhesives
- Composites and Adhesives

### AERODYNAMIC CONFIGURATIONS
- Interceptors and Nuzzles
- Airframe Aerodynamics
- Space Shuttle: Convironments and Aerothermodynamics

### AERODYNAMIC DRAG
- Helicopter Aerodynamics
- Aeroelasticity and Structural Dynamics

### AERODYNAMIC HEATING
- Flight Loads Measurement Techniques
- Wake Vortex Minimization

### AERODYNAMIC STABILITY
- Nonsteady Aerodynamics
- Missile Aerodynamics
- Space Shuttle Dynamics and Aerelasticity

### AERODYNAMIC STALLING
- Vehicle Dynamics - Stall/Spin/High Alpha Characteristics
- General Aviation Technology
- Space Probes/RPV Flight Tests

### AERODYNAMICS
- Simulation Technology for Aeronautics
- Turbine Technology
- Unsteady Aerodynamics
- Conceptual Aerodynamics

### AERONAUTICS

### ACCELERATION TESTS (PHYSIOLOGY)
- Flank Quality
- Acclimation of Mammals to Acceleration

### ACCELEROMETERS
- Mammals
- ACOUSTIC ATTENUATION
- Basic Noise Research
- ACOUSTIC CONFIGURATIONS

### ACOUSTIC SIMULATION
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The text in the image appears to be a page from a document listing various research projects and tasks at Marshall Space Flight Center. The projects range from space vehicle dynamics to electrical power systems, and the text includes project numbers, dates, and descriptions. The page also includes a section titled "Responsible NASA Organization Index" with various topics listed, such as "Marshall Space Flight Center, Huntsville, Ala." and "Responsibilities."
RESPONSIBLE NASA ORGANIZATION INDEX

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