NASA TM-87394

Research and Technology Objectives and Plans

SUMMARY

National Aeronautics and Space Administration

FISCAL YEAR 1985 RESEARCH AND TECHNOLOGY PROGRAM

Date for general release May 1987

INTRODUCTION

This publication represents the NASA research and technology program for FY 1985. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and 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 contact which might be disruptive to ongoing 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
Washington, D.C. 20546
Attn: Edmund L. Sanchez
Deputy Director for Resources (RI)

John Martin
Associate Administrator for
Aeronautics and Space Technology

TABLE OF CONTENTS

Office of the Chief Engineer

PAGE

Office of Space Science and Applications

Office of Space Tracking and Data Systems

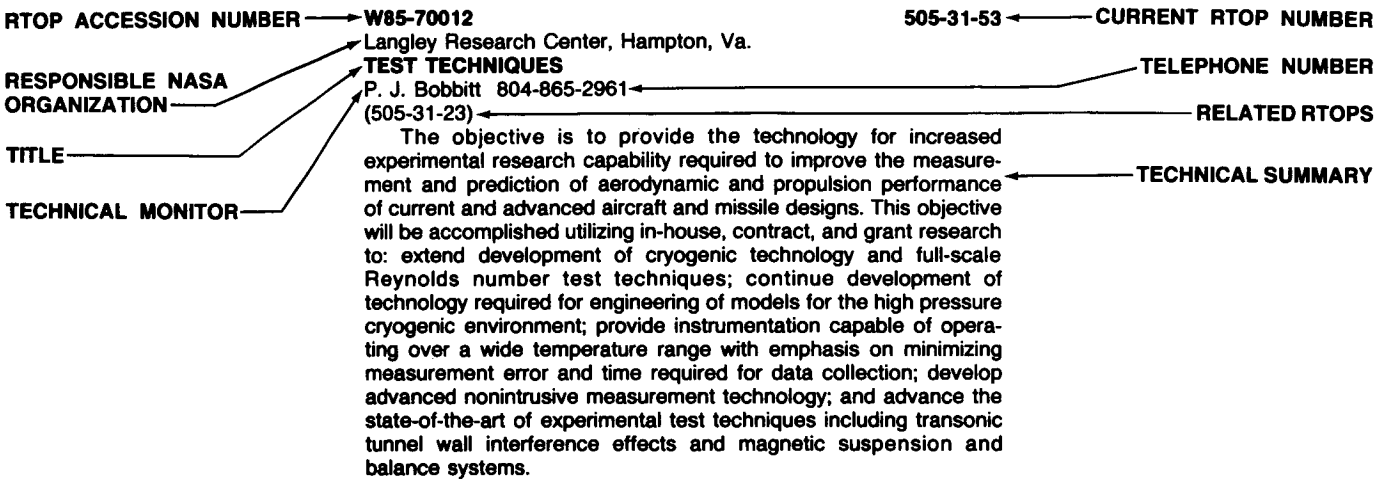
Office of Space Flight

Office of Space Station

PAGE

Indexes

TYPICAL CITATION AND TECHNICAL SUMMARY



RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS

a summary

FISCAL YEAR 1985

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics Research and Technology Base

Fluid and Thermal Physics Research and Technology

W85-70001 **505-31-01**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL METHODS AND APPLICATIONS IN FLUID DYNAMICS
V. L. Peterson 415-965-5065
(505-31-21; 506-51-11; 505-37-01)

The objective is to develop the capability for predicting complete aerodynamic characteristics of given aircraft and missile shapes and for designing new configurations aerodynamically optimized for specific missions to a degree that preliminary concepts can be developed, evaluated, and screened with less time, cost, and wind tunnel testing. New numerical methods, languages, and compilers will be constructed to realize the most effective use of available computer resources. Computer programs will be developed to simulate turbulence and to solve fluid dynamics problems for the complete spectrum of flight speeds from low subsonic, transonic, to hypersonic speeds, and for steady and unsteady, inviscid and viscous flow over two- and three-dimensional complex configurations. Fundamental experiments will be performed to verify these codes and to provide the necessary turbulence models. The Reynolds number domain will extend from conventional wind tunnel conditions to full scale flight conditions for present and future flight vehicles. Transfer of advanced computational aerodynamics technology to the aerospace community will be implemented by developing and disseminating computer codes applicable to practical aerodynamics problems.

W85-70002 **505-31-03**
Langley Research Center, Hampton, Va.
COMPUTATIONAL AND ANALYTICAL FLUID DYNAMICS
P. J. Bobbitt 804-865-2961
(505-31-13; 505-31-23; 505-31-53)

The objective is to provide the fundamental computational methods required for calculating complete aerodynamic characteristics of complex aircraft shapes and for optimizing aircraft shapes for a given mission. The primary emphasis will be basic research in numerical and analytical methods coupled with large-scale computers. Research includes viscous and inviscid flow methods for all speed ranges. The main interest is in large, nonlinear problems; studies include acceleration of iterative methods for large systems of finite difference equations, processor computers such as CYBER 203 and CRAY.

W85-70003 **505-31-04**
Lewis Research Center, Cleveland, Ohio.
INTERNAL COMPUTATIONAL FLUID MECHANICS
B. A. Miller 216-433-4000

The purpose was to develop understanding and modeling ability for fundamental internal fluid dynamic phenomena typical of gas turbine engines and to develop advanced computational analyses to simulate fluid flow and heat transfer in inlets, nozzles, compressors, turbines and combustors. The approach was to conduct experiments to support the modeling activity and to provide benchmark data for code verification. Computational methods are developed into practical computer codes for use by government and industry. The codes are applied to both simplified geometries and realistic hardware. The work is conducted through in-house, contract, and grant efforts.

W85-70004 **505-31-11**
Ames Research Center, Moffett Field, Calif.
VISCOUS FLOWS
C. Thomas Snyder 415-965-5066

The objective of this RTOP is to investigate viscous flow phenomena using advanced experimental, computational, and analytical methods. Studies are focused in the areas of: (1) steady turbulent and vortical flows, (2) unsteady turbulent flows, (3) boundary layer drag-reduction devices, and (4) low-speed separated flow. Benchmark data obtained using a variety of wind tunnels and advanced measurement systems are thoroughly correlated with available computational and analytical methods.

W85-70005 **505-31-13**
Langley Research Center, Hampton, Va.
VISCOUS DRAG REDUCTION AND CONTROL
R. V. Harris, Jr. 804-865-2658

Research to significantly improve our ability to predict and control the behavior of turbulent shear flows including boundary layers, free shear layers, and recirculating/vortex flows. Theoretical and experimental research to (1) reduce turbulent skin friction drag, (2) control stream disturbances in supersonic and hypersonic tunnels, (3) determine sensitivities of compressible boundary layer transition process to stream and wall disturbances and optimize supersonic LFC, (4) control vortex and separated flows through turbulence and stability alteration, and (5) determine turbulence structure of non-simple shear flows. Drag reduction research investigates non-planar geometries such as riblets, large-eddy breakup devices, convex curvature, long wavelength (waisted body) surfaces, large-eddy substitution techniques slot injection, fuselage relaminarization and active (feedback) control, primarily for CTOL, SST, and missile applications. Free stream disturbance research develops laminar flow nozzles to improve flight validity of supersonic and hypersonic wind tunnel measurements. Detailed compressible boundary layer transition studies with controlled input disturbances determine sensitivity of supersonic transition process and supersonic LFC to operational factors such as engine noise and surface irregularities. A unique technique for simultaneous real time and three-space turbulence measurements is developed (holographic velocimeter) with applications such as (1) direct

verification of numerical turbulence simulations, (2) turbulent coherent structure identification in non-simple shear flows, (3) optimization of viscous flow control techniques and (4) turbulence modeling.

W85-70006 **505-31-15**
Jet Propulsion Laboratory, Pasadena, Calif.
BOUNDARY-LAYER STABILITY AND TRANSITION RESEARCH
L. M. Mack 818-354-2138

Knowledge of where laminar-turbulent transition will occur is important for accurate drag calculations, and a significant reduction in total drag is possible if transition can be delayed by passive or active means. It is the purpose of this RTOP to investigate experimentally and theoretically the production of instability waves by external disturbance sources and the propagation of the resultant wave trains and wave packets in two- and three-dimensional boundary layers. In addition, a rational method for the prediction of transition will be developed. In the experimental work, study of the receptivity of the boundary layer to freestream turbulence will continue. The movement of the location of transition in response to a variation in the scale as well as the amplitude of this turbulence will be determined. The interaction of harmonic Tollmien-Schlichting waves with the longitudinal structures produced within layers by freestream turbulence and by spatially uniform and non-uniform distributed surface roughness will be investigated separately. The theoretical program is closely coordinated with the experiments. The harmonic and pulsed point-source initial value problems are solved both with direct numerical integration and by the method of steepest descent. The wave motion downstream of discrete arrays of point sources and of finite-length line sources is obtained from the superposition of point-source solutions. Multiple point and line sources make it possible to study the effectiveness of wave cancellation. A model for the receptivity problem will be developed from the experimental findings, and the long-term objective is to combine the results of the wave propagation and receptivity investigations in a method for transition prediction.

W85-70007 **505-31-21**
Ames Research Center, Moffett Field, Calif.
EXPERIMENTAL/THEORETICAL AERODYNAMICS
C. Thomas Snyder 415-965-5066

The objective of this research is to expand the aerodynamic technology base and provide a basic understanding of the aerodynamic flow fields about complete aircraft configurations, as well as individual components through the angle-of-attack range and from subsonic through supersonic Mach numbers. This includes ground-based testing, flight experiments and the application and development of theoretical prediction methods. Elements of this research are: (1) develop a computer structure for theory/experiment integration; (2) develop an advanced panel code (PAN AIR); (3) develop a transonic wing/body/tail code and three dimensional transonic wing design codes; (4) develop a carefully documented data base of transonic viscous flows over modern wings; (5) develop prediction techniques for unsteady flows; (6) conduct investigations of three dimensional bodies at high angles-of-attack; (7) develop a subsonic aerodynamic analysis code (VSAERO); (8) conduct experimental and analytical studies of aircraft trailing wake vortex flows; and (9) conduct flight experiments which are complementary to the analytical and wind tunnel research programs.

W85-70008 **505-31-23**
Langley Research Center, Hampton, Va.
EXPERIMENTAL AND APPLIED AERODYNAMICS
P. J. Bobbitt 804-865-2961
(505-31-53)

The objective of this research is to provide the fundamental data base needed for efficient design of advanced aircraft and for development of aerodynamic prediction techniques. In-house, contract and grant research will be used to advance the state-of-the-art with regard to: (1) advanced airfoils; (2) transonic high Reynolds number research; boundary layer transition research; vortex formation and control; and maneuvering supersonic aircraft. The scope was changed to include transonic High Reynolds Number Research moved from RTOP 505-31-53, and Nonintrusive Measurement Technology moved to Test Techniques RTOP (505-31-53).

W85-70009 **505-31-33**
Langley Research Center, Hampton, Va.
AEROACOUSTICS RESEARCH
H. G. Morgan 804-865-3577

The objective of this research is to understand and predict the effects of noise on aerodynamic performance, structural integrity, and passenger/community acceptance of aircraft and spacecraft systems by understanding and predicting the generation of aeroacoustic loads by fluid flows, the generation of flow noise and its propagation to the acoustic farfield, and the interaction of acoustic waves with fluid flows. A further objective is to use this fundamental knowledge to develop techniques for reducing or controlling the loads and noise, or for controlling the flow, with minimum weight, performance, and economic penalties when applied to aerospace systems. Analytical, computational, and experimental approaches are included in the research that is conducted in-house and by grant and contract. The experimental portion of the program emphasizes model scale laboratory studies under controlled conditions, supplemented by flight tests when appropriate. The immediate research is focused on the problem areas of coannular and nonaxisymmetric supersonic jet plumes, interaction of acoustic waves with boundary layers, and shallow angle, long distance atmospheric propagation.

W85-70010 **505-31-41**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL FLAME RADIATION RESEARCH
R. L. Jaffe 415-965-6458
(506-53-11)

The objectives of this research are to provide an in-depth, theoretical understanding of both combustion processes and spectroscopic techniques for non-intrusive, laser-based flame diagnostic measurements. The research will be coordinated with several experimental programs (at LaRC, LeRC, and ARC) which are not part of this RTOP. First principles calculations will be performed to determine the spectroscopic, thermodynamic, and chemical kinetic properties of molecules which have important roles in combustion processes. The theoretical molecular property data will be coupled with the results from numerical flame structure models to produce synthetic spectra which can be compared to experimental and theoretical spectra generated for the identical conditions used in the flame models. The models will then be improved resulting in validated combustion models for the prediction of flame properties. The theoretical molecular property data will also be used to synthesize cross sections for spectroscopic transitions which can be used for diagnostic measurements of flame temperature and composition. This will help experimentalists develop new non-intrusive analytical combustion probes and add to the effectiveness of existing diagnostic methods.

W85-70011 **505-31-51**
Ames Research Center, Moffett Field, Calif.
TEST METHODS AND INSTRUMENTATION
C. Thomas Snyder 415-965-5066

The objective of this research is to provide the technology for improved experimental research capability for new aircraft designs and the exploration of advanced aerodynamic concepts. This includes both ground-based and flight test capability improvements. Flow quality, measurement of model attitude and deformation, minimization or elimination of wind tunnel wall constraint effects, and means for simulating higher Reynolds number flows will be investigated analytically and experimentally. Advanced optical instrumentation systems will be developed to obtain fundamental fluid mechanics measurements such as velocities, turbulence intensities, densities, and Reynolds stress components. Flight based research work will include an air data inertially based integrated sensor, a miniature multichannel pressure system, and an airborne laser doppler velocimeter.

W85-70012 **505-31-53**
Langley Research Center, Hampton, Va.
TEST TECHNIQUES
P. J. Bobbitt 804-865-2961
(505-31-23)

The objective is to provide the technology for increased experimental research capability required to improve the measurement and prediction of aerodynamic and propulsion performance of current and advanced aircraft and missile designs. This objective will be accomplished utilizing in-house, contract, and grant research to: extend development of cryogenic technology and full-scale Reynolds number test techniques; continue development of technology required for engineering of models for the high pressure cryogenic environment; provide instrumentation capable of operating over a wide temperature range with emphasis on minimizing measurement error and time required for data collection; develop advanced nonintrusive measurement technology; and advance the state-of-the-art of experimental test techniques including transonic tunnel wall interference effects and magnetic suspension and balance systems.

W85-70013 **505-31-55**
Jet Propulsion Laboratory, Pasadena, Calif.
THREE-DIMENSIONAL VELOCITY FIELD MEASUREMENT
V. Sarohia 818-354-6758

The objective is to develop a nonintrusive diagnostic technique to simultaneously visualize and quantify velocity vectors at a large number of points. The technique is based on the combined use of digital image analysis techniques and luminescent particle traces excited by accurately aimed laser beams. Optically activated phosphorescent particles in the flow will be used as tracers. The experiments will be performed on a free water surface and internal rotating and jet flows. The traces will be photographed on a suitable film. These photographs will be digitized for automatic mapping of the three dimensional velocity field using the digital image analysis techniques developed in the Fluid and Thermal Sciences Laboratories at JPL. Applicability of this technique in air will be determined.

W85-70014 **505-31-63**
Langley Research Center, Hampton, Va.
NATIONAL TRANSONIC FACILITY (NTF)
P. J. Bobbitt 804-865-2961
(505-31-23)

The objective is to support the National Transonic Facility, a ground base test facility which operates at super cold conditions, as cold as 300 degrees below zero Fahrenheit, in order to match the critical flow parameters needed to scale from small scale models to vehicles in flight. To support this operation, liquid nitrogen will be procured, throughout the year, and used to generate the cold test environment. The services of a support contractor for the operation and routine maintenance of the ancillary systems will be provided under this RTOP.

W85-70015 **505-31-83**
Langley Research Center, Hampton, Va.
MATHEMATICS FOR ENGINEERING AND SCIENCE
E. J. Prior 804-865-2664

The objective of this RTOP is to provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments. The research is carried out by a combination of in-house efforts, university research grants, and the continuing operation of the institute for Computer Applications in Science and Engineering (ICASE) located at the Langley Research Center. The in-house and grant efforts include research dealing with geometry modeling, grid generations, and numerical solutions of differential and algebraic systems and visualization of computed results. The broad research areas pursued in ICASE include: numerical analysis with particular emphasis on the development and analysis of basic numerical algorithms; computational research in engineering and science in selected research areas of concern to the Langley Research Center, including fluid dynamics, structural analysis, acoustics, guidance and control, and other appropriate areas; and computer systems and software, such as advanced computers, microprocessors, and parallel systems.

Materials and Structures Research and Technology

W85-70016 **505-33-10**
National Aeronautics and Space Administration, Washington, D.C.
RESEARCH IN ADVANCED MATERIALS CONCEPTS FOR AERONAUTICS
Michael A. Greenfield 202-453-2748

The objective is to conduct fundamental research on advanced materials concepts for aeronautics. The interdisciplinary program in polymeric composites includes research into the properties of the constituent fibers and matrix properties, advanced structural analysis methods, fatigue response of laminates, environmental response modeling, and processing science for light weight airframe structures. The interdisciplinary project in ceramic materials addresses critical research in material performance and design methodology as related to brittle materials. Emphasis to be placed on understanding the processing and properties of these materials. Activities include fundamental characterization of silicon nitride and silicon carbide materials, environmental response processing science, and impact behavior of high temperature ceramic bodies for gas turbine engine application. Advisory services to guide Research and Development in advanced aerospace materials are provided by the National Materials Advisory Board, a unit of the National Academies of Science and Engineering.

W85-70017 **505-33-13**
Langley Research Center, Hampton, Va.
ADVANCED STRUCTURAL ALLOYS
C. P. Blankenship 804-865-2042
(505-33-23; 505-43-43; 506-53-23)

The objective of this RTOP is focused on understanding the relationship between metallurgical structure and mechanical properties characteristic of advanced alloys. This understanding is expected to provide a basis for new or improved concepts to achieve more efficient structural alloys for future aircraft applications. Current research includes: (1) fundamental studies of the structure/property relationships in advanced PM aluminum alloys as they relate either to alloy chemistry, thermomechanical treatments, or aging behavior, and (2) the development of new and/or improved processing methods to provide a basis to achieve more efficient structural shapes. Research in advanced PM aluminum alloys will emphasize the optimization of powder processing techniques, alloy chemistry, and thermomechanical treatments based on a fundamental understanding of the metallurgical features desirable for high-performance applications. Research in processing technology will emphasize superplastic forming (SPF) of advanced aluminum alloys to achieve unique and highly efficient structural shapes. SPF effects on microstructure and mechanical properties will be characterized and the adaptability of the SPF process to advanced PM aluminum alloys will be explored.

W85-70018 **505-33-21**
Ames Research Center, Moffett Field, Calif.
LIFE PREDICTION: FATIGUE DAMAGE AND ENVIRONMENTAL EFFECTS IN METALS AND COMPOSITES
H. G. Nelson 415-965-6137

The objective of this research is to perform fundamental experimental and analytical research to better characterize and understand the fatigue and fracture behavior of both metals and organic matrix composites in order to more accurately predict the service life of real, engineering structures. For metals, crack initiation, subcritical crack growth, and rapid unstable fracture will be characterized using a fracture mechanics approach with the primary purpose being to understand the influences of the chemical environment to better predict stress corrosion and corrosion fatigue behavior. Considerable emphasis will be placed on the kinetic aspects of environment-induced degradation and, in particular, the

importance of surfaces and surface reactions. For composites, correspondence relationships will be identified between stress, moisture, temperature, and time with the primary purpose being to develop the methodology required to predict long-term behavior. The scope has been changed to reflect a reduced effort in metals.

W85-70019 **505-33-23**
Langley Research Center, Hampton, Va.
LIFE PREDICTION FOR STRUCTURAL MATERIALS
C. P. Blankenship 804-865-2042
(505-33-13; 505-33-33; 506-53-23)

The objectives of this research are to understand the fatigue and fracture behavior of experimental and engineering materials and to develop reliable life prediction techniques that are applicable to the use of these materials in aircraft structures. Formulation of a theoretical framework for life prediction and experimental validation of the theoretical concepts involved form a major part of this research focus. Characterization of the integrity of structural materials by nondestructive techniques is also included. The nondestructive materials research involves both theoretical modeling and experimental verification of advanced ultrasonic/acoustic phenomena as related to understanding fundamental material properties and behavior under complex loads. Research in fatigue and fracture includes structural alloys as well as thick section, polymeric composites. Indepth analyses of the fracture and crack growth processes will be conducted and comparisons made to validate and extend the reliability of current life prediction models. Nondestructive materials research will focus on providing a scientific basis for quantitative ultrasonic analysis of the integrity and properties of composites and metals. Precision measurement techniques to determine the physical mechanisms of materials behavior such as the mechanics of impact damage in composites will constitute a significant part of the nondestructive materials research.

W85-70020 **505-33-31**
Ames Research Center, Moffett Field, Calif.
POLYMERS FOR LAMINATED AND FILAMENT-WOUND COMPOSITES
J. A. Parker 415-965-5225
(505-45-11; 552-06-15)

The objective is to establish a better and more quantitative relationship between composite processing parameters, materials properties and performance characteristics, than now exists. To use these relationships to optimize the processing of composites for filament wound cases, X-wing, and rocket nozzles within the constraints of current design, materials and processing facilities. To use the relationships established above to develop an algorithm for making materials that are ideal for the above structures. A further objective is to develop molecular design criteria for new resins for such applications. Resins will be sought having high strength, impact resistance, thermal stability, fire resistance, easy processing and curability, and imparting desired mechanical properties and cost effectiveness to fiber reinforced composite structures. The search for improvements over state-of-the-art resins will involve appropriate structure/property correlations and the preparation of prepolymers (oligomers) through chain extension and curing of such compounds as bismaleimides, stilbazoles, vinyl-terminated styrylpyridine oligomers, and perhaps also perfluoroalkylaryl monomers.

W85-70021 **505-33-33**
Langley Research Center, Hampton, Va.
COMPOSITES FOR AIRFRAME STRUCTURES
C. P. Blankenship 804-865-2042
(505-33-23; 506-53-23; 534-06-23)

The objective is to achieve the full weight reduction potential of highly loaded composite structures. The approach is to improve matrix properties, damage tolerant concepts, analytical predictive methods, and understanding of aging effects. Structural resins and adhesives with improved toughness, moisture resistance, processability, and thermal performance will be synthesized. Fundamental factors with control toughness and damage tolerance in resins and composites will be determined. Impact damage and residual strength will be measured and modeled mathematically. The effectiveness of bolted composite joints and woven buffer strips will be studied. Using advanced structural concepts and design methods, flat, curved, and stiffened structures will be made and tested in compression, tension, combined loads, and after damage. Analytical methods will be developed to predict properties. Long-term durability under expected service environments will be studied using ground-based and flight service exposure. Predictive analytical methods for environmental effects will be developed with emphasis on verification of accelerated test methods. Analyses for describing the nonlinear behavior of structures including postbuckling and ultimate strength will be developed. Processing methods for new resin systems will be established with emphasis on economics and consistent quality. Resin rheology and cure mechanics studies will be used as the basis for developing cure processes.

W85-70022 **505-33-41**
Ames Research Center, Moffett Field, Calif.
FLIGHT LOAD ANALYSIS
A. L. Carter 805-258-3311

The objective of this activity is addressed toward improving structural flight test technology and examining the predictive capability of current state-of-the-art analysis methods using flight measurements.

W85-70023 **505-33-43**
Langley Research Center, Hampton, Va.
LOADS AND AEROELASTICITY
C. P. Blankenship 804-865-2042

The objective is to develop and validate improved methods for analytically determining loads, structural response, and structural stability of aerospace systems considering the dynamic and aeroelastic characteristics of the systems and structural interactions with flight control sub-systems, and to use these methods in the development and evaluation of techniques for eliminating or minimizing flutter, buffet, and other undesirable response phenomena, and for the enhancement of performance, ride quality, and service life. Research will be conducted to provide more accurate unsteady aerodynamic theories, particularly in the transonic range. The capability for design of multi-functional active control systems will be expanded. Advanced aeroelastic analysis methods will be evaluated and validated by both wind tunnel tests and flight tests using the DAST concept (Drones for Aerodynamic and Structural Testing). Emphasis will be on measurements of transonic aerodynamic loads, and flight validation of active control systems for load alleviation and flutter suppression. A decoupler-pylon concept for wing store flutter suppression will be evaluated in flight tests on a fighter airplane. Basic wind tunnel flutter studies will be used to gain a better understanding of the flutter characteristics of advanced aerodynamic configurations. The obsolete dynamic data acquisition system of the LaRC transonic dynamics tunnel will be replaced with modern hardware and appropriate software to allow efficient operation.

W85-70024 **505-33-53**
Langley Research Center, Hampton, Va.
ADVANCED AIRCRAFT STRUCTURES AND DYNAMICS
C. P. Blankenship 804-865-2042

The objective of this RTOP is to develop and validate design-oriented analysis methods to support formal optimization methodology for multidisciplinary applications; advanced structural analysis and computational methods and a standard generics software system; structural analysis and sizing methods for nonlinear behavior; and better understanding of global response characteristics of composite structures under crash loading conditions. Passenger safety through improved analysis, structural concepts, and seat/restraint system concepts for future aircraft under crash conditions will be enhanced. Active control landing gears will be demonstrated by flight tests. Airframe structural concepts and thermal management techniques appropriate for aircraft which cruise from supersonic to hypersonic will be developed and

evaluated. Concepts for oxygen enrichment and alternate Mach numbers in the 8-ft. High Temperature Structures Tunnel will be developed and verified. Operational capabilities of high enthalpy facilities, and advanced measurement techniques for proposed LaRC Hypersonic Vehicle Test Facility will be developed and verified. Analytical procedures for predicting transmission of noise through aircraft structures and human response will be developed and verified. FY-1985 thrusts include defining standard generic software system and acquire initial test bed system. An in-house-developed transformation for postbuckling problems will be implemented into STAGS; dynamic response of composite frames and beams will be investigated; definitive transport crash data will be acquired and compared with DYCAST analysis; and F-106B will be prepared for flight demonstration of active control gears.

W85-70025 **505-33-62**
Lewis Research Center, Cleveland, Ohio.
PROPULSION MATERIALS TECHNOLOGY
Carl E. Lowell 216-433-6922
(506-53-12; 533-04-12; 533-05-12)

The major objective of this RTOP is to advance the level of materials and processing technologies for high-temperature metallic, polymeric, and ceramic materials in order to contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines. The prime emphasis of the work is directed toward developing greater understanding of the interrelations between material composition/microstructure, fabrication processes, and mechanical/physical properties. Such understanding will serve to guide the creation of advanced materials concepts and options for future higher performance/higher durability/lower cost aircraft propulsion system components. Research includes the influence of microstructure on mechanical properties as well as the identification of potential substitutes for conventional superalloys. Further basic studies focus on the interactions between phase composition/distribution and advanced fabrication process variables for cast/wrought/powder metals and ceramics and include rapid solidification technology (melt spinning). Also, fundamental studies of potential service environment attack (oxidation/hot corrosion/etc.) are conducted in controlled and simulated engine environments to guide and support basic and applied research on the identification and validation of advanced metallic and thermal barrier coating concepts. Research in polymer matrix composites is focused on improved toughness and increased temperature capability. Metal matrix composites research is focused on improving models to predict performance which should result in improved design of components. Tribology research aims at understanding material/lubrication/wear interaction fundamentals.

W85-70026 **505-33-72**
Lewis Research Center, Cleveland, Ohio.
PROPULSION STRUCTURAL ANALYSIS TECHNOLOGY
D. J. Gauntner 216-433-4000
(505-33-62; 533-04-12; 533-05-12)

The major objectives of this RTOP are: (1) develop and verify advanced analysis and synthesis methods and advanced generic structural concepts for turbine engine components. Emphasis will be on high temperature applications. Material behavior constitutive relations will be developed emphasizing anisotropy of DS, single crystal and composite materials. Generic structural concepts will be conceived to exploit the capabilities of advanced material systems; (2) develop and experimentally validate improved analytical methods to describe and predict the dynamic and aeroelastic response of aircraft turbine engine components and turbine engine systems. Develop improved understanding of the basic physical processes pertinent to dynamic phenomenon in turbomachinery and to evaluate the effectiveness of vibration reduction methods for bladed disk assemblies, rotating structures and turbomachinery systems; (3) advance quantitative life prediction capabilities applicable to high temperature aerospace propulsion components. An experimental, analytical, and theoretical approach is applied to the development of these models incorporating thermal, mechanical and environmental damage contributions. Fracture mechanics is being extended to ceramic materials and small crack behavior. Mechanisms of damage provide physical base for life prediction models. Models will be verified through benchmark tests and incorporated into analytical codes.

Controls and Guidance Research and Technology

W85-70027 **505-34-01**
Ames Research Center, Moffett Field, Calif.
APPLIED FLIGHT CONTROL
G. W. Condon 415-965-5009
(505-34-11; 505-34-03; 505-42-11)

Research in advanced control technology will be pursued to develop the technology base for design of safe and efficient flight control systems for aircraft and aerospace craft that provide improved operational capabilities over these vehicles' flight envelopes. Analytical studies will be conducted to investigate concepts and methodology. Ground-based simulation and flight experiments will be carried out to substantiate the methodology. Nonlinear inverse system concepts and optimal control methods will be employed for vehicles that exhibit significant aerodynamic and kinematic non-linearities and control redundancy. Fly-by-wire control, fault tolerant microcomputer and actuation system concepts will be explored for the purpose of enhancing control reliability. Flying qualities design requirements for superaugmented aircraft will be defined based on inflight simulation. University grants will be awarded to support promising research in the field.

W85-70028 **505-34-03**
Langley Research Center, Hampton, Va.
CONTROL THEORY AND ANALYSIS
J. R. Elliott 804-865-4681
(505-34-01; 505-34-02; 505-35-02; 505-34-09; 505-45-03)

The goal of this RTOP is to provide a base of controls technology which will enable the safe utilization of advanced avionic, structural, aerodynamic and propulsion concepts in aircraft design. The objectives are to establish guidelines and criteria for designing full-authority control systems for highly augmented aircraft; to devise and validate methodology for the integrated design of advanced flight control systems; to conceive and validate advanced theoretical concepts for control of aircraft and their trajectories; to develop techniques for flight crucial controls which will accommodate unanticipated failures, and to conceive, develop, evaluate and apply new sensor concepts for flight control. The research to be conducted is an effort towards fulfilling the need to maintain the U.S. in a competitive position in the stability, control and guidance disciplines applied to highly augmented civil and military aircraft. Aircraft flying qualities and control system design criteria research; advanced control theory and system identification procedures; computer program and development and techniques for computer-aided aircraft design process; mathematical modeling procedures and analysis/synthesis procedures for flexible aircraft with active controls; and restructurable controls will be pursued through in-house, contract, and grant studies with leading specialists. Research activities will encompass theoretical, simulation, and flight test studies.

W85-70029 **505-34-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED CONTROLS AND GUIDANCE
D. A. Deets 805-258-3311

The objective of this research is to develop a technology base for the design, validation, and assessment of flight critical controls applicable to both civil and military missions. The work will be accomplished within two tasks: (1) the development, evaluation, and flight test of advanced flight control techniques utilizing the F-8 flight facility; (2) the development and evaluation of advanced verification and validation tools applicable to digital flight control systems. The approach will involve analysis, simulation, and experimentation and flight research. Task 1 will empha-

size experimentation using the F-8 Flight and Iron-Bird Facility. Task 2 will emphasize simulation and experimentation using the Digital Flight Control System Verification and Validation Laboratory.

W85-70030 **505-34-13**
Langley Research Center, Hampton, Va.
FAULT TOLERANT SYSTEMS RESEARCH
H. Milton Holt 804-865-3681
(505-34-23; 505-45-03; 505-37-13; 505-45-33; 505-34-03; 505-37-23; 505-43-13)

Aircraft and space vehicles of the 1990 to 2000 time period and beyond can be more efficient and profitable as a result of new technology advances. The acceptance of those advances can be accelerated by reducing the risk of the new technology. The objective of this effort is to develop a technology base for the design, validation, and assessment of flight-crucial controls for improving aircraft and space vehicle flight path guidance. The approach is to develop the methodology for fully integrated flight-crucial controls and guidance functions; identify candidate system architectural concepts; establish a credible validation process for advanced digital system designs through the development of new assessment methods, emulation/simulation techniques, and physical testing techniques; develop theories and techniques to design and evaluate advanced control systems; and investigate lightning environmental effects.

W85-70031 **505-34-17**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED INFORMATION PROCESSING SYSTEM (AIPS)
E. S. Chevers 713-483-2851
(551-67-01)

The goal of this program is the development and demonstration of a system architecture and the associated design and evaluation methodologies which will effectively serve the need for advanced information processing across a broad spectrum of future NASA missions. The output will be proof-of-concept demonstration of processing core with associated data and power distribution media that can be gracefully expanded to support various specific applications. The design methodology, hardware/software tradeoffs, modularity, and testing processes are significant elements of this output. A primary goal is to evaluate the system in a flight test environment. This evolutionary program will be accomplished over a six year period and have milestones which might be directed towards various applications. The basic program is intended to be generic in context, and utilize output from parallel programs as appropriate. The system will demonstrate high reliability with minimum maintenance costs.

W85-70032 **505-34-23**
Langley Research Center, Hampton, Va.
AIRLAB OPERATIONS
Dale G. Holden 804-865-3681
(505-34-13)

The objective of this RTOP is to operate, maintain, and enhance the role of AIRLAB as a major facility for conducting controls and guidance research. Descriptive system documentation and operational support to assist AIRLAB users in the study, evaluation, and demonstration of the safety reliability and performance of fault tolerant electronic systems for future aerospace applications will be provided. The utility and operating time of AIRLAB equipment will be maximized by providng hardware and software maintenance support in an efficient and timely manner. New or improved hardware and support software will be implemented to enhance AIRLAB capabilities, improve ease of use, and increase productivity

W85-70033 **505-34-31**
Ames Research Center, Moffett Field, Calif.
AIRCRAFT CONTROLS: RELIABILITY ENHANCEMENT
D. G. Denery 415-965-5425
(505-34-11; 505-42-41; 505-45-11)

The objective of this research is to investigate advanced guidance and control concepts applicable to various types of aircraft performing complex civil and military missions, and to develop air traffic flow management concepts. The work will be accomplished within five tasks: (1) the development of theory and techniques to design fuel-conservative and four-dimensional trajectory guidance systems compatible with airline and air traffic control requirements; (2) the investigation of air traffic flow management concepts compatible with the FAA's National Airspace System Plan; (3) the development of non-linear state estimation techniques to improve flight path guidance and flight data analysis; (4) the development of air-to-air combat maneuvering guidance laws using optimal control theory and heuristic programming techniques; (5) flight experiments on optimum air-to-air combat maneuvering guidance laws. The approach will involve analysis, simulation and flight experiments. Task 1 will utilize the 727 simulator of the Man Vehicle Systems Research Facility and Task 2 the Ames Terminal Area Air Traffic Control Facility. Task 3 and 4 emphasize analytical studies. Task 5 primarily involves experimentation using the F-15 and the F-8 flight facilities at Ames Dryden.

W85-70034 **505-34-33**
Langley Research Center, Hampton, Va.
AIRCRAFT CONTROLS: THEORY AND TECHNIQUES
J. J. Hatfield 804-865-2171

The objective of this RTOP is to find high payoff options for significantly improving aerospace vehicles and their operational safety, efficiency, and productivity in the 1990 to 2000 time period through research on flight path guidance and crew station interface technology. Advanced techniques and guidance laws that can minimize fuel use, flight time, increase the crew's ability to meet precise position/time constraints, and to minimize the exposure threat will be developed. Another objective is to develop advanced electronics technology for innovative crew station configurations which can integrate the man/machine interface to increase safety, performance, and reliability while reducing workload and equipment volume, power, and costs. The third objective is to apply interdisciplinary R&D to problems of improving guidance within the present and future ATC systems. The approach is to apply modern control theory, along with singular perturbation techniques to study flight path optimization problems; develop theories and techniques to design and evaluate advanced flight path guidance and control systems; utilize grants and contracts for selected studies and software development; develop and integrate advanced display concepts, 3-D display techniques, display media, pictorial graphics generators, and information management techniques; evaluate/validate new techniques and technology through laboratory and piloted simulation techniques; and establish a technology criteria and performance base for future vehicle designers.

Human Factors Research and Technology

W85-70035 **505-35-10**
National Aeronautics and Space Administration, Washington, D.C.
SUPPORT FOR THE COMMITTEE ON HUMAN FACTORS OF THE NATIONAL ACADEMY OF SCIENCE
Melvin D. Montemerlo 202-453-2784

This RTOP provides support for NASA's joint sponsorship with the Office of Naval Research (ONR), the Army Research Institute (ARI), and the Air Force Office of Scientific Research (AFOSR), of the National Academy of Sciences' (NAS) Commission on Behavioral and Social Science (CBASS) Committee on Human Factors. The National Academy of Sciences and its committees provide advice to governmental agencies in solving advanced technological problems. The committee on Human Factors was established to provide advice on determining the most important theoretical and methodological issues in Human Factors.

W85-70036 **505-35-11**
Ames Research Center, Moffett Field, Calif.
FLIGHT MANAGEMENT SYSTEM - PILOT/CONTROL INTERFACE
Joseph C. Sharp 415-965-5100
(505-35-21; 506-57-21; 199-22-62)

The safe and effective management of the flight of modern automated aircraft depends critically on the management of information to and from the flightcrew. Technological advances in cockpit technology have radically increased the options available to the system designers. In fact, the range of options is so broad and the role of the flightcrew so altered, that pilot models and man-machine interface studies are essential to the making of intelligent tradeoffs between design alternatives. Perception, cognition, and human-machine interface research will be carried out with the goal of developing analysis techniques for flight deck design and evaluation. Since simulation plays such an important role in aircraft design and evaluation, further studies will be conducted to understand better perception and performance in simulators and the validation of effective simulation systems. Prototype flight deck display and control systems will be developed that are based on the analysis techniques. University Centers of Excellence will be funded to provide an accelerated flow of ideas in this program.

W85-70037 **505-35-13**
Langley Research Center, Hampton, Va.
FLIGHT MANAGEMENT
S. A. Morello 804-865-3621

The objective of this program is the development of a research and technology data base from which solutions to human problems impeding the growth and safety of air transportation may be derived. Specific objectives include: the exploration and development of concepts for integrated control/information transfer between crew and aircraft; the application of artificial intelligence concepts to cockpit aids such as system status monitoring and diagnosis to facilitate safe and efficient flight operations; the exploration and development of innovative control/display operational concepts, involving cockpit displays of traffic and flight management information that will insure the efficient and safe use of ATC system technology; the determination of single pilot cockpit requirements for operation in an advanced ATC environment; the establishment of a quantitative and qualitative data base for display format/arrangement factors; and the development of a technology base that will allow reliable substitution of simulators for research applications involving atmospheric environment factors. Analytical studies, computer modeling, and impact assessments will be conducted for initial evaluations of research concepts. Simulation facilities and flight vehicles, equipped with new display/control interfaces, will be operated in conjunction with a simulated ATC environment to represent flight operations in advanced en-route and terminal area scenarios.

W85-70038 **505-35-21**
Ames Research Center, Moffett Field, Calif.
HUMAN PERFORMANCE AFFECTING AVIATION SAFETY
Joseph C. Sharp 415-965-5100
(505-35-11; 506-57-21; 505-42-11)

Human error continues to play a disproportionate role in aircraft accidents. For some classes of aircraft operation, e.g., rotorcraft, the human error rates appear to be increasing. To reduce the error rates, and therefore to increase levels of flight safety, the fundamental mental causes of human error must be understood and effective means found to prevent or counteract such errors. Studies of the roles that pilot fatigue and jet lag play in flight crew performance will be conducted. Other research will be done to understand crew errors and their prevention. The special problems associated with rotorcraft operations will be studied in part through use of the Aviation Safety Reporting System. Finally, flight crew training research will be conducted with industry participation, in the newly completed Man-Vehicle Systems Research Facility.

W85-70039 **505-35-31**
Ames Research Center, Moffett Field, Calif.
PILOTED SIMULATION TECHNOLOGY
Joseph C. Sharp 415-965-5100
(505-35-11; 506-57-21; 505-42-11)

As the role of the flight crew changes from one of manual control to one of supervisory control and information management, new methods are needed to predict the mental workload associated with the combination of cognitive and manual tasks. Valid measures of flight crew performance are needed, in addition, which are nonintrusive and suited for use in mission oriented simulation as well as in actual flight. With these two tools, valid workload and flightcrew performance measures, new cockpit systems, operational procedures and training technologies can be evaluated and improved. The objective of this research will be to perform studies of the basic components of mental and manual workload and to develop valid workload methods. Additional studies will be carried out to better understand and measure individual pilot and flightcrew performance, in part through studies conducted in the Man-vehicle Systems Research Facility.

W85-70040 **505-35-33**
Langley Research Center, Hampton, Va.
HUMAN ENGINEERING METHODS
A. T. Pope 804-865-3917

The major objective of this RTOP is the development and validation of human response measurement technologies for the assessment of aerospace crew mental state. This objective is achieved by means of integrated analytical and experimental studies conducted both in-house and through contract. The objectives of this research are designed to be responsive to both the short-term and long-term needs of aerospace crew systems research. The objectives include the following: (1) to develop and validate psychophysiological response measurement techniques for the assessment of crew mental state; (2) to develop requirements for information about crew mental state needed for allocation of tasks between the electronic crew member and the human crew; (3) to develop and evaluate graphic display information transfer rate methodologies based upon oculometric techniques; and (4) to implement and maintain a battery of state-of-the-art crew workload assessment techniques. These objectives will be pursued through review and evaluation of candidate workload battery techniques, through experimental and analytical studies of central and autonomic nervous system and skeletomuscular responses, and through physiological self-regulation training studies.

W85-70041 **505-35-81**
Ames Research Center, Moffett Field, Calif.
HUMAN FACTORS FACILITIES OPERATIONS
F. J. Styles 415-965-5728
(505-35-11; 505-35-21; 505-57-21)

This Facility Operating Plan provides for the operation, maintenance, modification and upgrade of the human factors research facilities at Ames Research Center. The Center conducts a variety of human factors research programs for NASA, DOD, FAA, industry and other Government agencies in areas of advanced concepts and operational problems of flight management systems, human factors in aviation safety, helicopter/VTOL human factors, workload/performance measurement, perception, simulation and training technology, and space human factors. This research requires the utilization of both the small, relatively simple and flexible experimental setups, computers, cockpit simulators and space station mockups in buildings N239 and N239A (the Human Factors Research Laboratories) and the highly sophisticated, full system/full mission aeronautical flight simulators and supporting equipment of the Man-Vehicle Systems Research Facility (MVSRF), in Building N257.

Multidisciplinary Research

W85-70042 **505-36-21**
Ames Research Center, Moffett Field, Calif.
AERONAUTICS GRADUATE RESEARCH PROGRAM
David J. Peake 415-965-5113
(505-36-41)

The objective of this program is to develop the interest of student engineers in the field of aeronautical and aerospace

engineering, provide on-the-job training in experimental and computational research methods, and augment NASA's research program by encouraging strong interaction between students, faculty, and Center researchers. The approach is to bring the Center's needs to the attention of the academic community. Research topics are established by mutual agreement to foster cooperative programs between the government and academia. Cooperation may be evidenced by use of each other's facilities and performance of the research at NASA installations. The Ames-North research conducted under this RTOP will include aerodynamics, acoustics, flight mechanics, and computational fluid dynamics. It will be both theoretical and experimental in nature. The Ames-Dryden activities support work to improve methods and techniques in flight research and testing of aeronautical vehicles. The program is to promote the overall improvement in flight research through simultaneous advancement in instrumentation, testing methods, equipment, data recording, and data analysis.

W85-70043 **505-36-22**
Lewis Research Center, Cleveland, Ohio.
GRADUATE PROGRAM IN AERONAUTICS
Marvin E. Goldstein 216-433-4000

The objective is to sponsor graduate research and training in Aeronautics which is relevant and acceptable to both NASA and the University and to encourage a greater number of newly graduating, U.S. Citizen engineers to pursue graduate training. A significant portion of that training will be through student research conducted at Lewis Research Center.

W85-70044 **505-36-23**
Langley Research Center, Hampton, Va.
GRADUATE PROGRAM IN AERONAUTICS
Samuel E. Massenberg 804-865-2188

The objective of this plan is to support university research in Aeronautics in which there is substantial involvement of graduate students at the Langley Research Center. While formal classroom activities are conducted at a university campus, a substantial portion of the graduate research activity is carried out at the Langley Research Center in conjunction with Langley staff and under the overall guidance of a faculty advisor. The research pursued under this RTOP is Aeronautics related. Research grants or cooperative agreements are awarded to a number of universities to pursue aeronautical research with support being mainly for graduate research students and to some extent faculty members associated with those students. The selection of graduate research topics is determined by joint agreement between the university and NASA staff.

W85-70045 **505-36-41**
Ames Research Center, Moffett Field, Calif.
JOINT INSTITUTE FOR AERONAUTICS AND AEROACOUSTICS (JIAA)
Wallace H. Deckert 415-965-5486
(505-36-11; 505-36-21)

The objectives of this RTOP are to conduct basic and applied research in Aeronautics and Acoustics, to develop the interests and talent of student engineers in these fields, and to promote continued and intense involvement in joint research endeavors between Center scientists and those at the Institute. This will provide opportunities for mutual enhancement and augmentation of the graduate's research and education and NASA's research programs. The RTOP provides core funding for the Ames/Stanford Joint Institute for Aeronautics and Aeroacoustics.

W85-70046 **505-36-42**
Lewis Research Center, Cleveland, Ohio.
JOINT INSTITUTE FOR AEROSPACE PROPULSION AND POWER BASE SUPPORT
F. J. Montegani 216-433-6432

The Joint Institute for Aerospace Propulsion and Power (JIAPP) is a collaborative undertaking between Lewis Research Center and the University of Akron, Case Western Reserve University, Cleveland State University, the University of Toledo, and other academic institutions yet to affiliate. The objective is to conduct scholarly research in the multiple disciplines underlying aerospace propulsion and power utilizing the preeminent resources of the collective institutions. The approach is to engage center engineers and scientists and university personnel, especially principal investigators, in collaborative research efforts of a personal, day-to-day nature at a working level with emphasis on utilization of center research facilities.

W85-70047 **505-36-43**
Langley Research Center, Hampton, Va.
JIAFS BASE SUPPORT
Samuel E. Massenberg 804-865-2188
(505-36-23)

The objective of this plan is to provide a core level of funding for the Joint Institute for Advancement of Flight Science (JIAFS), which is an extension of the School of Engineering and Applied Science, George Washington University, located at the Langley Research Center. This core program allows the flexibility for developing new areas of research and through support for ongoing administrative personnel and provision for additional Graduate Research Scholar Assistantship appointments, will give JIAFS a degree of institutional stability and flexibility. The specific research topics in the program will be determined through mutual agreement between LaRC and GWU.

W85-70048 **505-36-60**
National Aeronautics and Space Administration, Washington, D.C.
TRAINING PROGRAM IN LARGE-SCALE SCIENTIFIC COMPUTING
Randolph A. Graves, Jr. 202-453-2763

The objective of the program is to produce highly skilled technical personnel with advanced degrees in computationally intensive major studies related to engineering and physical sciences disciplines. The approach is to develop a balanced graduate training program in large-scale computing at a few selected universities. A balanced program contains training in engineering or a physical science, computational methods, and computer science.

Computer Science and Applications Research and Technology

W85-70049 **505-37-01**
Ames Research Center, Moffett Field, Calif.
ADVANCED COMPUTATIONAL CONCEPTS AND CONCURRENT PROCESSING SYSTEMS
J. O. Arnold 415-965-6209
(505-31-01; 506-51-11; 506-53-11)

The objective is to support Computational Fluid Dynamics (CFD), Computational Chemistry, and other disciplines of Agency interest by developing an understanding of the relationships and tradeoffs between algorithms and computer architectures for these applications. Approaches, techniques, and tools are needed to apply this insight to the development of optimal hardware/software systems for this class of problems. The research will permit better utilization of emerging concurrent processors, and will influence the design of systems crucial to NASA in the 1990's. The approach involves collaboration of the Advanced Computational Concepts Group, Computational Research and Technology Branch, and Ames' Research Institute for Advanced Computer Science (RIACS). This collaboration will bring together computer science and computational physics expertise to analyze the requirements, evaluate extant concepts and products, and conduct the necessary research and development. The steps involved include the development of requirements, evolution of promising systems concepts; simulation, emulation, or modeling techniques to validate system concepts; and the building of prototypes to serve as proof of concept.

W85-70050 **505-37-03**
Langley Research Center, Hampton, Va.
SOFTWARE TECHNOLOGY FOR AEROSPACE NETWORK COMPUTER SYSTEMS
E. C. Foudriat 804-865-2077
(505-37-13; 505-37-23; 505-31-83)

The objective is to demonstrate cooperative autonomous systems technology by supporting research and building a number of experimental network systems. As total system complexity increases, vehicles will utilize autonomous subsystems for individual tasks like imagery, guidance, and control. These nodes will be networked to form a total system; hence, the concept cooperative autonomy. In order to demonstrate cooperative autonomy inhouse, the components of the Software Development Lab and the Intelligent Systems Research Lab will be integrated into a simulation of a typical spacecraft. The basic component integrating the network computer nodes will be a time-critical operating system designed to support node common and unique service. It will demonstrate that special purpose subsystems can be integrated and that multipath networking will provide the reliability, flexibility, and extensibility for future spacecraft computer systems. The approach for implementing cooperative autonomous software includes at least three critical technologies: language, programming environments, and operating systems. The approach is to conduct coordinated grant, contract, and inhouse research and to assimilate that and other research into the inhouse development system. The research provides a coordinated feedback between team members. As the software network O/S and environment features unfold, this cross activity is critical. The inhouse approach uses, to a large degree, presently available hardware.

W85-70051 **505-37-13**
Langley Research Center, Hampton, Va.
RELIABLE SOFTWARE DEVELOPMENT TECHNOLOGY
Susan J. Voigt 804-865-2083

As complex computing systems play an increasing role in NASA programs and projects, the requirement for reliable software intensifies. This research addresses methodologies for developing reliable software and techniques for assessing software reliability. Prototype tools and environments for both software developers and their managers are being developed, adapted, and studied to identify the most cost effective approaches to develop reliable, quality software. Emphasis in this year will be on source code management and requirements specification and design analysis. A Unix-based work station augmented with special management support tools and software development aids is currently the focus of this work. Experimental studies are underway to collect software reliability data and to characterize software failures. A data base of fault descriptions, failure conditions, and interfailure times is being built and used to analyze software reliability models. Models which include the effects of correlated errors are being developed and validated. Fault tolerant software design techniques and the feasibility of automatic software synthesis are being examined.

W85-70052 **505-37-23**
Langley Research Center, Hampton, Va.
ENGINEERING DATA MANAGEMENT AND GRAPHICS
Susan J. Voigt 804-865-2083

The major objective of this research is to improve the ability to process, analyze, and display large quantities of scientific and engineering data. Raster graphics and image processing tools are being developed and demonstrated which are suitable for interactive use on current and advanced workstations. Under a grant with George Washington University, graphical extensions to PASCAL are being developed to allow the user to define and manipulate graphical objects (lines, points, and panels) and dialog (prompts and menus). This high level graphics extension to a programming language will encompass the three central tasks of interactive graphics: modeling, viewing, and human-workstation interaction. The work will introduce graphical data types with a natural syntax which will reduce programming errors and raise productivity. This research will continue through implementation and demonstration. Research on bivariate interpolation, approximation, and smoothing will continue under a grant with North Carolina State University. This work is directed toward developing algorithms for shape preserving quadratic splines which preserve the monotonicity and convexity of the prescribed data. Shape preservation is important in CAD/CAM applications and the rendition of shaded surfaces. A surface interpolation algorithm is in use. Approximation and smoothing of noisy data and knot compaction to reduce storage requirements will be investigated. It is anticipated that research on the application of algebraic data types to the specification of image enhancement techniques will be initiated via a grant to the College of William and Mary.

W85-70053 **505-37-41**
Ames Research Center, Moffett Field, Calif.
CENTRAL COMPUTER FACILITY
C. E. Rhoades, Jr. 415-965-5258

The objective is to provide Ames with state-of-the-art large scale processors, which will enable the researchers, particularly in the computational physics and fluid dynamics communities, to maintain their preeminence. This RTOP provides computational capabilities, hardware, software, maintenance, operations, enhancements and management of the centralized computer facilities.

W85-70054 **505-37-49**
Marshall Space Flight Center, Huntsville, Ala.
PROGRAM SUPPORT COMMUNICATIONS NETWORK
E. D. Hildreth 205-453-3470

The objective of this effort is to obtain a complete end-to-end high speed mainframe Computer Networking Subsystem (CNS) including its operation and maintenance utilizing the Program Support Communications Network (PSCN) as the communications medium. This subsystem is to provide for the sharing of unique mainframe computational capabilities embodied in the various large scientific computers located at NASA Centers. CNS must be adaptable to changes in the volume of traffic, number of mainframes at each site, mainframe operating systems, number of sites and rate of data transfer. The initial system will link the unique computational capabilities of the OAST Centers. The system to support this link will consist of data buffering and mainframe interface equipment, and utilize the NASA PSCN as the communications medium.

Propulsion Systems Research and Technology

W85-70055 **505-40-14**
Lewis Research Center, Cleveland, Ohio.
TECHNOLOGY FOR ADVANCED PROPULSION INSTRUMENTATION
N. C. Wenger 216-433-6646

The objective of this RTOP is to provide the technology for advanced instrumentation for propulsion system research as well as to provide the propulsion sensors and control stratgies for safe, reliable, stable operation of future propulsion systems. Part of the effort is focused on the development of minimally intrusive sensors for measuring temperature, heat flux and strain with emphasis on thin film technologies. Part of the emphasis is on development of non-intrusive measurement systems for the mapping of strain, flow, smoke and gas species and temperature with approaches which usually employ lasers. The remainder of the emphasis is on developing the sensors, actuators, electronics, fiber optics and control strategies for future, more sophisticated propulsion systems.

W85-70056 **505-40-64**
Lewis Research Center, Cleveland, Ohio.
HIGH THRUST/WEIGHT TECHNOLOGY
Daniel C. Mikkelson 216-433-6820
(505-40-84)

The objective is to establish a technology base for achieving high thrust/weight ratios for advanced propulsion systems. The

approach is to conduct anaytical and experimental studies of advanced concepts including the supersonic throughflow fan and use of advanced materials.

W85-70057 **505-40-62**
Lewis Research Center, Cleveland, Ohio.
INTERMITTENT COMBUSTION ENGINE TECHNOLOGY
Edward A. Willis 216-433-4000

The objective is to identify and establish the technology base for the most promising advanced intermittent combustion engines for future light civil airplanes, commuter, rotorcraft, and light military aircraft for the late 1980's and on. Advanced intermittent combustion engines having multi-fuel capability, substantially lower BSFC, weight, maintenance and improved reliability are being defined through studies and engine tests, supplemented by analyses and experimental investigations in key technology areas.

W85-70058 **505-40-74**
Lewis Research Center, Cleveland, Ohio.
AERONAUTICS PROPULSION FACILITIES SUPPORT
Frank J. Kutina, Jr. 216-433-4000

This RTOP provides the resources for maintenance, normal repair, limited improvements, and support of interagency and industrial assistance testing in all the major aeronautics facilities at LeRC. These facilities consist of the 10x10 foot supersonic wind tunnel, 8x6 foot supersonic wind tunnel, 9x15 foot low speed wind tunnel, 6x9 foot icing research tunnel, the altitude engine test cells, and several other smaller test locations. This RTOP also provides for the planning, management, and conduct of required contractual and in-house efforts necessary to provide for the successful design and fabrication of the rehabilitated altitude wind tunnel. All resources required for the altitude wind tunnel rehabilitation are provided in this RTOP except those provided through the CoF budget. Also included in this RTOP are the resources for the lease and maintenance of the LeRC CRAY computer.

W85-70059 **505-40-84**
Lewis Research Center, Cleveland, Ohio.
ADVANCED PROPULSION SYSTEMS ANALYSIS
Daniel C. Mikkelson 216-433-6820
(505-40-64)

The objective is to conduct near term and long range aeropropulsion planning exercises to assist in the development of future NASA aeronautics plans. The approach is to perform studies of the feasibility and potential benefits of advanced propulsion concepts, to identify technology research requirements, and define opportunities for capitalizing on technology advances. Studies will be performed on a wide variety of engine cycles, propulsion systems, and engine/airframe combinations in aircraft missions.

Rotorcraft Research and Technology

W85-70060 **505-42-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT AEROMECHANICS AND PERFORMANCE RESEARCH AND TECHNOLOGY
C. Thomas Snyder 415-965-6577
(505-42-51; 532-06-11; 532-09-11)

This RTOP covers research on rotor aerodynamics, dynamic loads and stability, performance and noise characteristics, rotorcraft flight dynamics, and rotorcraft human factors. Theoretical and experimental research will be conducted to improve fundamental understanding and develop techniques to design rotors optimized for aerodynamic performance and noise reduction. Effects of planform geometry, airfoil section, and dynamic stall will be included. Prediction of aerodynamic and dynamic phenomena of rotorcraft will be improved by conducting analytical, small-scale, and full-scale experimental investigations of helicopter performance and noise; rotor aerodynamics and wake characteristics, drag and aerodynamic interference; and rotor loads, vibration, and vibration reduction systems. Flight dynamics research will be conducted through analysis, simulation, and flight experiments to provide handling qualities and design criteria for specific missions. Human factors research will concentrate on fundamental laboratory studies to reveal the needs and information processing of helicopter pilots.

W85-70061 **505-42-23**
Langley Research Center, Hampton, Va.
ROTORCRAFT AIRFRAME SYSTEMS
Charles P. Blankenship 804-865-2042
(532-06-13)

The objectives of this research are: (1) to develop the technology for the application of composite materials and design concepts in helicopter structures; (2) to improve performance and efficiency, reduce costs, and provide equivalent durability and energy absorption capability compared to metal structures; (3) to determine by analytical and experimental study effective means for reducing helicopter vibrations; (4) to determine and evaluate the aeroelastic characteristics of new rotor concepts; (5) to develop an experimental data base and improved analytically and empirically-based prediction methods for determining rotor blade unsteady aerodynamic loads; (6) to gain a fundamental understanding of the dynamics of blade/vortex interaction and other leading components of helicopter rotor noise with an aerodynamic origin; and (7) to acquire experimental aerodynamics and acoustics data for helicopter systems and components for correlation with analysis.

W85-70062 **505-42-41**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT GUIDANCE AND NAVIGATION
D. G. Denery 415-965-5427
(505-42-01; 505-34-11; 532-06-11)

The objective of this research is to provide the critical technology needed to significantly improve all-weather rotorcraft operational capability in remote areas and in the National Airspace System (NAS). The research program will be based upon the needs, requirements, and operating experience of the users, in coordination with the DOD, FAA, and industry. The design criteria and performance tradeoffs will be defined and evaluated in simulation and flight. The technology thrusts will include: (1) low-altitude flight and remote-site landing-guidance concepts; (2) satellite-based guidance; and (3) advanced guidance concepts for use in the future air traffic-control system.

W85-70063 **505-42-51**
Ames Research Center, Moffett Field, Calif.
RSRA FLIGHT RESEARCH/ROTORS
Wallace H. Deckert 415-965-5486

The objectives of this RTOP are to provide and validate integrated rotorocraft and rotor-systems technology required for the low-risk design of advanced rotorcraft systems and components based on verified design tools and experimental methods. The performance, utility, efficiency, dynamics, noise, maintainability and ownership cost of civil and military helicopters will be improved. Program emphasis is on rotor system performance; rotor/airframe aerodynamics and aeroelastic methodology; vibration prediction and control; noise prediction and control; advanced materials application; advanced rotor concepts; and advanced vehicle concepts which have significant potential gains in utility, efficiency, maintainability, and productivity. The activity involves design studies and focused and coordinated research in prediction methods, simulation, ground testing, and flight testing of current rotors and advanced-concept rotor systems. This program is in cooperation with U.S. Army utilizing the Rotor Systems Research Aircraft (RSRA) and other testbeds as appropriate. The flight data base will be expanded on existing rotors that can be readily adapted for evaluation.

W85-70064 **505-42-61**
Ames Research Center, Moffett Field, Calif.
FLIGHT TEST OPERATIONS
F. J. Drinkwater 415-965-5687
(505-42-51; 532-09-11; 533-02-51)

This RTOP provides for the overall operations support for Ames research aircraft flight experiments in low speed aerodynamics, flight dynamics and control, guidance and navigation and avionics systems. This activity consists of the support and operation of certain fixed and rotary wing aircraft and associated ground support equipment at Moffett. Support is also provided to operate and maintain flight data facilities including aircraft instrumentation, post flight processing, data storage and noise measurements.

W85-70065 **505-42-71**
Ames Research Center, Moffett Field, Calif.
SIMULATION FACILITIES OPERATIONS
Anthony M. Cook 415-965-5162

This RTOP covers the support and operation of the Flight Simulation Facilities at Ames Research Center. These facilities consist of the Vertical Motion Simulator (VMS), the Flight Simulator for Advanced Aircraft (FSAA), the Interchangeable Cab (ICAB) Development Station, and a Flight and Guidance Laboratory containing multiple simulation facilities and computer labs. The objective of this RTOP is to provide flight simulation support in research and technology programs for NASA, DOD, FAA, industry and other Government agencies in the areas of handling qualities, flight dynamics, control systems development, guidance and navigation, pilot/systems interface, cockpit displays, and simulation technology. Flight simulation experiments will be related to various types of aircraft and rotorcraft as well as Space Shuttle vehicles.

W85-70066 **505-42-81**
Ames Research Center, Moffett Field, Calif.
LOW-SPEED WIND-TUNNEL OPERATIONS
J. V. Kirk 415-965-5045

The objective of this facility operating plan is to support research on basic fluid mechanics, rotorcraft aeromechanics, and acoustics, V/STOL powered lift aerodynamics, and the high-lift aerodynamics of conventional aircraft. This research is to be accomplished in the National Full-Scale Aerodynamics Complex (NFAC). The 40 ft. by 80 ft. and 80 ft. by 120 ft. wind tunnels will not be available for research operations until the second quarter of FY 1986; however, extensive facility checkout and acceptance will be conducted in the third and fourth quarters of FY-1985. In the interim, the 40 ft. by 80 ft. by 120 ft. test sections are being used to conduct static testing on models and aircraft to obtain both research and facility aerodynamic verification results. The 7 ft. by 10 ft. wind tunnel is being used in excess of one shift per day to conduct scale model research programs and the outdoor aerodynamic research facility continues to be used at the one-shift-per-day level to support such national programs as JVX.

W85-70067 **505-42-92**
Lewis Research Center, Cleveland, Ohio.
ROTORCRAFT PROPULSION TECHNOLOGY (CONVERTIBLE ENGINE)
K. L. Abdalla 216-433-5175

Part of the NASA Rotorcraft Program is focused on advancing critical technology needed to solve propulsion, power transfer, and propulsion system control integration problems associated with operation of military and civil rotorcraft and VTOL aircraft. Objectives are to improve propulsion system durability, reliability, and cruise fuel consumption to reduce life cycle cost, to develop propulsion technology unique to high productivity vehicles, and to improve operational capability, flexibility, ride quality, and passenger comfort. Technology readiness will be demonstrated in experimental propulsion systems incorporating advanced engine concepts such as convertible engines, advanced integrated airframe/engine controls systems, contingency power concepts, torque converters for high speed rotorcraft propulsion systems, and cross-shaft shared power technology for subsonic V/STOL.

W85-70068 **505-42-94**
Lewis Research Center, Cleveland, Ohio.
HELICOPTER TRANSMISSION TECHNOLOGY
John J. Coy 216-433-5258
(505-42-92; 505-42-98)

The objectives of this work are to advance the state-of-the-art in helicopter power transmission and gearbox technology. This will be done with improvements in the technology of components such as gears, bearings, seals, shafting, lubrication systems, and gearbox housings. Goals are to achieve improved transmissions which will be more reliable, lighter, quieter, longer lived, and more efficient in high speed/high temperature/high load environments in advanced rotorcraft. Emphasis will be given to analytical performance predictions with experimental verification to create long term opportunities as well as to satisfy goals for improved transmission and power drive train system performance. Experimental studies will be performed with standard type and advanced transmissions. Baseline transmission performance will be compared with analytical predictions. Advanced transmission performance and predictions will be verified and documented. Materials, lubricants, and design variables will be studied for improved transmission system performance reliability and life.

W85-70069 **505-42-98**
Lewis Research Center, Cleveland, Ohio.
ROTORCRAFT ICING TECHNOLOGY
John J. Reinmann 216-433-5542
(505-45-54)

The objective of this program is to advance the technology related to the safe operation of helicopters in atmospheric icing conditions. The program encompasses both analytical and experimental research and is conducted using in-house, contracted, and university efforts. Cooperative efforts with other government agencies, private companies, and foreign governments will be conducted when appropriate. Icing Research and Deveopment testing will be conducted using the NASA Lewis Icing Research Tunnel, other ground icing facilities, conventional wind tunnel test facilities, and flight tests in natural icing clouds and behind icing cloud simulators. The research will be coordinated among the rotorcraft industry/users, civilian government agencies, and the military. The focal point for assembling and disseminating the technology which is acquired will be NASA.

High-Performance Aircraft Research and Technology

W85-70070 **505-43-01**
Ames Research Center, Moffett Field, Calif.
POWERED LIFT RESEARCH AND TECHNOLOGY
C. Thomas Snyder 415-965-6039
(533-02-51)

The objective of this RTOP is to develop basic research and technology required to enable the development of military and civil aircraft having STOVL, V/STOL, and STOL capability and viable mission performance. Theoretical and experimental generic and configuration specific research will be undertaken in the areas of aerodynamics, propulsion, configuration integration, and flight dynamics. An experimental database for V/STOL fighter aircraft will be expanded using high-speed wind tunnel models. To evaluate the propulsion/airframe interactions on these configurations, propulsion simulator technology will be developed and applied. Methods for predicting high-speed aerodynamic performance will be refined. Low-speed aerodynamic research will continue to develop aerodynamic prediction techniques for both transition and ground effects. Experimental database will be expanded using large-scale components and complete models. An Ejector Augmented Lift Technology Program jointly funded by NASA, the Canadian government and the U.S. Navy will conduct generic and configuration specific research to investigate advanced ejector concepts and aircraft installed flight-type ejector system performance. Flight control system and display requirements will be

investigated. In-house studies will be continued to determine USB cruise efficiency.

W85-70071 **505-43-03**
Langley Research Center, Hampton, Va.
V/STOL FIGHTER TECHNOLOGY
R. E. Bower 804-865-3285

The broad objectives are to provide fundamental aerodynamics, stability and control, and flight dynamic information on advanced fighter concepts designed for short or vertical takeoff and landings. The work will be conducted with recognition of and in support of the Ames lead-Center role in V/STOL technology. The research will include work on advanced thrust vectoring and reversing concepts proposed for STOL/STOVL demonstrator aircraft, powered-lift arrangements such as spanwise blowing, over-the-wing or externally blown jet flaps, ejectors, and lift engines and lift-fan concepts. Specific objectives are: (1) to investigate low-speed performance, stability, and control in and out of ground effect of advanced STOL/STOVL fighter concepts; (2) to investigate low-speed handling qualities, stall/spin characteristics, and control system requirements for safe and effective STOL/STOVL operation; and (3) to define and develop airframe/propulsion control concepts (aerodynamic, thrust vectoring, and reaction jet) and control-law techniques to meet operational requirements. The method of approach for these efforts is to use the unique facilities available at Langley which include the moving ground belt test technique in the 4 meter by 7 meter tunnel and the free flight test technique in the 30 foot by 60 foot tunnel. In addition, testing will include static and dynamic force measurements, spin-tunnel tests, and piloted simulator studies in the Langley Differential Maneuvering Simulator (DMS).

W85-70072 **505-43-11**
Ames Research Center, Moffett Field, Calif.
HIGH-ALPHA AERODYNAMICS AND FLIGHT DYNAMICS
C. Thomas Snyder 415-965-6208
(533-02-91)

The objective is to provide a basic understanding of the high-alpha aerodynamics and flight dynamics of high performance aircraft and highly maneuverable fighter aircraft. Wind tunnel and flight tests are directed towards: (1) providing improved wind tunnel and flight test techniques and hardware and analytical methods for predicting the flight behavior of such vehicles in all phases of flight from controlled maneuvers to fully developed spins; (2) providing better understanding of the fundamental fluid dynamics phenomena including 3-D separated and vortex flows; and (3) improving analytical techniques for determining stability and control derivatives from flight data and developing new techniques for evaluating handling qualities. Emphasis in the ground-based tests is in the high angle-of-attack, high Reynolds number regime, and addresses both static and dynamic characteristics. A coordinated program of wind tunnel and flight tests is planned to provide means for wind tunnel/flight correlation. Both generic configurations and actual flight aircraft configurations will be utilized (F-15, F-18).

W85-70073 **505-43-13**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS AERODYNAMICS AND CONTROLS
R. E. Bower 804-865-3285

The principal objectives of this program for high-performance military airplanes are to: (1) provide improved stall/spin characteristics (via aerodynamics and controls) and accomplish early prediction of stall/spin characteristics of advanced designs; (2) investigate aerodynamic flow separation fundamentals; and (3) explore architectures for integrated digital flight control systems. The approach for providing improved stall/spin characteristics is to investigate airframe and control system concepts providing improved stability using wind-tunnel, flight, and pilot simulation methods. Results are used to define new configuration concepts and design guides. The approach to aerodynamic flow separation fundamentals is to conduct experimental studies of 3-D flow phenomena associated with high-alpha. The integrated controls approach is to perform contractual studies to define validatable system architectures for demonstration in Avionics Integration Research Laboratory (AIRLAB).

W85-70074 **505-43-23**
Langley Research Center, Hampton, Va.
HIGH-SPEED AERODYNAMICS AND PROPULSION INTEGRATION
Roy V. Harris, Jr. 804-865-2658

The technical objective of this work is to develop the aerodynamic technology base for the design of future military aircraft and missile concepts. Analytical and experimental studies will be made to develop aircraft design rationale and evaluate advanced aerodynamic concepts. Supercritical aerodynamics, wing warp, maneuver devices, thrust-induced lift, nonaxisymmetric nozzles, and component interference will be studied. Similar studies will be made to extend the aerodynamic technology base for missile systems including conventional cruciform stability and control concepts, airbreathing propulsion integration and monoplanar concepts. Studies will also be made to provide a technology base for evaluation of missile carriage and separation aerodynamics.

W85-70075 **505-43-31**
Ames Research Center, Moffett Field, Calif.
INTERAGENCY ASSISTANCE AND TESTING
R. G. Bryant 805-258-3311

This RTOP is intended to cover interagency and intercenter assistance using applicable Ames Dryden flight test facilities. The broad objective is to provide technical assistance, consultative services and test facility support to DOD for military programs and to industry and other NASA Centers, which involve specific requests for NASA support. Past activities of this kind include a B-52 drop test for recertification of the F-111 crew escape system; component improvement tests involving F-15, T-37, F-111 aircraft and support of the AFTI/F-16 program. Current activities include planning for and conduct of Marshall Space Flight Center solid rocket booster recovery system drop tests and support of Joint Navy F-14 Flight Test Program. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pre-test conferences, technical evaluation boards, and technical coordination committees.

W85-70076 **505-43-33**
Langley Research Center, Hampton, Va.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
R. V. Harris, Jr. 804-865-2658

The broad objective is to provide technical assistance and consultative services to outside agencies and aircraft industry programs which involve specific requests for NASA support. The principal assistance is to the Department of Defense for aircraft and missile development programs. Currently, activity is focused in the areas of stall/spin; aerodynamic characteristics at subsonic, transonic, and supersonic speeds; flutter and aeroelasticity; structures; landing loads; simulation; and propulsion system interactions on airframes and nozzles. The approach will involve tests in applicable Langley facilities consistent with the availability of test time and the utilization need for the particular facilities requested. Analysis of test results will be performed and selected results will be documented. Consultation will include participation in pretest conferences, technical evaluation boards, and technical coordination and oversight committees.

W85-70077 **505-43-43**
Langley Research Center, Hampton, Va.
HIGH PERFORMANCE CONFIGURATION CONCEPTS INTEGRATING ADVANCED AERODYNAMICS, PROPULSION, AND STRUCTURES AND MATERIALS TECHNOLOGY
D. J. Maglieri 804-865-3838

The objective of this RTOP is to assess the potential for high speed military and civil aircraft design concepts of advanced configurations through the synergistic integration of improved aerodynamic performance, propulsion system/airframe integration

techniques, and structures and materials. This will be accomplished primarily through in-house studies aimed at evolving and refining advanced military and civil aircraft configurations to provide advancements in performance, range, speed, fuel consumption, etc. Use will be made of existing subsonic, transonic, and supersonic aerodynamic technology base to determine improvements in L/D, reduction in drag, refinement of aircraft concepts, and optimization of aircraft characteristics over the full operating speed range. In addition, application of the results of the composites, metal matrix, and high temperature structures and materials technology base will be applied to these configuration/concepts to indicate the significant reductions in structural weight using new materials, structural design, and fabrication techniques, thus providing satisfactory fatigue, fracture, and thermal/cyclic life characteristics under high speed flight conditions. Propulsion systems advances in cycle efficiency, inlet and nozzle improvements, engine thrust-to-weight ratio, and integration/installation will also be incorporated in the various concept evaluations.

W85-70078 **505-43-52**
Lewis Research Center, Cleveland, Ohio.
PROPULSION TECHNOLOGY FOR HIGH-PERFORMANCE AIRCRAFT
Robert E. Coltrin 216-433-8337
(505-40-64)

A technology data base will be generated in the area of propulsion systems for the development of effective military and civil high performance aircraft including powered-lift, short-takeoff and vertical landing (STOVL), supersonic aircraft, and hypersonic aircraft. Analytical and experimental investigations will be conducted in the areas of inlets, nozzles, ejectors, fans, unique propulsion systems, and propulsion/airframe integration.

W85-70079 **505-43-60**
Ames Research Center, Moffett Field, Calif.
FACILITY UPGRADE
D. C. Bacon, Jr. 805-258-3311

This RTOP provides for the operation, maintenance and enhancement of the Ames Dryden Ground Experimental Facilities. These facilities consist of the Flight Loads Research Facility, the Data Analysis Facility, the Calibration and Environmental Test Facility, and the Simulation and Remote Commanded Vehicles and Display Facility. The Integrated Flight Test Information System (IFTIS) is the Ames Dryden system which is required to collect, process and distribute data in the flight test environment. IFTIS spans the facilities listed above plus the OSTDS funded NASA Aeronautical Test Range. The objective of the Ames Dryden Experimental Ground Facilities is to support research and testing of aircraft and remotely commanded research vehicles across the speed range from take off and landing through hypersonic flight and re-entry.

W85-70080 **505-43-61**
Ames Research Center, Moffett Field, Calif.
HIGH-SPEED WIND-TUNNEL OPERATIONS
Daniel P. Bencze 415-965-5848

This RTOP covers the operation, maintenance, repair and enhancement of the high speed wind tunnels at ARC. These facilities consist of the unitary plan wind tunnels (11-foot Transonic, 9-by 7-Foot and 8-by 7-Foot Supersonic Wind Tunnels), 12-Foot pressure Wind Tunnels, and the 6-by 6-Foot Supersonic Wind Tunnel. In addition, a number of smaller scale aerodynamic research and test facilities are maintained and supported as required. The objective of the RTOP is to provide aerodynamic testing in support of research and technology programs for NASA, DOD, industry, and other government agencies. Wind tunnel tests will be conducted to generate experimental test data to advance the state-of-the-art in generic research and vehicle configuration research.

W85-70081 **505-43-71**
Ames Research Center, Moffett Field, Calif.
FLIGHT SUPPORT
L. C. Barnett 805-258-3311

This RTOP provides for maintenance and operations of support aircraft located at the Ames Dryden Flight Research Facility, consisting of program support and service aircraft along with necessary supporting equipment. The objective is to provide flight support to the OAST high performance research and technology programs and to support joint/cooperative programs with other NASA Centers and other government agencies. Program support aircraft included are: (1) five Lockheed F-104 Starfighters; (2) one NORAIR T-38 Talon Trainer; and (3) one Bell 47-G Helicopter. Service aircraft included are: (1) one Boeing B-52 Bomber; (2) one JetStar light transport; and (3) one Piper Twin Comanche (PA-30).

W85-70082 **505-43-81**
Ames Research Center, Moffett Field, Calif.
HYPERSONIC AERONAUTICS TECHNOLOGY
B. M. Kock 805-258-3311

The Hypersonic Vehicle program is conducting research addressing the technology needs of long range cruise airplanes designed to operate at Mach numbers in excess of 3.0. The YF-12 research program provided an engineering data base that is supportive of the Hypersonic program. The focus of this RTOP is to apply that data base, as well as the experienced engineering personnel, to the aerodynamics, propulsion, structures and airplane operational disciplines for hypersonic vehicles. Analysis and laboratory testing will be provided.

W85-70083 **505-43-83**
Langley Research Center, Hampton, Va.
HIGH SPEED (SUPER/HYPERSONIC) TECHNOLOGY
R. V. Harris, Jr. 804-865-2658

The program is aimed at fundamental aerodynamic, propulsion, and structures technologies to support future development of airbreathing aircraft and missiles in the Mach 3-7 class. NASA in-house research capabilities and facilities will be utilized, supplemented by selected contracts and grants, to develop and combine critical methodologies. The aerodynamics effort will concentrate on propulsion/airframe integration aspects of hypersonic configurations, including the forward aircraft flow field, spillage effects, and exhaust nozzles for multicycle turboramjet engines. Scramjet propulsion research will consist of combustion fundamentals for hydrogen and hydrocarbon fuels to include analytical techniques and flow field diagnostic, and of component and engine testing to investigate feasibility for the Langley airframe-integrated modular scramjet concepts. The structures effort will focus on scramjet fuel injector strut design and fabrication, and on light-weight, long-life structural concepts applicable for methane-fueled ramjet engines. The approach will combine the development and application of advanced analytical methods with representative experiments. A parametric range of geometric shapes will be addressed to identify the best fundamental approaches to achieve high vehicle, engine, and structures performance. Detailed flow field analyses will include parabolic and elliptic 3-D techniques, embedded shocks, inlet spillage effects, shock-boundary layer interactions, fuel injection, mixing and combustion.

Subsonic Aircraft Research and Technology

W85-70084 **505-45-10**
Langley Research Center, Hampton, Va.
ATMOSPHERIC TURBULENCE MEASUREMENTS - SPANWISE GRADIENT/B57-B
C. P. Blankenship 804-865-2042

The objective is to measure the spanwise gradient of atmospheric turbulence with emphasis on the first 3000 ft. above the surface. Turbulence measurements will be made in vertical, lateral,

and longitudinal components. Sampling runs are primarily to be made in clear air under different atmospheric conditions. Some runs will be made on a glide slope. Some long runs (10 min. duration) are needed to provide data with good statistical reliability. A highly instrumented B-57B aircraft with turbulence sensors at the wing tips is utilized as the sampling airplane. Data will be reduced to time history and power spectral form for further correlations and analyses. Results will be used in aircraft response studies and simulations to assist in minimizing turbulence hazards in design and operations.

W85-70085 **505-45-11**
Ames Research Center, Moffett Field, Calif.
OPERATIONAL PROBLEMS - FIREWORTHINESS AND CRASHWORTHINESS
D. G. Denery 415-965-5427

One objective of this RTOP is to improve aviation safety. This study will: (1) enhance our knowledge of atmospheric processes; (2) increase the understanding of the causes of accidents; and (3) help us to develop systems technology and piloting techniques for avoiding hazards. This research is being conducted in cooperation with the National Transportation Safety Board (NTSB) and the FAA. Research will also be conducted to gather atmospheric data using the B-57B Aircraft, and to provide new technology to enhance the operational safety of civil and military aircraft. The second objective is to improve aircraft crashworthiness and cabin safety in post-crash fires. The program includes: (1) development of fire-resistant fuselage insulation; (2) development of lightweight graphite composites for fire-resistant aircraft interiors; (3) development of fire-test methodology such as measurement of the mass injection rate of materials into the environment; (4) fabrication of advanced aircraft interior materials for testing by the FAA; and (5) completion of joint NASA/FAA full-scale transport aircraft controlled-impact demonstration test.

W85-70086 **505-45-13**
Langley Research Center, Hampton, Va.
AVIATION SAFETY: SEVERE STORMS/F-106B
J. W. Stickle 804-865-2037

The objective of this RTOP is to improve the knowledge of severe storm atmospheric processes as they affect the design and safe and efficient operation of aircraft and aircraft systems. Existing experimental programs will be continued to provide additional data for improving the detection and avoidance of severe storm hazards, and for the development of design and operating criteria for those hazards which cannot be avoided. Specific hazards include precipitation, wind shear, turbulence, and in-flight lightning. The lightning program is part of the joint NASA/FAA/DOD Atmospheric Electricity Hazards Program, and involves support from NASA and DOD. Some Wallops support is also covered by the RTOP.

W85-70087 **505-45-14**
Langley Research Center, Hampton, Va.
AIRCRAFT LANDING DYNAMICS
C. P. Blankenship 804-865-2042

The objective of the research is to advance the technology for safe, economical all-weather aircraft ground operations, including the development of new landing systems concepts, and to provide a description of spanwise gradient for low altitude atmospheric turbulence through data measurement on instrumented B-57B aircraft. The scope of the effort includes the national tire modeling program; detailed studies of forces and moments in tire footprint; spray ingestion tests; analytical model to predict temperature gradients in yawed, rolling aircraft tire; and data for improved understanding and modeling of turbulence hazards for aircraft operations. The FY-1985 thrust is to develop analyses to predict asymmetric distortion and frictional forces in airplane tires. Work will be completed on the upgrade of the aircraft landing dynamics facility and checkout tests will be conducted.

W85-70088 **505-45-15**
Jet Propulsion Laboratory, Pasadena, Calif.
CLEAR AIR TURBULENCE STUDIES USING PASSIVE MICROWAVE RADIOMETERS
B. L. Gary 818-354-3198
(147-14-07)

This RTOP is for completion of data analysis, and writing-up of results, of measurements taken with airborne microwave radiometer (AMR). The AMR has been flown in the NASA/Ames C-141 Kuiper Airborne Observatory for two years. The instrument uses passive remote sensing techniques to determine altitude temperature profiles, which cover a 6000 ft. altitude region centered on the aircraft's altitude. These profiles are used to locate tropopause and inversion layer features. Clear air turbulence, CAT, is generated at the tropopause and within inversion layers. Although it is felt at other altitudes, CAT severity is strongest at the altitudes where it is generated. Thus, knowledge of the altitude of the tropopause (or an inversion layer) is equivalent to knowledge about where CAT is most likely to be generated (and to be most severe). If CAT is being felt, or if it is expected (based on pilot reports, or another sensor's when prediction), the AMR provides a basis for requesting altitude changes that may reduce the severity of the CAT encounter. The principal objective of this RTOP is to determine statistics on the occurrence of CAT at the tropopause, within inversion layers, and at other altitudes, based on two years' worth of flight observations. These statistics will enable an evaluation to be made of the merits of using the AMR as a CAT avoidance sensor.

W85-70089 **505-45-18**
Langley Research Center, Hampton, Va.
AIRBORNE RADAR TECHNOLOGY FOR WIND-SHEAR DETECTION
L. D. Staton 804-865-3631

The objectives of this program are to research the applicability of airborne Doppler radar instruments to the problems of detection and warning of hazardous wind-shear encounters on aircraft takeoff and landing, and to develop radar instrumental and signal analysis techniques to underlie the future practical application of such radars in the aircraft industry. Existing airborne radar techniques will be substantially modified and extended so as to enable the measurement of the velocity spectrum of wind-carried raindrops near the ground and the inference from this measurement of the degree of wind-shear hazard. The program will use both analytical studies and experimental flight data from specially developed radar systems and subsystems, as well as supportive truth data from ground based meteorological and radar systems. The program will be jointly funded by the Federal Aviation Administration.

W85-70090 **505-45-19**
Marshall Space Flight Center, Huntsville, Ala.
AVIATION SAFETY - ATMOSPHERIC PROCESSES/B-57
D. W. Camp 205-453-2087

The objective of this RTOP is to investigate and define atmospheric processes of concern to aviation safety in terms of engineering models and parameters for use in aircraft design tradeoff studies and performance simulations. This objective will be accomplished by use of in-house MSFC talents, supported by university and other groups as necessary, for the tasks as identified in the RTOP.

W85-70091 **505-45-23**
Langley Research Center, Hampton, Va.
FLIGHT DYNAMICS - SUBSONIC AIRCRAFT
R. E. Bower 804-865-3285
(505-45-43)

An advanced technology base will be developed to provide improved stall/spin characteristics for small and medium sized subsonic aircraft with both single and twin engines. The goal for this technology includes the development of test techniques and prediction capability. An experimental program will be conducted utilizing models and full-scale airplanes for both wind tunnel and flight testing. Experiments will be conducted to determine appropri-

ate wing leading edge modifications on existing and advanced natural laminar flow airfoils for improved stall/departure resistance with minimum impact on aerodynamic performance. The experimental program will provide a data base and insight to guide the theoretical analysis, computer code development and simulator studies.

W85-70092 **505-45-30**
National Aeronautics and Space Administration, Washington, D.C.
RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)
Lee D. Goolsby 202-453-2813

This RTOP provides for the continuation of support to the Radio Technical Commission for Aeronautics (RTCA) located in Washington, D.C. The RTCA brings together experts from Government, unversities, and industrial establishments to advance the art and science of aeronautics through the investigation of present and potential applications of avionics and telecommunications. RTCA and its Special Committees seek solutions to problems involving the application of electronics, avionics, and telecommunications to aeronautical operations; they frequently recommend technical performance standards and common operational requirements for consideration by Government, industry, and aviation users. As a member of the Executive Committee, NASA's representative can present subjects or problems for discussion and action, authorize new special committees, and approve completed studies. Through the mechanism of RTCA, NASA can be kept abreast of aeronautical needs and requirements and can initiate relevant research and participate in development of solutions to common problems with other members of the aviation community.

W85-70093 **505-45-33**
Langley Research Center, Hampton, Va.
ADVANCED TRANSPORT OPERATING SYSTEMS
M. A. Burgess 804-865-2224

The objectives are to develop flight hardware, software and display concepts enabling safe and effective operation in the evolving National Airspace System while more efficiently using fuel, airspace and time; increasing traffic flow capacity; and improving operational capability in adverse weather. The approach is to: (1) propose and investigate improvements to flight deck design, ground and aircraft equipment, and procedures to provide more efficient operations; (2) develop improved takeoff, approach, and landing rollout and turnoff capabilities; (3) investigate methods to improve the exchange of information between ATC and aircraft throughout the flight profile; (4) identify and promote incorporation of aircraft capabilities in the design of ATC improvements to facilitate efficient operations; and (5) propose and investigate strategies for optimization of terminal area traffic flow. This research involves analysis, simulations, and flight studies using facilities at Langley, Wallops, FAA Technical Center, and FAA-designated controlled airspace. Simulation facilities and the transport systems research vehicle, a modified B-737 airplane equipped with flexible display and control systems, are used to study new hardware, software and procedures in simulated and real ATC environments. The program includes active participation by major airframe manufacturers, the FAA and airline and other transport aircraft operations representatives.

W85-70094 **505-45-36**
Goddard Space Flight Center, Greenbelt, Md.
WALLOPS FLIGHT FACILITY RESEARCH AIRPORT
D. L. Feller 804-824-3411

This RTOP covers the Fiscal Year 1985 Program Support costs associated with OAST programs that use the facilities of the Wallops research airport and other supporting services. Included are: program aircraft ground servicing; control tower management of the Wallops airport control area; shop support; ADP operations; SAR, chase, and other aircraft flight services; crash, fire, and rescue services; specialized instrumentation; and miscellaneous equipment.

W85-70095 **505-45-41**
Ames Research Center, Moffett Field, Calif.
CONFIGURATION/PROPULSION - AERODYNAMIC AND ACOUSTICS INTEGRATION
W. H. Deckert 415-965-5486

The objective of this research is to develop the technology for the efficient integration of aircraft airframes and advanced propulsion systems for subsonic transports. This research is a coordinated experimental and theoretical program with emphasis on the acoustic performance of the integrated airframe/propulsion systems. Conventional aircraft configurations such as wing-mounted propellers will be studied. Unconventional configurations such as tail-mounted pusher propellers and aft-fuselage systems will also be studied. Wind tunnel experiments will be planned for the acoustically treated 40- by 80-ft. wind tunnel and will be conducted in the open-jet configured or the closed acoustically-treated 7- by 10-ft. wind tunnel. The test program will be designed so that the effects of important geometric and aerodynamic parameters can be studied in a systematic manner. In addition to providing experimental measurements that are essential for the development of modern, efficient aircraft, these experimental results will also be integrated in appropriate aerodynamic analyses and noise prediction codes in such a way that designers can use the information for configuration trade-off studies.

W85-70096 **505-45-43**
Langley Research Center, Hampton, Va.
AERODYNAMICS/PROPULSION INTEGRATION
R. E. Bower 804-865-3285
(505-45-23)

An advanced technology base will be developed for subsonic aircraft to improve safety and productivity, reduce cost, and improve performance. The technology base will be applicable to both military and civil subsonic aircraft including large transport airplanes, commuter aircraft and general aviation airplanes. The research will involve analytical and experimental investigations including computer analysis, simulation studies, and wind-tunnel and flight tests of model and full-scale aircraft.

W85-70097 **505-45-54**
Lewis Research Center, Cleveland, Ohio.
ICING TECHNOLOGY
John J. Reinmann 216-433-5542
(505-42-98; 505-36-42; 505-90-28)

The objective of this program is to update and advance the technology related to the safe operation of aircraft in atmospheric icing conditions. The program addresses the ice protection needs of general aviation, light transports, commercial transports, and helicopters. The program is broad-based, encompassing both analytical and experimental research and is conducted using in-house, contracted, and university efforts. Icing Reseach and Development testing will be conducted in the NASA Lewis Icing Research Tunnel and in flight tests in natural icing clouds and behind icing cloud simulators. The research will be coordinated among the aircraft industry/users, civilian government agencies, and the military. The focal point for assembling and disseminating a wide range of data will be NASA.

W85-70098 **505-45-58**
Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP TECHNOLOGY (SRT)
G. K. Sievers 216-433-4000
(535-03-12)

The objective of the Advanced Turboprop Technology (SRT) effort is to develop propeller and related drive system and aircraft technologies critical to efficient, reliable, and acceptable operation of future advanced, high-speed, turboprop-powered aircraft. Both single-rotating and counter-rotating propeller technologies are being evaluated. This supporting technology effort (analysis and tests) is conducted in the areas of propeller aerodynamics, acoustics, structures, and dynamics; aircraft cabin environment (both noise and vibration), and aircraft installation aerodynamics. Studies of advanced turboprop propulsion systems and components, and of

advanced turboprop aircraft and their missions, are conducted to provide guidance to the technology efforts. NASA Lewis Research Center has overall management responsibility for the program, but other centers conduct portions of the program that lie within their areas of expertise (e.g., Ames and Langley Research Centers; installation aerodynamics; Langley Research: cabin environment).

W85-70099 **505-45-61**
Ames Research Center, Moffett Field, Calif.
LAMINAR FLOW INTEGRATION TECHNOLOGY (LEADING EDGE FLIGHT TEST AND VSTFE)
R. S. Baron 805-258-3311
(505-45-63)

One objective is to demonstrate by flight research the effectivenes of Laminar Flow Control (LFC) Leading-Edge Systems under representative flight conditions up to Mach 0.8 and 40, 000 feet. Two different contractor-developed LFC Leading-Edge Systems (including suction, cleaning and de-icing systems) will be installed, one on each wing of the JetStar Aircraft. The LFC Leading-Edge test articles will be designed and fabricated to demonstrate that required LFC systems can be packaged into a leading edge section of a wing representative of future LFC commercial transport aircraft. After the test articles are installed in the aircrft, a series of ground and flight tests will be performed to validate the laminar flow performance and also to verify operational capability of the LFC contractor systems. Another objective is to obtain accurate in-flight measurement of boundary layer transition location for wing pressure distributions, sweep angles and flight conditions representative of future natural laminar flow transpot aircraft. This variable sweep transition flight experiment (VSTFE) will be conducted for several advanced airfoil shapes based on wind tunnel test results.

W85-70100 **505-45-63**
Langley Research Center, Hampton, Va.
LAMINAR FLOW INTEGRATION
H. T. Wright 804-865-3265

Technology for practical, reliable, and maintainable laminar flow systems for application to future commercial and military transports will be developed. The effectiveness of leading edge systems to maintain laminar flow under representative flight conditions will be established. The performance of advanced suction surfaces in transonic wind tunnel tests, will be evaluated. A flight data base will be provided for transition analyses/design of NLF, LFC, or hybrid laminar flow wings. Systems concepts for hybrid laminar flow control for aircraft wings will be evaluated and a data base for design of integral or glove surface panel structure for laminar flow transports will be provided. Two leading-edge test articles (including suction surfaces and ducting, insect protection and deicing systems) will be tested on the DFRF JetStar at flight conditions and in an operational environment representative of commercial transport operations. Initial flight tests will determine optimum operational setting for the laminar flow systems. These flights will be followed with a simulated airline service phase of flight testing. In-house construction of a swept wing LFC model (with spanwise suction slots) and associated test apparatus was completed in 1982. Wind tunnel tests in the LaRC 8' TPT began in FY-82 to investigate various aerodynamic issues concerning the attainment of laminar flow on slotted supercritical swept wings. Following these tests, electron-beam perforated titanium panels will be installed on the upper surface of the model and tested in FY-85. Under this RTOP, the preparation of these panels for the wind tunnel tests will be completed.

W85-70101 **505-45-83**
Langley Research Center, Hampton, Va.
HIGH-ALTITUDE AIRCRAFT TECHNOLOGY (RPV)
C. E. K. Morris, Jr. 804-865-4576

The objective of this RTOP is to assess the potential for synergistic integration of critical, enabling technologies for unmanned, high altitude, long endurance aircraft. Initial emphasis will be placed on vehicle concept evaluation for near-term, representative missions. (Proposed Department of Energy and Department of Agriculture missions will be of primary concern). The list of relevant technologies for these studies includes: (1) subsonic, low Reynolds number aerodynamics; (2) propulsion (propellers and electric motors or combustible-fuel engines); (3) lightweight structures and materials; (4) autonomous, self-adjusting control systems for the entire vehicle; and (5) systems for acquiring, storing and managing energy for propulsion, payload or flight controls. Liason will be maintained with potential users, government agencies and commercial organizations interested in the development of such aircraft. Innovation and conceptual flexibility are important.

Interdisciplinary Technology

W85-70102 **505-90-28**
Langley Research Center, Hampton, Va.
FUND FOR INDEPENDENT RESEARCH (AERONAUTICS)
E. J. Prior 804-865-2664
(506-90-23)

The objective of this program is to support basic research in universities in areas related to aeronautics through the funding of a limited number of unsolicited research proposals. University research proposals, that have been given high technical evaluations but are not funded through the research programs, are reviewed by the Langley University Research Proposal Review Committee. Those research proposals that are judged by this committee to be worth supporting on a scientific or engineering basis are selected as candidates for funding through this plan. The committee establishes a priority listing of these proposals and selects those efforts that are judged to be the more innovative and aimed at the longer term research of potential relevance to future NASA aeronautics programs.

W85-70103 **505-90-28**
Ames Research Center, Moffett Field, Calif.
INTERDISCIPLINARY TECHNOLOGY - FUNDS FOR INDEPENDENT RESEARCH (AERONAUTICS)
D. J. Peake 415-965-5113
(506-90-21)

The object of this RTOP is to support innovative and high-risk basic research in areas related to aeronautics. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics including the technical fields of aerodynamics, fluid mechanics, flight mechanics, power, guidance and navigation, applied mathematics, propulsion, and human factors including man-machine integration. The Ames Basic Research Council accepts unsolicited proposals, usually from universities, and judges these on the basis of the degree of innovation and the capacity to complete the task.

W85-70104 **505-90-28**
Lewis Research Center, Cleveland, Ohio.
AERONAUTICS INDEPENDENT RESEARCH
Marvin E. Goldstein 216-433-4000

The objective is to conduct innovative, long range, high risk, basic research in areas related to aeronautics. The program pursues basic investigations of, and facilities exchange of information about new technologies in fundamental science and engineering needed to satisfy NASA's requirements in aeronautics. The program is carried out primarily through grants which are selected by the Chief Scientist with the aid of the Research Advisory Board. It allows OAST to initiate fundamental studies in areas not presently included in a specific discipline program. The funds are also used to bring speakers and visiting university scientists to the Lab and to hold workshops and seminars.

Aeronautics Systems Technology Programs

Rotorcraft Systems Technology

W85-70105 **532-06-11**
Ames Research Center, Moffett Field, Calif.
ROTORCRAFT SYSTEMS INTEGRATION
C. Thomas Snyder 415-965-6577
(505-42-11; 532-09-11)

Research conducted under this RTOP will advance rotorcraft aeromechanics systems technology with an emphasis on improving basic design theory, rotor and rotor/airframe aerodynamics, and aeroelastic characteristics and methodology; vibration prediction and control; noise prediction and control; advanced control system concepts; advanced crew station concepts; and advanced vehicle concepts. The research involves focused and coordinated programs requiring analysis, wind tunnel model testing, simulation, and flight testing. These programs encompass civil and military aspects of advanced rotorcraft concepts which will increase performance, efficiency, and productivity; reduce noise and vibration; and improve reliability.

W85-70106 **532-06-13**
Langley Research Center, Hampton, Va.
ROTORCRAFT VIBRATION AND NOISE
Charles P. Blankenship 804-865-2042
(505-42-23)

The objective of this research is: to develop the technology for reducing the interior noise of helicopters through transmission/airframe isolation: to develop the technology for improving rotor noise methodology and a design to a noise criteria capability through the acquisition of acoustic data and development of noise prediction methods; to exploit the full potential of modern analytical techniques such as finite element modeling analysis for predicting and controlling the vibration characteristics of new rotorcraft vehicles during the design process; and to develop methods for integrated analysis and design synthesis of rotorcraft, including applications of aeroservoelasticity to the X-wing vehicle. The noise and vibration work will be accomplished through a combination of major contractural efforts that involve all major U.S. manufacturers of helicopter airframes in parallel with in-house research. Contracted efforts on vibration characteristics will include coupled rotor-airframe analysis, modeling of difficult components, further development of FEM of both sheet metal and composite airframes, and advanced applications by the industry. Contracted efforts on noise include structural acoustics, basic aeroacoustic research, system elements development, further acquisition of noise data base and noise reduction technology developments.

W85-70107 **532-09-10**
Ames Research Center, Moffett Field, Calif.
RSRA/X-WING ROTOR FLIGHT INVESTIGATION
W. H. Deckert 415-965-6576
(532-03-11)

The goal of this Program is to adequately demonstrate specific X-Wing technology such that this proof-of-concept Flight Investigation Program coupled with the successful completion of the DARPA/NASA convertible engine program and the DARPA/Army NOTAR program would provide the necessary technology base such that a low risk development program could be initiated for an X-Wing prototype vehicle. The X-Wing is a four-bladed extremely stiff rotor utilizing circulation control aerodynamics for lift and rotor control, which is stoppable in flight. When stopped, the rotor/wing becomes two forward swept and two aft fixed wings in an X configuration. For the X-Wing flight experiment, one RSRA will be configured as a compound helicopter using an X-Wing rotor system driven by two GE T-58 engines that will also drive a compressor through a modified S-61 gearbox and clutch. A digital fly-by-wire flight control system will be developed to control the rotor utilizing higher harmonic control and hub moment feedback. This approach includes detailed analysis, design, fabrication, ground tests, and flight testing of an X-Wing rotor system, modifications required to the RSRA, and supporting analysis, wind tunnel testing, and simulation.

W85-70108 **532-09-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED TILT ROTOR RESEARCH AND JVX PROGRAM SUPPORT
C. T. Snyder 415-965-5066
(532-06-11; 505-42-11)

The program will advance the state-of-the-art for tilt rotor configuration optimization and will provide technology transfer support for on-going military aircraft development (JVX). The goals of this effort are to provide simulation, wind tunnel, and flight test data support for the joint services JVX program and to provide for advanced tilt rotor technology development for subsequent tilt rotor vehicle applications. Flight test work includes military mission evaluation tests as well as terminal area and certification criteria development for the civil sector. Wind tunnel work is aimed at a more complete understanding of the vehicle aeromechanics and resultant vehicle optimization.

High-Performance Aircraft Systems Technology

W85-70109 **533-02-01**
Ames Research Center, Moffett Field, Calif.
F-18 HIGH ANGLE OF ATTACK FLIGHT RESEARCH
D. H. Gatlin 805-258-3311
(505-43-11)

The objective of this program is to perform flight and supporting ground facility research to enhance the ability to predict and exploit the high angle of attack regime in the areas of aerodynamics, predictive methodology and control concepts leading to enhanced agility for high performance military aircraft. Using an F/A-18 as the test vehicle, a series of ground and flight experiments will be conducted and correlated concentrating in the areas of vortex flows, configuration effects and component interactions. The initial emphasis will be on parameter identification for simulator upgrading and on the visualization of large separated vortex flows. Flight and rotary balance wind tunnel data will be integrated to produce mathematical models and predictive techniques validated at extreme angles of attack. State-of-the-art control techniques will be integrated with unconventional control effectors such as thrust vectoring to enhance agility at high alpha. Concurrent research will be conducted aimed at developing high alpha air data sensors suitable for both research and control system usage.

W85-70110 **533-02-03**
Langley Research Center, Hampton, Va.
HIGH ANGLE-OF-ATTACK TECHNOLOGY
R. E. Bower 804-865-3285
(505-43-13)

The objective is to advance the state-of-the-art in high angle-of-attack technology for high performance aircraft with emphasis on: fundamental and applied aerodynamics; agility; control augmentation; and experimental and computational analysis techniques. Specific objectives are: (1) to define the fundamental nature of vortex flows, separated flow phenomena, and component interference effects; (2) to define aerodynamic and propulsive control concepts for enhanced high-alpha stability and control; (3) to define agility and handling quality requirements for high-alpha conditions including post-stall maneuvers; and (4) to develop computational methods for prediction of aerodynamic characteristics, flight dynamics, and piloted simulation. Methods of approach for these efforts include wind-tunnel tests, free-flying model tests, theoretical analysis, piloted simulator studies, and flight research with an F-18 research vehicle at the Dryden Flight Research

Facility. This effort is part of an intercenter program involving the Ames Research Center, Langley Research Center, and Dryden.

W85-70111 **533-02-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED FIGHTER TECHNOLOGY INTEGRATION/F-111 (AFTI/F-111)
L. L. Steers 805-258-3311

The objective of this program is to conduct a series of experiments to verify in flight the predicted performance gains for AFTI/F-111 mission adaptive wing. The flight experiments will verify the performance of active controls for load alleviation and reduced static stability incorporated in the AFTI/F-111 mission adaptive wing (MAW) aircraft. Ames Dryden Flight Research Facility will operate the F-111 aircraft and conduct an investigation of the MAW as a part of the joint NASA-Air Force AFTI/F-111 program. Ames Dryden will participate in design reviews, develop and operate instrumentation, define flight test plans and have the overall responsibility for conducting the test program.

W85-70112 **533-02-21**
Ames Research Center, Moffett Field, Calif.
ADVANCED FIGHTER AIRCRAFT (F-15 HIGHLY INTEGRATED DIGITAL ELECTRONIC CONTROL)
B. M. Kock 805-258-3311

The objective is to perform flight research and related ground facilities research to advance the technology for the integration of airframe and propulsion control systems in high performance aircraft. This will include conducting studies for implementation options, developing hardware and software for flight system implementation, performing required wind tunnel tests/simulations, and conducting flight investigations. Flight test data will be compared to prediction methods. Documentation of the F-15 performance improvements due to airframe/propulsion control integration will also be obtained. The airplane, with integrated systems, will also be used as a test bed to support other experiments that capitalize on the unique airplane/systems capabilities.

W85-70113 **533-02-31**
Ames Research Center, Moffett Field, Calif.
F-4C SPANWISE BLOWING FLIGHT INVESTIGATIONS
R. G. Bryant 805-258-3311

The overall objective is to verify, through full-scale flight tests with a modified F-4C airplane, the low speed and transonic performance and the flying qualities improvements predicted by analytical and wind tunnel studies for spanwise blowing. This program is a cooperative effort between Ames and Langley Research Centers. Factors not readily assessable in the wind tunnel will also be evaluated during the flight tests. These include the use of spanwise blowing for improved maneuverability, control of low-speed wing rock, alleviation of shock-induced separation effects, and improved landing performance. Reynolds number and scale effects will be investigated.

W85-70114 **533-02-33**
Langley Research Center, Hampton, Va.
SPANWISE BLOWING
P. J. Bobbitt 804-865-2961

The potential improvements in aircraft maneuvering performance at subsonic and transonic speeds from spanwise blowing have been investigated in wind-tunnel studies and limited flight tests. Optimum spanwise blowing system parameters, blowing locations and other factors have not been thoroughly studied, and adequate correlations between real world flight behavior and predictions from ground facilities tests have not been made. This program will produce validated technical data on spanwise blowing and will provide another potential option for incorporation in future advanced military aircraft. The technical objective is to study the application of spanwise blowing as a technique for enhancing and controlling the wing leading edge vortex flow and develop the augmented vortex technology for use on advanced aircraft at high-lift conditions. The approach involves wind-tunnel tests of an F-4C model in the LaRC 7- by 10-Foot High-Speed Tunnel to determine the effects of spanwise blowing on flight characteristics.

W85-70115 **533-02-43**
Langley Research Center, Hampton, Va.
VORTEX FLAP FLIGHT EXPERIMENT/F-106B
R. E. Bower 804-865-3285
(505-43-23)

The objective of this RTOP is to reach flight validation of the vortex flap concept in order to instill needed confidence in its durability and performance for aggressive exploitation by DOD/industry in preparation for advanced fighter aircraft programs. This RTOP will complete the ground-based testing, analysis, simulation and flight-related research associated with vortex flap technology validation using the F-106 aircraft as a focus and test article. During FY-1986 an F-106B aircraft will be outfitted with a ground adjustable vortex flap and flown under maneuvering conditions at transonic speeds to validate the design procedure and wind-tunnel results.

W85-70116 **533-02-51**
Ames Research Center, Moffett Field, Calif.
POWERED LIFT SYSTEMS TECHNOLOGY - V/STOL FLIGHT RESEARCH PROGRAM/YAV-8B
C. Thomas Snyder 415-965-5440
(505-34-01)

The broad objective of the YAV-8B flight research program is to develop and validate the technologies required for V/STOL aircraft to effectively operate in all mission bases. Specifically the objectives are: (1) to develop and evaluate, in flight, advanced V/STOL aerodynamic, flight dynamics, controls and guidance, and propulsive-lift technologies that will contribute to an improved adverse weather launch and recovery operational capability; and (2) to produce an increased understanding of V/STOL controls and performance technologies for AV-8 and advanced V/STOL aircraft. Promising concepts will be configured for flight on the YAV-8B aircraft and evaluated throughout the aircraft's entire flight envelope with emphasis on takeoff, transition, hover, and landing operations. Adverse weather operating procedures will be developed in conjunction with system concepts. Flying quality design criteria will be defined from the results of these experiments. In addition, parameter identification, flow field, and propulsion system documentation will be conducted in flight to establish aerodynamic and performance characteristics of the aircraft. These data will be correlated with theoretical predictions and wind tunnel measurements to produce improved aerodynamics and propulsion interaction prediction methods.

W85-70117 **533-02-61**
Ames Research Center, Moffett Field, Calif.
ADVANCED FIGHTER TECHNOLOGY INTEGRATION/F-16
M. L. Arebalo 805-258-3311

The overall objective of the AFTI/F-16 program is to quantify the benefits and penalties of the individual and integrated technologies proposed to improve weapon system effectiveness and survivability by flight demonstration of air-to-air and air-to-surface offensive and defensive mission roles. The digital flight control system (DFCS), automatic maneuvering attack system (AMAS), and pilot-vehicle interface (PVI) technologies are being implemented in a modified F-16 to allow flight evaluations of such non-classical control modes as direct lift and side force, flat turn, fuselage pointing, and uncoupled independent control of aircraft rotation and translation. The AFTI/F-16 airplane will be flight tested and evaluated by a joint Ames Dryden, USAF, and contractor flight test team and will be operated and maintained from Ames Dryden facilities.

W85-70118 **533-02-71**
Ames Research Center, Moffett Field, Calif.
DECOUPLER PYLON FLIGHT EVALUATION
M. L. Arebalo 805-258-3311
(533-02-23)

To obtain maximum utilization of flighter aircraft, different types

and combinations of stores are pylon-mounted to the wings. The transport of these stores can result in reduced flutter speeds or flutter placards with a corresponding degradation in mission effectiveness. The NASA Langley Research Center (LaRC) has developed a decoupler pylon which suppresses wing/store flutter in wind tunnel tests. The decoupler pylon dynamically isolates the wing from the store pitch inertia effects. The decoupler pylon is effective in suppressing wing/store flutter in transonic wind tunnel tests on the F-16 and YF-17 flutter models. These results have encouraged NASA to conduct a program to flight test the decoupler pylon. A feasibility study and conceptual design, conducted under contract, have established that the decoupler pylon concept can be implemented in flight hardware for testing on the F-16 aircraft. General Dynamics has fabricated a decoupler pylon for the F-16 aircraft under contract to LaRC. Flight tests of the decoupler pylon will be conducted under this RTOP.

W85-70119 **533-02-81**
Ames Research Center, Moffett Field, Calif.
FORWARD SWEPT WING (X-29A)
W. J. Sefic 805-258-3311

The objective is to provide technical advisory support, conduct analysis, wind tunnel tests, simulations, ground facility tests and flight tests in order to discharge responsibilities established in the NASA/DARPA Memorandum of Agreement concerning the Forward Swept Wing Program. Ames Dryden will provide technical support through participation in design reviews, independent analysis, ground tests, flight certification and readiness reviews and through the implementation of a high fidelity real-time piloted simulation at Ames Dryden. Ames Dryden will also provide approval of quality assurance plans and will provide proven flight test instrumentation from the Ames Dryden inventory.

W85-70120 **533-02-91**
Ames Research Center, Moffett Field, Calif.
OBLIQUE WING RESEARCH AIRCRAFT
C. R. Jarvis 805-258-3311
(505-34-11)

The objective of this RTOP is to develop the concept of an oblique wing airplane which shows promise for efficient transonic and supersonic operations. Feasibility studies applying this concept to specific applications have shown that significant reductions in aircraft structural weight can be achieved over designs using conventional variable sweep wing technology. Flight test results with a subsonic oblique wing research aircraft also indicate no aerodynamic or flying qualities problems that would preclude transonic or supersonic applications. An important step in proving the oblique wing concept is to produce a full scale, manned test aircraft capable of operating in the transonic and supersonic speed range. The NASA F-8 Digital Fly-by-Wire research aircraft is well suited as a test bed for this program because of its high wing configuration, three-point wing attach arrangement, Digital Fly-by-Wire Flight Control System, airborne instrumentation system as well as Iron-Bird and ground-based simulation facilities.

W85-70121 **533-04-12**
Lewis Research Center, Cleveland, Ohio.
TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST) PROJECT
D. E. Sokolowski 216-433-6910

The overall objective of this effort is to improve durability of combustor liners and turbine vanes and blades for advanced aircraft turbine engines by improved life prediction during the design process. Life prediction systems will be made more effective by improving system elements which characterize fundamental behavior. These elements include models for the behavior of materials at high temperatures and cyclically loaded, aerodynamics, heat transfer, and nonlinear finite element structural analyses. The effort consists of contract, grant, and in-house research, both analytical and experimental in nature, in six technical disciplines. The analytical activities are those needed by industry and include computerized models, some of which describe the environments and complex thermal and mechanical loading in combustors and turbines. The experimental activities provide data required to accurately develop the analytical models. In addition, experimental testing will enable demonstration of the validity of the models and superiority over current methods.

W85-70122 **533-05-12**
Lewis Research Center, Cleveland, Ohio.
STRUCTURAL CERAMICS FOR ADVANCED TURBINE ENGINES
R. B. Lancashire 216-433-6489

The overall objective of this project is to develop the technology base required to apply structural ceramic materials to advanced turbine engines. The effort covered by this RTOP is interdisciplinary in nature. It integrates research and technology development in materials/processing, design methodologies and life prediction for both monolithic and ceramic matrix composites. It will include a range of contracts, grants, and an expanded in-house research program to define and improve the processing variables that control ceramic material reliability. The work in the early years of this effort will concentrate on obtaining improved ceramic material properties. The work in the later years of this effort will focus on evaluation of time dependent properties and maintaining the improved ceramic material properties. The approach to this program will be to systematically study the variables involved in ceramic material processing, to apply non-destructive evaluation as a research tool to better understand processing, and, finally, to evaluate material properties both in modulus of rupture sized test bars and in larger shapes to demonstrate the scale up potential of the technology. The technology developed under this RTOP will permit the application of ceramic materials to a wide range of aerospace propulsion and power systems.

Subsonic Aircraft Systems Technology

W85-70123 **534-06-13**
Langley Research Center, Hampton, Va.
TRANSPORT COMPOSITE PRIMARY STRUCTURES
H. L. Bohon 804-865-3081
(534-06-23)

The primary objective of the Transport Composite Primary Structures (TCPS) program is to develop technology for and accelerate the introduction of composite material in wing and fuselage components of U.S. military and commercial transport aircraft. The program will provide generic design approaches and structural data required to achieve a level of technology maturity in the application of heavily loaded, post-buckled, strength critical, safety-of-flight composite structures to large transport vehicles. The development of the technology data base is required to understand the unique characteristics of composite primary structures and the interactions with operational loads, environmental exposure, and systems effects. Analytical capabilities will be developed, as required, to reliably model composite structural characteristics and accurately predict failure modes and loads under realistic conditions. The development of technology applicable to composite empennage structure will continue under an existing contract with a transport manufacturer.

W85-70124 **534-06-23**
Langley Research Center, Hampton, Va.
COMPOSITE MATERIALS AND STRUCTURES
C. P. Blankenship 804-865-2042
(505-33-33)

The objective of this research is to develop the technology required to achieve the full weight reduction potential of advanced filamentary composites applied to airplane structures. Primary emphasis will be placed on understanding the fracture behavior of composites, particularly the rapid growth of damage induced by low-velocity impacts of loaded structure. Experiments and analytical studies will be used to relate material performance to constituent properties. Mechanisms of material toughening will be studied and the results used to guide new material development.

Structural concepts for enhancing damage tolerance will be developed, analyzed and verified through tests of panels and built-up structural components. The efficiency of bolted and bonded joints will be compared for both static and repeated (fatigue) loading. Concepts for efficiently and reliably joining composites will be developed. The cure mechanics of new resin systems will be studied and techniques developed to assure consistent quality of laminated parts. Noise control methodology for advanced composite material structures will be developed.

Advanced Propulsion Systems Technology

W85-70125 **535-03-12**
Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP TECHNOLOGY
G. K. Sievers 216-433-4000
(505-45-58)

The objective of the Advanced Turboprop Systems effort is to evaluate at large-scale, propeller and related drive system components and systems critical to the efficient, reliable, and acceptable operation of future advanced, high-speed, turboprop-powered aircraft. Both single-rotating and counter-rotating propeller systems are being evaluated. A major emphasis in the program is the design, fabrication, and flight test of an advanced single-rotating 9-foot diameter propeller, powered by an available gas-turbine engine with a modified existing gearbox, to evaluate and correlate propeller structural integrity and cabin environment. Also included in this effort is subscale model testing of testbed aircraft configurations with wing-mount turboprop installations, in direct support of the large-scale design activity. Another major emphasis is the evaluation of large-scale counter-rotating propellers and their unique drive systems. Advanced gearbox technology will also be addressed by designing and rig testing gearbox components and assemblies in order to establish a design data base for this critical element of conventional drive systems.

Numerical Aerodynamic Simulation

W85-70126 **536-01-11**
Ames Research Center, Moffett Field, Calif.
NUMERICAL AERODYNAMIC SIMULATION (NAS) PROGRAM
F. R. Bailey 415-965-6419

The objectives of the NAS Program are to develop a computer resource that will act as the pathfinder in advanced, large-scale computer system capability through systematic incorporation of state-of-the-art improvements in computer hardware and software technologies; provide a national computational capability, available to NASA, DOD, industry, other Government agencies, and universities, as a necessary element in insuring continuing leadership in computational fluid dynamics and related disciplines; and to provide a powerful research tool for OAST. The NAS Program consists of three major elements: the NAS Processing System Network (NPSN), Numerical Aerodynamic Simulation Facility (NASF) to house the NPSN and support personnel, and the management and operation of the NPSN/NASF complex. This RTOP supports overall NAS Program planning, NPSN development, implementation, integration and test. This RTOP does not support NASF construction nor the NAS operations. The NPSN development is organized into three major phases in a building block approach. Phase 1 - network prototype development; Phase 2 - initial operating configuration development; and Phase 3 - extended operating configuration development.

Space Research and Technology Base

Fluid and Thermal Physics Research and Technology

W85-70127 **506-51-11**
Ames Research Center, Moffett Field, Calif.
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
V. L. Peterson 415-965-5065
(505-31-01; 506-53-31; 506-63-39)

The objective is to establish aerothermodynamic technology and configuration design concepts to improve vehicle safety, reliability, versatility, and aerodynamic efficiency with maximum payload for Earth-orbital missions and planetary exploration. Advanced computational methods and computer codes will be developed for predicting vehicle flow fields and performance. Flow models (used in these computer codes) will be developed from building block numerical and physical experiments. Aerothermodynamic studies will be performed of aero-assisted orbital transfer vehicles (AOTV) and advanced maneuvering entry vehicles. Flight data for existing reentry vehicles will be analyzed. The use of the Shuttle Entry Air Data System (SEADS) will be investigated at subsonic and transonic speeds by the Dryden Flight Research Facility.

W85-70128 **506-51-13**
Langley Research Center, Hampton, Va.
ENTRY VEHICLE AEROTHERMODYNAMICS
G. D. Walberg 804-865-3887

The objective of this effort is to improve the fundamental understanding of aerodynamic and aerothermodynamic flow phenomena over entry vehicles in the continuum, transitional, and rarefied flow regimes. Results of this work will permit significant advances in capabilities, reliability, versatility, and efficiency of future space transportation vehicles. The intent is to conduct fundamental and applied research using wind tunnels, flight data, and analytical techniques to expand the data base and the pertinent technologies beyond that established for shuttle. Specific studies will be directed toward the solution of aerothermodynamic problems associated with Earth-to-orbit and orbital transfer vehicles, including aerodynamic performance, viscous interaction and real gas effects, vortex interactions, heat transfer, basic configuration shaping, and the development of computational techniques using both continuum flow and noncontinuum flow assumptions. These techniques will be applied to analyze the flows about complex, three-dimensional, high angle-of-attack configurations representative of advanced space transportation systems; the rarefied flow entry of aeroassisted OTV's, to space station drag, and to contamination from propulsion exhaust products.

W85-70129 **506-51-14**
Ames Research Center, Moffett Field, Calif.
ENTRY VEHICLE LASER PHOTODIAGNOSTICS
R. L. Mckenzie 415-965-6158
(506-54-11)

The general objective is to perform the laboratory research and development leading to on-board laser instrumentation for entering space-craft, such as the Space Shuttle, that will allow the remote optical measurement of local ambient atmosphere and space-craft flow-field properties. Modern laser technology and photodiagnostic techniques are to be applied. The results will support a broad range of long-term scientific objectives for flight experiments, in the fields of both stratosphere physics and aerothermodynamics. The unique scientific capabilities offered by the combination of entry vehicle flight conditions and short-range laser optical sensing will be emphasized. In the near-term, laboratory research will be performed to develop, verify, and implement the application of a UV laser system on board the

Space Shuttle, for the accurate measurement of local atmosphere density along the flight path during entry.

W85-70130 **506-51-17**
Lyndon B. Johnson Space Center, Houston, Tex.
AEROBRAKING ORBITAL TRANSFER VEHICLE FLOWFIELD TECHNOLOGY DEVELOPMENT
C. D. Scott 713-483-3905

Flowfield simulations based on numerical solutions to the equations governing the flow of 3-D viscous, compressible, reacting air have provided benchmark heating and shock layer predictions for both the orbiter thermal protection system (TPS) design and post-flight data analysis. Although the experience gained in using this advanced flow field simulation capability for design purposes was a positive one, the complexity of the orbiter flow field challenged both the numerical and physical aspects of this capability. Because of the severity of the environment, the stable temperature limitations of surface materials in this environment, and the anticipated complexity of an aerobraking OTV flow field, the current flow field capability must be improved in the areas of computational efficiency, accuracy, and physical fidelity which will help to enable a reusable TPS design. To this end, the objectives of this RTOP are to: (1) determine production and rate of disposition of excited molecules formed in the gas phase and from catalytic recombination on relevant TPS surfaces; and (2) determine the effects of gas phase and surface reactions on heat flux on TPS surfaces for an AOTV. The approach will include numerical flow field simulations that parametrically established the sensitivity of heating rate predictions to varying chemical reaction assumptions, and laboratory experiments in flow tube reactors and arc jet facilities to establish reaction dynamics information. This information will be incorporated into the flow field codes for use in establishing the most realistic heating environment and TPS design for an AOTV.

W85-70131 **506-51-23**
Langley Research Center, Hampton, Va.
AEROTHERMAL LOADS
C. P. Blankenship 804-865-2042
(506-51-13; 506-53-33)

The primary objective of this effort is to identify and understand flow phenomena and flow/surface interaction parameters required to define detailed aerothermal loads for structural design. The secondary objective of this effort is to develop and validate analysis and test methods for the prediction and verification of structural response in thermal environments for use in the support of design and qualification of aerospace vehicles. Effects of wavy surfaces, coves, gaps, protuberances, wing/body and wing/elevon junctions will be studied in wind tunnel tests. Selected problems will be studied analytically. Some effort will also be focused on mass addition cooling effects on flow phenomena with initial emphasis on conical shapes.

W85-70132 **506-51-41**
Ames Research Center, Moffett Field, Calif.
THERMO-GASDYNAMIC TEST COMPLEX OPERATIONS
Frank J. Centolanzi 415-965-5269
(506-51-11; 506-53-31; 506-63-39)

This RTOP covers the operation, maintenance, repair, and improvement of the facilities of the thermo-gasdynamic test complex. These facilities consist of: the arc-jet complex, 3.5-foot hypersonic wind tunnel, high Reynolds number channels, ballistic range facilities, and the electric arc shock tube facility. The objective of this effort is to provide aerodynamic and thermal testing in support of research and technology programs for NASA, the Department of Defense, other government agencies, and industry. Program areas supported include generic research applicable to spacecraft thermal protection systems, planetary entry aerothermodynamics, fluid dynamics (including boundary layers) and experimental verification of various computer codes.

Materials and Structures Research and Technology

W85-70133 **506-53-11**
Ames Research Center, Moffett Field, Calif.
SURFACE PHYSICS AND COMPUTATIONAL CHEMISTRY
J. O. Arnold 415-965-6209
(505-37-01)

The objective is to provide a detailed understanding of the mechanisms which control the properties of matter over a wide range of environments. This understanding is leading to the development of new materials and processes needed by the Agency. In surface physics, chemical properties of metal-metal and metal-non metal interfaces are being determined by auger electron spectroscopy. Gas-surface interactions are being studied by measuring surface reactions on macroscopic and microscopic metal surfaces. Electronic and other physical properties of small atomic clusters (10 to 10,000 atoms) are being measured. In computational chemistry, the physiochemical properties of molecules and small atomic clusters (2 to 66 atoms) are being calculated from first principles. The quantum mechanical results are extrapolated by classical mechanics to determine surface and bulk properties of materials. Improvements in precision, code optimization, computers, and methods are allowing larger systems to be studied, requiring smaller extrapolations to compare with experiment and to obtain surface and bulk properties. These results are used to study crack initiation and propagation, chemisorption, corrosion, catalysis, and physical properties of polymers.

W85-70134 **506-53-12**
Lewis Research Center, Cleveland, Ohio.
MATERIALS SCIENCE-NDE AND TRIBOLOGY
S. J. Grisaffe 216-433-4000
(506-33-12; 506-33-32)

The objectives of this RTOP are to develop greater understanding of materials with aerospace propulsion and power potential and to develop guidelines for improving their physical/mechanical properties and reliability. Fundamental studies are aimed at investigating mechanical and other factors that limit material reliability, performance, and useful life. Fundamental studies are also aimed at identifying scientific concepts that might be applied to substantially improve aerospace materials. The research includes: part 1, material properties/performance enhancement via innovative application of nondestructive evaluation concepts/models for characterization of microstructure and mechanical properties. This involves advanced nondestructive evaluation technology that goes beyond defect detection and characterization. The objective, therefore, is to develop technology for assessing material properties as well as diverse flaw populations that govern or influence mechanical behavior, reliability, and residual life. Part 2, understanding of the basics of friction, wear, adhesion, thin film liquid lubrication, and the chemistry and morphology of solid lubricants. The work will focus on new tribological materials such as amorphous alloys and single as well as polycrystalline ceramics subjected to temperaures ranging from room to 1200 C (in terms of chemical, morphological, and tribological characteristics. The analytical and experimental results of both parts of this RTOP will have far reaching practical applications for a wide range of aerospace materials, structures, and components.

W85-70135 **506-53-15**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTALS OF MECHANICAL BEHAVIOR OF COMPOSITE MATRICES AND MECHANISMS OF CORROSION IN HYDRAZINE
Amitava Gupta 818-354-5783

The long term objective of this task is to develop a fundamental understanding at the molecular level of the behavior of polymers with major emphasis on candidate composite matrix materials. Both thermosets and thermoplastics will be studied to correlate molecular parameters with the observed mechanical properties. In the thermosetting polymers, the FY-85 objectives are to assess the

effect of addition of a tough thermoplastic to a model thermoset, both on its cure characteristics and on its physical response. The approach will involve utilization of high resolution as well as solid state NMR and ESR spectroscopy to characerize the cure process, and measurement of the stress-strain response of the modified resins. In thermoplastics, the FY-85 objectives are to measure the physical response of a model thermoplastic under torsion and torsion-tension loading conditions, and determine the segmental relaxation processes involved in strain energy dissipation. A second FY-85 objective is to develop and utilize novel pulsed magnetic resonances techniques in order to probe specific molecular relaxation. The general technical objective is to develop a short-term test method to predict the long-term behavior of metals in the presence of liquid rocket propellants, both fuels and oxidizers. An accelerated test method which can be validated by comparison with the long-term data is to be developed for candidate storge materials. The initial effort will concentrate on the hydrazine/metal experiments. Experimental conditions will be selected to minimize extraneous variable and to determine the kinetics of corrosion and activation parameters. As a result of the problems with the APUs on the Columbia in STS-9, additional consideration must be given to the environmental factors such as the presence of air and the ambient temperatures existing during re-entry.

W85-70136 **506-53-23**
Langley Research Center, Hampton, Va.
SPACE DURABLE MATERIALS
C. P. Blankenship 804-865-2042
(505-33-23; 505-33-33)

The objective of this research is to provide the technology necessary to assure the timely availability of materials for spacecraft, large area space structures, and advanced space transportation systems. Emphasis is placed on establishing the performance capability of polymer films and composites in the radiation environment of space, characterizing the thermomechanical stability of metal and polymer matrix composites, developing concepts to provide thermal control coatings with tailored optical and electrical properties, and understanding the behavior of composites to improve their damage tolerance. Current and advanced polymer films and composites will be subjected to laboratory simulated space radiation (proton, electron, UV, etc.) to establish overall material performance and to identify radiation damage mechanisms. Precision experimental and analytical techniques will be developed to characterize the thermomechanical stability of composite materials. Sputter coating techniques will be developed to tailor metallic/oxide thermal control coating having desired emittance/absorptance and durability features. A generic methodology will be established for prediction of the fracture strength of composites as well as concepts to achieve improved damage tolerance.

W85-70137 **506-53-25**
Jet Propulsion Laboratory, Pasadena, Calif.
EFFECTS OF SPACE ENVIRONMENT ON COMPOSITES
Amitava Gupta 818-354-5783

The long range objective is to utilize pulsed charged and neutral particle beams (e.g., electrons, protons, and oxygen atoms) and UV photons along with advanced spectroscopic and analytical techniques to gain an understanding of the primary degradation processes caused by the space environment in polymeric and composite materials. This information coupled with conventional test data will be used to develop a reliable methodology for estimation of the long term effects of the space environment on such materials. This RTOP will be divided into two tasks. In task 1, the FY-85 objectives are to: (1) initiate a detailed investigation of the effect of the synergism between energetic electrons and UV photons in order to develop guidelines for multistress tests; (2) determine the primary energy dissipation processes involved in interaction of near and vacuum UV photons with model polymers; and (3) demonstrate the stabilization concept developed previously in the prototype thermoset material TGDDM-DDS. In task 2, the objectives are to design, build and demonstrate a pulsed oxygen atom beam with a flux and translational energy distribution comparable with that encountered in near Earth orbit; perform flight experiments on polymers of specific chemical structure and morphology in order to validate the oxygen atom interaction model developed previously; and initiate investigation of long term effects of exposure to energetic oxygen atoms on metal matrix composites. For both tasks the approach will involve time resolved spectroscopic measurements in the micro-nanosecond time scale in order to determine the chemical structure of the primary intermediates involved, and the rate of their conversion into secondary degradation products. Additionally in task 2 polymers fluorinated at certain specific sites will be synthesized and flown aboard the shuttle (e.g., STS-14) in order to determine long term degradation rates.

W85-70138 **506-53-27**
Lyndon B. Johnson Space Center, Houston, Tex.
HYPERVELOCITY IMPACT RESISTANCE OF COMPOSITE MATERIALS
J. L. Crews 713-483-5171

Composite materials are being used in spacecraft structures on an increasing scale. In orbit, these materials may be exposed to hypervelocity impacts with meteoroids and space debris at relative velocities of 20km/sec and 10km/sec respectively. Past research has defined the hypervelocity impact resistance of aluminum alloys, but little or nothing is known about the properties of composite materials. A series of tests is planned to define the hypervelocity impact properties of a number of composite materials and some simple structures made of the composites. These tests will provide an engineering design criteria for the use of composites in structures exposed to the meteoroid/debris environment. Several materials will be selected for intensive tests, using a large light gas gun at Ames Research Center to impact projectiles up to 2 cm diameter at approximately 7km/sec, and a small light gas gun at Johnson Space Center to impact smaller projectiles.

W85-70139 **506-53-31**
Ames Research Center, Moffett Field, Calif.
THERMAL PROTECTION SYSTEMS MATERIALS AND SYSTEMS EVALUATION
H. E. Goldstein 415-965-6103
(506-51-11; 506-63-39; 506-51-41)

The objective is to provide thermal protection systems (TPS) concepts and materials for heat shields to protect Earth and planetary entry vehicles during atmospheric entry. The specific objectives are to develop concepts and materials for aerobraking orbital transfer vehicles and transatmospheric vehicles; develop improved materials and minimum weight TPS to enhance the Space Shuttle and enable fully reusable advanced space transportation systems development; develop planetary probe and solar probe heat shield materials and determine methods to minimize heat shield weights; develop concepts and heat shield materials for safe Earth entry of radioactive power sources; support DOD requirements. Candidate thermal protection concepts and materials are chosen and subjected to systematic analysis and testing to qualify them for the defined end use. Extensive unique Ames arc plasma test facilities are used in the experimental evaluations. Analytical studies are performed utilizing unique environmental computer codes developed by ARC that include detailed models of both the aerothermal environmental and material response to obtain in-depth understanding of the material characteristics. Materials are often developed as a result of these studies to meet the ever more stringent requirements for atmospheric entry thermal protection.

W85-70140 **506-53-33**
Langley Research Center, Hampton, Va.
THERMAL STRUCTURES
C. P. Blankenship 804-865-2042
(506-51-23)

The objectives of this research are to provide primary structure and thermal protection system materials and concepts for advanced space transportation systems that provide improved durability and operational costs compared to the current FRSI, LI-900 and LI-2200 RSI systems. Materials research includes development,

characterization, and enhancement. Development efforts will be focused on fabricability of advanced carbon-carbon (ACC). Characterization effort will be focused on foil gage titanium, ODS alloys and superalloys, and thin gage ACC. Enhancement efforts will be focused on emittance, creep, oxidation and strength for titanium, superalloys, and ACC. Inhouse and contract research on structures for future space transportation systems will include fabrication of test panels for cryogenic tankage and small component test of advanced carbon-carbon structures. TPS concepts research includes metallic prepackaged and ACC post supported standoff concepts. These concepts will be evaluated in various Langley high temperature wind tunnels and will be subjected to other types of tests such as foreign object impact and radiant heating. Arc tunnel and other facilities will be used as required to validate and certify TPS for multimission use. Heat shield testing support to the current STS program will be provided.

W85-70141 **506-53-40**
National Aeronautics and Space Administration, Washington, D.C.
ADVANCED SPACE STRUCTURES AND DYNAMICS
Samuel L. Venneri 202-453-2747

The objective of this RTOP is to develop a wide range of analytic tools and experimental techniques for use in the design, development, and analysis of the structures and structural dynamics of complex spacecraft and space structures. The program will be structured to foster innovative engineering solutions and design concepts for such vehicles. A number of key structural integrity issues will be addressed in order to develop the understanding and tools needed for the next generation of space structural design concepts.

W85-70142 **506-53-41**
Ames Research Center, Moffett Field, Calif.
TECHNOLOGY FOR LARGE SEGMENTED MIRRORS IN SPACE
R. K. Melugin 415-965-6530
(159-41-01; 506-62-21)

The objective of this RTOP is the development of the technology required for the design, fabrication, and test of lightweight mirror segments for large segmented mirrors in space. The Large Deployable Reflector (LDR) is a prime candidate for this technology. The LDR is an orbiting 10- to 30-meter telescope for IR and submillimeter astronomy. Conceptual and system studies for the LDR have identified top level drivers on the telescope such as aperture, primary mirror focal ratio and mass per unit area, and image quality. From these drivers, it was concluded that an assessment of lightweight mirror segment technology was needed. A study by Perkin-Elmer to assess the capabilities of existing mirror segment technologies was completed. It identified basic characteristics and design requirements for LDR mirror segments. It surveyed a wide range of currently available and developmental materials and several fabrication techniques. Fabrication and test subscale and full-scale segments will provide crucial data for the tradeoffs ultimately leading to the choice of the mirror segment technology for the mission.

W85-70143 **506-53-43**
Langley Research Center, Hampton, Va.
ADVANCED SPACE STRUCTURES
C. P. Blankenship 804-865-2042

Research will be performed on structures for future spacecraft including platforms, antennas, and space station, and to provide for the ground test program for MAST. Capability for identification of structural parameters and for controlling excessive vibrations of flexible structures will be investigated. Analytical methods for predicting coupled structural dynamics and control of multibody space structures with flexible components, interfaces and dissipative mechanisms will be developed and validated. A contractual effort will be initiated to develop and deliver the MAST structures/controls flight experiment. Flight qualified experiment hardware for STS integration will be completed for ACCESS. FY-1985 thrusts are: complete ACCESS flight experiment, develop CAD capability for evolutionary space station research, begin tests of prototype beam (mini MAST), develop candidate control techniques for nonlinear systems, and develop 3-D multibody transient analysis techniques.

W85-70144 **506-53-45**
Jet Propulsion Laboratory, Pasadena, Calif.
LARGE DEPLOYABLE REFLECTOR (LDR) PANEL DEVELOPMENT
P. N. Swanson 818-354-3273
(159-41-01)

The objective of this RTOP is to continue the development of high surface precision structural composite reflector panels, based on results of the recent JPL accomplishments, for a class of antenna concepts for a large (10-30m) orbiting telescope for submillimeter and far infrared (50 micron to 1 mm) astronomy. Studies of submillimeter observatory concepts and results from a NASA sponsored workshop on LDR technology clearly identifies the reflector panel as a critical and enabling technology for LDR. The major contributions to reflector panels surface error include: (1) manufacturing tolerances; (2) on-orbit thermal distortions; and (3) long term material dimensional stability. JPL is initiating development of: LDR panel designs through a combination of (1) materials characterization; (2) structural/thermal analysis; (3) thermal/vacuum testing of high precision graphite/epoxy panels; (4) refinement of analytical models; and (5) the determination of materials properties and configurations required to produce thermally stable structural composite panels. Preliminary results of this development will be available for the LDR workshop scheduled for the spring of 1985. The proposed approach for this RTOP is to continue the development of the thermally stable designs for graphite/epoxy panels through a combination of analytical modeling, fabrication, and testing. This would involve (1) initiation of composite materials laminate analysis; (2) initiation of constituent composite materials laboratory characterization; (3) thermal analysis; (4) initiation of structural analytical characterization; (5) initiation job procurement of high precision graphite/epoxy panels; (6) laboratory and thermal testing of characteristic small sample pieces of proposed panel design; and (7) sample thermal/vacuum test.

W85-70145 **506-53-49**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED SPACE STRUCTURES PLATFORM STRUCTURAL CONCEPT DEVELOPMENT
E. E. Engler 205-453-3958

Develop the integrated structural systems that support a (LEO) space station thrust. The work defined by this plan shall be constrained/bounded by the following parameters and considerations: The structural concepts developed will be STS (Shuttle) compatible for both transport and construction. The preferred method of construction will be deployable/erectable, i.e., deployable modules that may be assembled or erected into a variety of geometric forms. This method will enhance the evolutionary growth of large space systems. Structural concepts will be developed to accommodate two basic structural forms: (1) linear/area structures, and (2) deployable volumetric structures. The premise is that area structure may be constructed from linear elements. The structural system concepts will be designed for deployment, assembly, operation, maintenance and repair in LEO. The designs will be based on using an optimized mix of man (EVA) and machine for the construction functions. The goal of the program is to develop, demonstrate, and document (by 1986) evidence of advanced structures technology that will enable the capability of a space station mission.

W85-70146 **506-53-51**
Ames Research Center, Moffett Field, Calif.
STRUCTURAL ANALYSIS AND SYNTHESIS
A. L. Carter 805-258-3311

The objective of this activity involves the development of improved laboratory and flight experimental technqiues, correlation of measured results with analytical predictions and demonstration of new structural concepts for thermal structures.

W85-70147 **506-53-53**
Langley Research Center, Hampton, Va.
MULTIDISCIPLINARY ANALYSIS AND OPTIMIZATION FOR LARGE SPACE STRUCTURES
Robert H. Tolson 804-865-2887
(505-33-53)

The objective of this RTOP is to develop basic interdisciplinary methodologies for multidisciplinary analysis of aerospace systems. Specifically, fundamental research will be performed in the development and validation of optimization algorithms and sensitivity analysis for space structures. The approach will be to develop methodology for performing sensitivity analysis with respect to shape design variables, to evaluate the effects of sensing errors on optional control of a flexible structure, and to couple nonlinear programming techniques, modern structural analysis, and sensitivity analysis to develop optimization methodology for advanced space structure design.

W85-70148 **506-53-55**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE VEHICLE DYNAMICS METHODOLOGY
J. A. Garba 818-354-2085

The long-term objective is to perform basic research in structural dynamics related to future NASA space missions. The research will primarily focus on technology directly applicable to Space Station. A secondary objective is the development of methods for the improved prediction of low frequency spacecraft dynamics using ground test and flight data. The emphasis of the research is shifting from the low frequency loads prediction methods for Shuttle payloads to the structural dynamics issues of Space Station design and verification. The objectives of the research in support of the Space Station type structural systems are to develop new methods for the analysis and synthesis of large complex structural systems. The approach will be to develop methods for the identification of structural parameters to improve the controllability, and to develop optimization methodology accounting for both structural and control parameters. The application of recent advances in computer technology to the analytical techniques will be investigated. The objectives of the low frequency dynamic payload response research are to reduce the cost of the STS payload integration analyses, to improve the accuracy of such analyses and to identify the requirements for research for future missions. The approach will be to improve methods for the prediction of upper bound payload member loads and to evaluate these methods using flight data. The activities in this RTOP will be coordinated with NASA Headquarters, other NASA centers, the Dynamic, Acoustic and Thermal Environment (DATE) Working Group, the Space Systems Technical Advisory Committee (SSTAC), and related activities sponsored by the Department of Defense (DOD), specifically the Air Force (AF).

W85-70149 **506-53-57**
Lyndon B. Johnson Space Center, Houston, Tex.
MICROPROCESSOR CONTROLLED MECHANISM TECHNOLOGY
W. K. Creasy 713-483-2561
(506-64-27)

The objective of this RTOP is to evaluate and define the performance and design characteristics of microprocessor controlled space mechanisms. Laboratory tests of breadboard smart mechanism elements, including a variety of internal and external sensors, will be used to evaluate smart mechanism control stability, accuracy, and range. A prototype smart actuator, representative of space station applications, will be fabricated and subjected to proof-of-concept ground testing.

W85-70150 **506-53-59**
Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE STRUCTURAL DYNAMIC ANALYSIS AND SYNTHESIS METHODS
R. S. Ryan 205-453-2481

The objective is to reduce the high costs and schedule delays due to structural dynamic response phenomena during the development of future spacecraft. Dynamics considerations have been critical for several recent NASA projects. The frequency range, number of modes, and model fidelity requirements have consistently been greater than those believed at project conception. A large number of costly hardware failures have occurred and design changes made at late stages of the projects. Structural dynamic considerations are expected to be even more critical for future projects due to fundamental physical principles. Two ongoing tasks are proposed for the development of improved prediction methods. Task 1: Load combinations for Design of STS Payload Components - Present methods are too conservative and no industry-wide standard exists. Very significant payload improvements should be possible. Task 2: Modal Modeling and Testing - An investigation into the properties of classical modes, complex modes, modes with closely spaced frequencies, and identification of modes from tests.

Computer Science and Electronics Research and Technology

W85-70151 **506-54-10**
National Aeronautics and Space Administration, Washington, D.C.
ADVISORY GROUP ON ELECTRON DEVICES (AGED)
Martin M. Sokoloski 202-453-2864

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 its constituent working groups, NASA program managers receive expert advice on the feasibility, currency, and soundness of planned Research and Development procurement activities, long ranging Research and Development requirements, complementary work in other government agencies, and forecasts of new technical developments.

W85-70153 **506-54-15**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLID STATE DEVICE AND ATOMIC AND MOLECULAR PHYSICS RESEARCH AND TECHNOLOGY
J. Maserjian 818-354-3801

This RTOP consists of four main thrusts in electronics research and technology: (1) Solid State Device Research (J. Maserjian, Coordinator). This subtask consists of MBE growth of superlattices and other modulated semiconductor structures that offer exciting prospects for new device breakthroughs in opto-electronics. Also included is submillimeter component development (using advanced device concepts) and a radiation effects task, CRESS. The key individuals are J. Maserjian, F. J. and P. J. Grunthaner, R. Tell,

M. H. Hecht, B. F. Lewis, H. M. Pickett, and M. G. Buehler. (2) Optical Signal Processing (S. T. Eng, coordinator). Optical processing of large amounts of remotely-sensed data is needed to enable and enhance new NASA scientific missions. This task applies optical processing concepts to SAR and imaging data, and includes development and testing of new ideas. The key individuals are T. J. Bicknell, J. B. Breckinridge, and A. R. Johnston. (3) Integrated Optics (S. T. Eng, coordinator). This task investigates new optical technology for very high bandwidth (GHz) real time signal processing and optoelectronics systems with integrated optics implementation. Quantum well devices, monolithic and hybrid integrated optics, electroabsorption spatial light modulators, and optical interconnections for VLSI optoelectronics circuits are included. The key individual is S. T. Eng. (4) Atomic and Molecular Physics (S. Trajmar, coordinator). This task is to generate laboratory data on the interactions of atoms, molecules, ions, electrons, and photons with each other and with material surfaces. Cross sections for collision and absorption processes, spectroscopic information, and basic understanding of these interactions are obtained in support of a wide range of NASA missions. Key individuals are S. Trajmar, S. Srivastava, A. Chutjian, and J. Laudenslager.

W85-70154 **506-54-21**
Ames Research Center, Moffett Field, Calif.
FAR IR DETECTOR, CRYOGENICS, AND OPTICS RESEARCH
C. R. McCreight 415-965-6549
(506-62-21; 423-30-01; 159-41-06)

The objective of this RTOP is to develop advanced infrared detection systems for astronomical research. This program will provide the sensing and sensor support technology for low- and moderate-background applications throughout the infrared (IR) spectrum (2 to 200 micrometers). It will benefit programs such as the Space Infrared Telescope Facility (SIRTF) and the Large Deployable Reflector (LDR). In the detector and detector array area, existing $<$ 30 micrometer arrays will be obtained, characterized, and optimized. Concepts for $>$ 30 micrometer arrays will be developed. Detailed laboratory tests will be followed by technology demonstrations on ground-based infrared telescopes. An additional objective is to develop a fundamental understanding of cryogenic systems and advanced optics. Besides SIRTF and LDR, this work is applicable to the space station, orbital transfer vehicles, and gravity probe B. The development of on-orbit cryogen resupply techniques, efficient means of long-term storage of cryogens in space, advanced refrigerators for $<$ 1 Kelvin cooling, and the effects of thermal environments on mirror performance are also included. The activities will blend analysis with component development and demonstration.

W85-70155 **506-54-22**
Lewis Research Center, Cleveland, Ohio.
SUBMILLIMETER WAVE BACKWARD WAVE OSCILLATORS
R. E. Alexovich 216-433-6689
(506-54-42)

The objective of this RTOP is to provide through research, design data and developments of materials and methods, the technology base for the development of voltage tunable local oscillator sources, capable of approximately I milli-watt output in the frequency range between 600 to 2000 GHz. The approach taken pursues the development of voltage tunable, electron beam excited Backward Wave Oscillators (BWO), with an expected frequency tuning range (by voltage tuning) of approx. + or - 10% above and below a center frequency. Because of the extreme smallness of slow wave structures dimensions ($<$ 50 micron) new methods of fabricating BWO circuits must be explored. These include reactive ion etching, laser cutting, and metallization techniques. In addition, skin effect losses and direct interception will necessitate novel approaches for heat rejection. Also for these micron size circuits, the technology for very small electron beams of densities around 1000 A/sq. cm. will be developed.

W85-70156 **506-54-23**
Langley Research Center, Hampton, Va.
REMOTE SENSOR SYSTEM RESEARCH AND TECHNOLOGY
Richard Nelms 804-865-3761

The objective of this RTOP is to advance tunable, all solid state laser technology to improve measurements of atmospheric properties from space platforms. The properties of Ti:AI2O3 (titanium doped sapphire) will be investigated to determine scalability to high pulse energy. The Ti:AI2O3 laser rods will be pumped with a dye laser to study the characteristics of a Ti:Sapphire laser. The dye laser will be capable of producing short and long pulses for pumping the laser rod with pulse durations from 1 micro sec down to 30 nsec for different remote sensing applications. With short pulses, gain switched operation is possible and for longer pulses a different mechanism may occur. Particular attention will be given to mode coupling between the Ti medium and the pumping laser. Methods of tuning and doubling the Ti laser for broad wavelength coverage will be developed. Optical properties of Ti:Sapphire and new laser materials will be investigated spectroscopically. Absorption and fluorescence spectra, fluorescence lifetimes, and gain will be measured using a tunable dye laser as a source. Group theoretical and quantum chemical models will be developed to calculate crystal field splittings and vibronic interactions. These will be developed in cooperation with the Langley computational chemistry group and the Christopher Newport Physics Department.

W85-70157 **506-54-25**
Jet Propulsion Laboratory, Pasadena, Calif.
SENSOR RESEARCH AND TECHNOLOGY
H. M. Pickett 818-354-6861

This RTOP has the objective of providing sensor technology for terrestrial, planetary and astronomical applications using space stations, dedicated satellites and deep space probes. The approach is to perform research and development in accordance with the following technical thrusts: (A) Submillimeter Detectors and Sources: 1. Far-infrared Detectors (V. Hadek, 354-7054) - development of advanced photoconductive detectors for submillimeter radiation. 2. SIS Mixers (P. Zimmermann, 354-7777; J. Lambe, 354-8238) - development of superconductor-insulator-superconductor mixers using Niobium alloys and magnetic supression. 3. Submillimeter L. O. Sources (H. Pickett, 354-6861) - development of advanced harmonic generators for use at 600 GHz and 2000 GHz. (B) Tunable U. V. Lasers: (J. Laudenslager, 354-2259) - development of excimer laser sources for use in remote sensing. (C) Innovative CCD Devices: (S. Collins, 354-7393) - development of techniques to use CCDs in the ultraviolet and X-ray regions. (D) Advanced Radar Components Development: (W. Brown, 354-2110) - development of advanced radar components for future NASA SAR missions.

W85-70158 **506-54-26**
Goddard Space Flight Center, Greenbelt, Md.
DETECTORS, SENSORS, COOLERS, MICROWAVE COMPONENTS AND LIDAR RESEARCH AND TECHNOLOGY
M. Mumma 301-344-6994

The objective is to produce an array of high quantum efficiency high energy resolution X-ray detectors capable of imaging X-ray sources at energies above 1 Kev by utilizing deep diode technology; to develop components for IR heterodyne spectrometers for use in the study of electromagnetic radiation from remote sources at wavelengths between 15 and 30 micron; to develop advanced active laser sensing instruments in support of NASA programs in geophysics, climatology, and the atmospheric sciences; to transition mechanical cooler technology which will be applicable to the large number of future missions that will require instrument cryogenic cooling; and to extend previous work on ultra-sensitive coherent millimeter-wave detectors (mixers) into the submillimeter region, and to provide the technological base for submillimeter detectors approaching the ultimate quantum-limited sensitivity.

W85-70159 **506-54-50**
National Aeronautics and Space Administration, Washington, D.C.
AEROSPACE COMPUTER SCIENCE UNIVERSITY RESEARCH
Ronald L. Larsen 202-453-2783

The aim is to develop a university-based center for aerospace computing technology, focusing on concurrent processing, highly reliable computing, and scientific and engineering information management. The approach will be to foster cooperative, coordinated research coupling computer science with aeronautics, astronautics, and space sciences.

W85-70160 **506-54-55**
Jet Propulsion Laboratory, Pasadena, Calif.
COMPUTER SCIENCE RESEARCH AND TECHNOLOGY: SOFTWARE IMAGE DATA/CONCURRENT SOLUTION METHODS
J. E. Solomon 818-354-2722
(656-61-01; 656-13-50; 677-41-25; 506-58-15)

The objectives are to: provide an Agency foundation in fundamental computer science, particularly concurrent processing, reliable computing, software engineering, and space data management; develop advanced computing concepts and system architectures for computationally intense aerospace applications such as image processing and distributed cooperative control; develop the engineering capability to cost effectively build high-integrity computing systems and software for large, complex aerospace systems (in cooperation with the DOD Software Technology for Adaptable, Reliable Systems program); and advance data base management and computer networking technology to improve the availability of space-derived data to the user community. The approach is to: develop and validate a dynamic cost model for the software life cycle (FY-1986); develop robust, numerically stable, concurrent algorithms for solving sets of thousands of simultaneous linear and non-linear equations (FY-1987); and develop and demonstrate artificial intelligence techniques of information extraction from image data (FY-1986).

W85-70161 **506-54-56**
Goddard Space Flight Center, Greenbelt, Md.
COMPUTER SCIENCE RESEARCH
Paul H. Smith 301-344-5876

The objectives are to conduct fundamental research in computer science, demonstrate the potential of computer science for major agency programs, improve institutional facilities and resources, and develop close ties with industry and universities as research partners, beginning with the following specifics (1) develop a theoretic base of knowledge and prototype implementation of derived methodologies, technologies, and systems required to handle very large multi-source databases managed at distributed locations; (2) perform software management research leading to a well-defined operational structure termed the software management environment, including the creation of a Technology Assessment Laboratory and the identification, evaluation, and development of software management tools, software design metrics, and approaches to rapid prototyping; (3) develop systems level software critical to the Massively Parallel Processor (MPP); and (4) extend current theoretical work in user level protocols to support the control and sharing of programs, information, and processing resources, and in interfaces to represent network capabilities in terms meaningful to the user's problem environment.

W85-70162 **506-54-57**
Lyndon B. Johnson Space Center, Houston, Tex.
HAL/S INTER-CENTER BOARD
J. L. Fisher 713-483-2246

The HAL/S Language Definition and User Group, also referred to as the NASA HAL/S Board, was established in 1977 to provide language support for the standard HAL/S compiler, tools, and documentation. The objectives are to maintain the standard compiler and documentation, control change requests and discrepancy reports, and improve user tools and interfaces to maintain compiler viability in evolving environments. The approach is to contract with Intermetrics Inc., to: (1) provide Secretariat Functions for the Board, (2) provide compiler maintenance/documentation; and (3) develop tool improvements and special studies as approved by the NASA HAL/S Board. The FY-85 tasks include completion of studies and upgrades begun in FY-84, and development of improved user interfaces.

W85-70163 **506-54-61**
Ames Research Center, Moffett Field, Calif.
ADVANCED CONCEPTS FOR IMAGE-BASED EXPERT SYSTEMS
H. Lum 415-965-6544

The objective of this RTOP is to emphasize research in the areas of spaceborne symbolic processing architectures, image understanding and information extraction techniques, software tools for development of expert systems, and natural languages/ interfaces. Overall end objective for the research effort is an image-based expert system for spaceborne applications with an emphasis towards the astrophysics and upper atmospheric scientific applications. Early feasibility demonstrations will be conducted as major milestones are accomplished. Benefiting programs include the Kuiper Airborne Observatory (KAO) Astronomy Program, Space Infrared Telescope Facility (SIRTF), Large Deployable Reflector (LDR), Space Station, and Environmental Observational Satellite (EOS). A joint Ames-University-Industry Research Team has been formed which includes Stanford, U.C. Berkeley, University of Texas, Research Institute for Advanced Computer Science (RIACS), SRI International, GSFC and JSC for the transfer of research technologies to project applications.

W85-70164 **506-54-63**
Langley Research Center, Hampton, Va.
AUTOMATION SYSTEMS RESEARCH
A. J. Meintel, Jr. 804-865-2489
(506-57-23; 506-64-23)

The objective of this activity is to extend and enable the technology base required to design and automate teleoperator and robotic systems to enhance the capabilities for future space activities including servicing, maintenance and repair, structural assembly, and space manufacturing. To achieve these objectives, the program focus will be to conceptualize, investigate and verify algorithms, sensors, actuators, software, and system architecture required for remote space operations. The research will be conducted through simulation and laboratory hardware experimental tests. Parametric studies and analysis will be conducted to identify subsystem and component requirements. Controls research will include control modes, stability, time delays, trajectory optimization and evaluation of various levels of direct, shared man/computer, and supervisory control. Basic research on the application of adaptive control techniques for the control of flexible or limber manipulators with distributed sensing and actuation will also be supported. The application of artificial intelligence techniques for autonomous task planning, multiple system coordination, and monitoring and diagnosing the functioning of systems and subsystems will be evaluated.

W85-70165 **506-54-65**
Jet Propulsion Laboratory, Pasadena, Calif.
AUTOMATION TECHNOLOGY FOR PLANNING, TELEOPERATION AND ROBOTICS
S. Grenander 818-354-5854
(605-57-25)

The general objectives are to develop the technology base required in automated planning and decision making in the space program and to provide automated manipulation, sensing and actuation technology for future NASA teleoperation and robotics applications, such as satellite servicing, space assembly, and space construction. The objectives of this effort are to identify, develop, and guide development and demonstrate techniques and technologies which have the potential of automating and unifying the design and operation of mission operations process control to assure significantly reduced cost, increased responsiveness and a higher degree of accuracy than is possible with currently applied techniques and technologies. The objective of this effort is to develop software tools that automate NASA mission operations

functions which are now labor intensive. The research areas are: (1) automatic generation of computer code by planning methods and concommitant automated scheduling (applied to mission command sequence generation.) (2) automated fault diagnosis of spacecraft (applied to monitoring of telemetered data). In addition, assistance in using these tools is provided to the workers engaged in the uplink and downlink process control tasks of mission operations. The objective of this task area is to advance technology in sensing, perception, and manipulation needed for future NASA missions utilizing teleoperators and robots. Included are subtasks: (1) interactive automation for teleoperations; (2) machine vision for robotic systems.

W85-70166 **506-54-67**
Lyndon B. Johnson Space Center, Houston, Tex.
AUTOMATED SUBSYSTEMS MANAGEMENT
F. H. Samonski 713-483-4823

Space Station Subsystems will require a significant degree of autonomous control in order to reduce the demand on crew time and ground support personnel. Rapid, efficiently organized local and archival storage, retrieval and display of subsystem status, operation, and maintenance and repair information will be required across the various Space Station subsystems. The objective of this program is to develop and demonstrate the feasibility of generic automation techniques for the control of spacecraft subsystems through the use of regenerative life support subsystems as a demonstration pilot system.

Space Energy Conversion Research and Technology

W85-70167 **506-55-22**
Lewis Research Center, Cleveland, Ohio.
ELECTRIC PROPULSION TECHNOLOGY
D. C. Byers 214-433-6850

The overall objective of this program is to conduct research on, and develop technology for electric propulsion systems for future Earth orbital and planetary missions. Potential applications include auxiliary propulsion for space station, geosynchronous spacecraft, and Earth orbital platforms. Primary propulsion applications include Earth orbit change and transfer, and many planetary missions. Technologies are identified and advanced for electrostatic (ion) and electrothermal thruster systems. The program consists of analytic and experimental efforts. Mission studies will be conducted to establish the performance potential of specific propulsion concepts. Research will be carried out to understand basic physical processes and to establish the promise of specific approaches. Technology activities will be directed toward characterizing the performance, lifetime, and interfaces of critical system elements such as thrusters and power processors. Work will be performed in-house, on contract, and with university grants.

W85-70168 **506-55-25**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTRIC PROPULSION SYSTEMS TECHNOLOGY
G. Aston 818-354-2696

This RTOP seeks to study and define mission requirements, to develop specific system technology for the application of electric propulsion to planetary spacecraft, and to perform fundamental research into the physical processes inherent in this technology. In FY-85, a Planetary Spacecraft Integration task has been introduced to compliment on-going mission studies. This new task will investigate both ion engine and arcjet thruster system technology requirements for specific adaptation to planetary spacecraft. Concurrently, at JPL and Princeton University, research into hydrazine arcjet thruster characteristics will seek to identify the major technical challenges associated with the successful development of this very promising propulsion system. Work will continue on further understanding MPD thruster operation, in the steady state, as a potential high power thrust system for far future missions. The Solar System Exploratioon Committee is considering a variety of planetary missions, and these will be assessed for applicability of electric propulsion and the benefits compared to conventional propulsion. Finally, studies of concepts such as laser propulsion and perforated solar sails will continue as they promise a breakthrough in performance over existing propulsive means.

W85-70169 **506-55-42**
Lewis Research Center, Cleveland, Ohio.
PHOTOVOLTAIC ENERGY CONVERSION
H. W. Brandhorst, Jr. 216-433-4000

The objective of this RTOP is to improve conversion efficiency, reduce mass, reduce cost, and increase the operating life of photovoltaic converters and arrays. Research and technology programs will be continued in the following areas: radiation tolerant Si and III-V compound solar cells, including InP; concentrator cells; n+/p/p+ shallow homojunction III-V cell development, with emphasis on high efficiency, ultralightweight thin film cells; multiple bandgap cells, both monolithically and mechanically stacked; advanced device concepts such as superlattice solar cells and the surface plasmon solar cells; advanced techniques for laser-assisted solar cell processing; and various aspects of solar cell blanket technology, including metallization and interconnect development for advanced blankets and arrays. The approach combines a strong in-house effort with judicious use of university grants to explore key basic research areas, and industrial contracts to demonstrate feasibility of various device designs and to investigate cell and blanket technology options.

W85-70170 **506-55-45**
Jet Propulsion Laboratory, Pasadena, Calif.
HIGH PERFORMANCE SOLAR ARRAY RESEARCH AND TECHNOLOGY
Paul M. Stella 818-354-6308

The long range objective of this RTOP is to develop and demonstrate high performance solar array technology capable of enhancing or enabling future NASA missions. As a goal this effort will demonstrate the feasibility of a 300 W/kg and/or 300 W/square meter beginning-of-life (BOL) solar array capable of operating at 300 V in either high earth or geosynchronous orbit, and will establish a radiation data base for designing this array for end-of-life mission requirements. The specific objectives for FY-85 are to develop an array design which is technology transparent and suitable for a space flight demonstration of its high performance characteristics and demonstrate an array structure that will allow a 300 W/kg BOL array to be developed by FY-89. Multiple industry contracts will develop a realistic, high performance (300 W/kg and/or 300 W/square meters as goals) array design (second generation flexible substrate) that will be capable of a space flight demonstration experiment within 5 years. A spaceworthy, prototype array structure including a low mass deployer with a retraction capability will be fabricated and undergo preliminary ground based testing. A welded, ultrathin cell and cover blanket design that will operate at less than 20 C in the space environment will be demonstrated. The damage equivalence for silicon and GaAs solar cells in an omnidirectional space radiation environment will be completely determined.

W85-70171 **506-55-49**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-kW SOLAR ARRAYS
M. R. Carruth, Jr. 205-453-4275
(481-50-58)

The objective of this RTOP is to advance the state-of-the-art in multi-kW solar arrays for Earth orbit; it is necessary for support of future NASA missions which will require significantly higher power than on previous spacecraft. This RTOP will be a combination of in-house and contracted efforts and will consist of the following: Task 1 - Low Cost Multi-100 kW Solar Array Concept and Technology Development; Task 2 - Investigation of Theoretical Concepts for Power Generation; Task 3 - Materials Evaluations for Earth Orbital Solar Arrays and Task 4 - Solar Array Flight Experiment (SAFE) Post Flight Data Analysis and Reporting.

W85-70172 **506-55-52**
Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE
L. H. Thaller 216-433-5260

The objective of this program is to provide the technology base for future space power systems by developing critical technologies in electrochemistry which will lead to very high capacity, long-life, high-energy-density battery and fuel cell systems. The in-house work on the nickel hydrogen battery aims at firmly establishing the component technology of current cell designs (IPV) as well as investigating advanced cell design concepts (bipolar) applicable for multi-kilowatt systems. The in-house fundamental efforts support the nickel hydrogen battery work. Synthetic battery cycling and system assessments continue to provide guidance to the program.

W85-70173 **506-55-55**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED ELECTROCHEMICAL SYSTEMS
I. Stein 818-354-6048

The overall objective of this RTOP is to achieve improved performance, energy density and lifetime of space batteries for applications in Earth orbital and interplanetary missions. FY-85 objectives for each of the three tasks are as follows: (1) Advanced Concepts - To maintain awareness of improvements in electrochemical technology and assess their applicability for NASA missions. One specific area, solid state polymeric electrolytes, continues to be evaluated as a new concept for rechargeable cells. (2) Primary Lithium Batteries - To generate a preliminary Manufacturing Control Document (MCD) for fabrication of flight quality Li-SOCl2 cells and to determine the optimum electrode configurations and material ratios for performance and safety. (3) Secondary Lithium Batteries - To understand cycle life driven degradation chemistry and to identify stand related chemical processes to complete the simulated GEO cycle life/chemistry study of Li-TiS2 cells; and to elucidate fundamental mechanisms coupling cell performance and capacity decline with cathode materials and processes. Task 1 - To continue to survey the manufacturers, users and government technologists for improvements in performance, life and reliability of electrochemical power sources; and to determine the properties and factors necessary to produce candidate cycleable polymer electrolytes - Task 2 - Implement first phase of contracts with two vendors to develop MCD. Fabricate prototype Li-SOCl2 cells with alternate cathode configurations and anode-to-cathode material ratios. Evaluate electrical performance and chemistry of these cells - Task 3 - Establish cycle life and stand related degradation chemistry using quantitative surface analytical and electrochemical studies of the lithium electrolyte reactions; evaluate the use of double salt and/or mixed solvents to improve electrolyte stability and expand the compatibility domain of cell materials; develop and understand improved cathode materials and processes.

W85-70174 **506-55-62**
Lewis Research Center, Cleveland, Ohio.
SP-100 AND SOLAR DYNAMIC POWER SYSTEMS
T. S. Mroz 216-433-6381
(481-50-52)

The overall objective of this RTOP is to provide thermal-to-electric conversion system technology, including system definition studies and critical component technologies in the area of solar receivers, thermal storage, and both dynamic and static converters. This objective includes support of the tri-agency (NASA/DARPA/DOE) Space Nuclear Reactor Power Systems Technology (SP-100) program. There are two parts to this RTOP: Solar Dynamic and SP-100. The approach used to reach the objectives of this RTOP is to advance the state-of-the-art, provide fundamental understanding and demonstrate feasibility of thermal-to-electric conversion devices by means of contracted and in-house effort organized under the two parts.

W85-70175 **506-55-65**
Jet Propulsion Laboratory, Pasadena, Calif.
THERMAL-TO-ELECTRIC ENERGY CONVERSION TECHNOLOGY
J. F. Mondt 818-354-4380

In scope, the SP-100 Program has the DOD, DOE, and NASA charter for 100kW-class space nuclear reactor power systems technology development. The Project Office established at JPL manages all SP-100 technical work during the initial, technology assessment and advancement phase. In this phase, the project will develop nuclear and aerospace technology, evaluate NASA, commercial and military missions, and develop system designs. This phase ends in FY-85 with the selection of a specific system for the second, ground test phase. The objective of the Focused Fundamental Materials Research task is to perform research leading to the identification and evaluation of fundamental thermoelectric material properties which will guide the selection and development of new and improved thermoelectric materials for energy conversion. The approach is to continue the existing programs in fundamental thermoelectric material research at several universities with emphasis on the basic relationships between material parameters and the Seebeck effect, electronic and thermal transport.

W85-70176 **506-55-72**
Lewis Research Center, Cleveland, Ohio.
POWER SYSTEMS MANAGEMENT AND DISTRIBUTION
R. W. Bercaw 216-433-6143

The objective is to provide the technology base necessary to control the generation and distribution of energy in future space systems and to assure their environmental compatibility. The proposed work will define and develop the generic technology to enable large multi-kilowatt power systems in space. In-house and contractual studies will be conducted, as needed, to determine performance requirements, system constraints and new technology needs for future space power systems. Contract, grant, and in-house experimental and analytical programs will be conducted to explore the basic physics of conductor, semiconductor, insulator, dielectric, magnetic and thermal materials for power devices; develop an analytical model of their operating principles; and to demonstrate their performance in experimental devices and circuits as required. In addition, this program will perform ground tests to simulate and determine the impact of the environments on space systems, develop models of the physical phenomena and conduct space tests to verify ground test data. Discrete components will be developed and evaluated.

W85-70177 **506-55-73**
Langley Research Center, Hampton, Va.
ADVANCED SPACE POWER CONVERSION AND DISTRIBUTION
E. J. Conway 804-865-3781

The objectives are to assess, through analytical studies and research on key technologies, the degree of enhancement offered to NASA space power requirements by space-based laser power generation, and subsequent conversion to electricity, and to investigate a fast, high current switch, the liquid droplet radiator and other concepts offering space power advancements. For direct solar-pumped lasers (DSPL), lasant consideration will emphasize photodissociable halide molecules and photoexcitable elemental vapors, dyes, and liquid lasants. New halide molecules with improved DSPL characteristics will be lased. Gain and lasing characteristics of Nd in solution will be measured. Other major activities will include a flowing DSPL and a laser amplifier. For blackbody-pumped or indirect solar-pumped lasers (ISPL), two concepts (slow flow CO2 and mixing CO2) will be assessed experimentally. Conversion efficiencies of laser-to-electric power for MHD, and an advanced photovoltaic concept will be investigated. Exploration of a fast, high-current plasma switch mechanism and a liquid droplet thermal radiator for space thermal management will be sustained. The feasibility of a plasma switch with a million-amp current capability and rise time of a few microseconds

will be studied to determine its operating parameters and to explore its potential for achieving long electrode life.

W85-70178 **506-55-75**
Jet Propulsion Laboratory, Pasadena, Calif.
POWER SYSTEMS MANAGEMENT AND DISTRIBUTION - ENVIRONMENTAL INTERACTIONS RESEARCH AND TECHNOLOGY
P. Theisinger 818-354-6094

(1) Advanced Power Systems Technology: The general objective for this area is to achieve increased specific performance, higher efficiency, lower mass and improved regulation for low to medium power spacecraft power systems for interplanetary or Earth orbital applications. Specific objectives are Power Distribution and Control to develop advanced approaches for high voltage power distribution, distributed power processing; power control; and (Power Processing) to develop high efficiency high voltage/ frequency dc/dc and dc/ac converters, and advanced switching/ conversion topologies for energy storage and power transfer applications; (2) Environmental Interactions R and T: The general objective for this area is to develop the technology for controlling the interaction of a large and high voltage spacecraft surface with the space plasma environment. The specific objective of this investigation is to determine and model the electromagnetic interference (EMI) generated from arc discharges resulting from the interactions, and then use these results to establish a set of EMI immunity and discharge avoidance design guidelines for spacecraft systems. This activity is part of a joint AF/NASA comprehensive research and technology program. (1) Advanced Power Systems Technology: The approach in this area is to review existing and emerging technologies for advanced applications in components, circuits, and automated subsystems in order to develop promising approaches; analyze candidate approaches to determine key performance parameters, drives, and required technology improvements; implement these technology concepts/ improvements and verify, through testing, predicted performance improvements. (2) Environmental Interactions R and T: The approach in this area consists of four phases: (1) acquire test data on EMI generated from discharges from typical high voltage surfaces; (2) use this data to develop a model of EMI generation; (3) develop a model of discharge of high voltage surfaces; and (4) establish a set of design guidelines for EMI immunity and discharge avoidance.

W85-70179 **506-55-76**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED POWER SYSTEM TECHNOLOGY
F. E. Ford 301-344-5845

The basic objective for this RTOP is to convert advanced power technology R&D accomplishment at the various NASA centers and at other agencies (DOD, DOE) to a state of readiness for future flight applications. The approach includes the overall assessment of R&D status, the evaluation of technology advancements in terms of potential for flight application, the completion of engineering development necessary to bring high-potential advancements to technology readiness, and the analysis of power systems incorporating the advanced technology. The RTOP consists of four tasks: (1) Power Technology Assessment, (2) Analytical Modeling of Power Systems, (3) Power System Components, (4) Development of Spacecraft Power System Utilizing Inertial (Flywheel) Energy Storage.

W85-70180 **506-55-79**
Marshall Space Flight Center, Huntsville, Ala.
MULTI-100 kW LOW COST EARTH ORBITAL SYSTEMS
D. J. Weeks 205-453-4952
(506-64-19)

The objectives of this RTOP are to develop and evaluate high voltage, multi-100 kW power system control and distribution requirements and technologies which show potential for reducing space energy costs through improved efficiency, life, and/or reliability. The approach will be to use a combination of in-house and contracted efforts and will consist of developing control and distribution hardware and techniques and constructing a system breadboard for verification and evaluation of new technologies and power management techniques.

W85-70181 **506-55-80**
National Aeronautics and Space Administration, Washington, D.C.
SPACE ENERGY CONVERSION SUPPORT
J. H. Ambrus 202-453-2859

The aim is to provide support to the Headquarters operation of the OAST Space Energy Conversion Program. The approach will include operation of the multiagency supported Power Information Center of the Interagency Advanced Power Group, support to the Civil Missions Advisory Group, analytical efforts in support of Space Energy Conversion Technologies, and support of specialists' meetings and conferences in Space Energy Conversion Discplines.

W85-70182 **506-55-82**
Lewis Research Center, Cleveland, Ohio.
THERMAL MANAGEMENT
T. S. Mroz 216-433-6991

The objective of this effort is to develop the thermal management technology for advanced high capacity and high performance thermal management systems for future space missions. Radiator concepts, having the potential for dramatic performance improvements over fluid and heat-pipe radiators, will be identified and their basic feasibility demonstrated. Currently the Liquid Droplet Radiator (LDR) and the Liquid Metal Belt Radiator (LBR) have been identified and are under active investigation. Two-phase fluid heat transport systems combine the potential for dramatic reductions in mass and parasitic power with improved temperature control. A second part of the effort will provide the technology base needed to design two phase systems which operate under reduced gravity. The work will be accomplished through a combination of contracted efforts, university grants and in-house analysis and experiments. The in-house projects will utilize existing LeRC facilities such as high vacuum chambers, new experimental hardware, as required, the zero-gravity facility, and airplanes. When appropriate, in-space experiments using the facilities made available by the space transportation system will be identified, planned and carried out. The feasibility of the LDR is being demonstrated through a joint, dependent program with the Air Force.

W85-70183 **506-55-86**
Goddard Space Flight Center, Greenbelt, Md.
THERMAL MANAGEMENT FOR ADVANCED POWER SYSTEMS AND SCIENTIFIC INSTRUMENTS
Stanford Ollendorf 301-344-5228

The objective of this research is to develop, analyze and test heat acquisition and transport systems for application to power systems and for temperature control of scientific instruments. The approach will be (1) to design, fabricate, and test various two-phase flow devices in order to evaluate their potential. (2) to select candidate devices and their supporting components for prototype development. (3) to develop an integrated cold plate for thermal, power, and data handling. (4) to develop small flight experiments to study the problems associated with two-phase flow. (5) to develop analytical models for performance prediction and test verification.

W85-70184 **506-55-87**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT FOR ON-ORBIT ENERGY SYSTEMS
J. G. Rankin 713-483-4941

The objective of this RTOP effort is to: (1) develop the technology necessary for thermal management of a large evolutionary on-orbit spacecraft, (2) extend orbital lifetime capability of thermal management systems from months to several years, (3) provide the technology necessary for high energy density heat collection and transport, and (4) reduce the complexity and thus the cost of very large scale heat rejection systems by orders of magnitude. The approach will be to establish the technology required for the design, fabrication, and test of advanced thermal

concepts. Such advanced concepts might consist of a pump assisted two-phase flow circuit providing a constant temperature thermal bus or energy transport loop that would deliver or receive heat to/from the various subsystems and payload heat sinks or sources via one or more types of modular (i.e., easily connectable/removable) thermal interface devices (contact heat exchangers, fluid or heat pipe quick disconnects, etc.). The primary heat sink for such a system could be made up of independent radiator elements containing large, high capacity heat pipes that would provide a space constructible radiator system with long life due to low system vulnerability to the micrometeoroid environment.

W85-70185 **506-55-89**
Marshall Space Flight Center, Huntsville, Ala.
HIGH CAPACITANCE THERMAL TRANSPORT SYSTEM
J. W. Owen 205-453-5503

A concept for thermal energy storage (TES) has recently emerged that depends on the heat of mixing of a pair of different liquids at a critical solution temperature (CST). Liquid pairs that mix (or unmix) at a CST are called conjugating binary (CB) systems. The CB concept appears attractive for TES because only liquid phases are involved. Thus, energy transfer obstruction at heat transfer surfaces, a common problem in TES systems caused by crystallization, can be avoided. The subject of this effort is to expand upon this concept to include heat transport systems. It is postulated that use of CB systems, for transport of heat from sources to sinks, offers a significant reduction in the required pumping power with respect to conventional liquid transport systems. Because these systems exhibit the characteristics of reacting (or reversing reaction) in proportion to the available heat (or heat removal), a CB system may be self regulating and may not require an active control system. Because the liquid pairs exhibit significant heat capacitance without changing phase (e.g., liquid to vapor), operation of a CB system in zero gravity would be similar to conventional systems, and the technology development would not require extensive flight testing for verification.

Controls and Human Factors Research and Technology

W85-70186 **506-57-13**
Langley Research Center, Hampton, Va.
SPACECRAFT CONTROLS AND GUIDANCE
L. W. Taylor 804-865-4591
(506-53-43; 506-57-33)

Future space structures such as large-diameter antennas, manned space stations, or space platforms, will necessarily be light-weight, loosely coupled, and flexible. Control systems for such configurations must not only satisfy the requirements associated with spacecraft maneuvering and precision pointing, but also must provide active damping of flexible modes and effective shape control. The objective of this program, therefore, is to devise and evaluate advanced techniques for the analysis and synthesis of control systems for large space structures. To accomplish this objective, advanced control modeling techniques, and on-line identification will be utilized in conjunction with dynamics models of such spacecraft configurations as a manned space station, Shuttle-attached sortie experiments, and large-diameter antennas. Control system implementations resulting from these efforts will be thoroughly evaluated to establish their performance capability and limitations. The analytical efforts will be complimented by ground validation, on such test articles as the Langley grid, the Spacecraft Control Laboratory Experiment (SCOLE), and by flight experiments, such as in conjunction with a Shuttle-borne antenna experiment, to quantify the effectiveness of the various candidate control system designs.

W85-70187 **506-57-15**
Jet Propulsion Laboratory, Pasadena, Calif.
FUNDAMENTAL CONTROL THEORY AND ANALYTICAL TECHNIQUES
A. F. Tolivar 818-354-6215

The long range objectives of this RTOP are to develop and evaluate control concepts, designs, and components required for the autonomous control, pointing, and stabilization of future space systems including Space Station, space platforms, large antennas, and planetary spacecraft. This RTOP encompasses the following major tasks: (1) Autonomous Control Systems Theory, Algorithms and Software - Develop integrated controls/structure design methodology, system identification analysis and software for automated self-monitoring of controls performance, and adaptive control designs for autonomous compensation of dynamic uncertainties and/or configuration change. (2) Advanced Guidance and Control Components - Develop a high performance, long-life integrated optics laser gyro, and an optical sensor for attitude and dynamics determination and identification of flexible spacecraft. (3) Advanced Precision Pointing Technology - Develop and integrate technologies for precision pointing of scientific instruments on a variety of space vehicles. (4) Aeromaneuvering Guidance and Navigation - Develop guidance and navigatiion technology for aeroassisted orbital transfer and accurate landing following reentry.

W85-70188 **506-57-19**
Marshall Space Flight Center, Huntsville, Ala.
LARGE SCALE SYSTEMS TECHNOLOGY CONTROL AND GUIDANCE
H. J. Buchanan 205-453-4582

The objective of this research will be to define, develop, and demonstrate control techniques and devices required for future Space Platforms, Stations, Advanced Earth Orbiting Spacecraft, and Advanced Space Transportation Systems. The approach will include the following specific tasks: (1) Large Space Systems Control Technique, Development, and Verification - The current laboratory test program will be continued and expanded to address additional control applications. (2) Linear and Nonlinear Modeling of Flexible Structures in an Arbitrary Topology for Large Space Systems Control - The present version of the program, TREETOPS, will be expanded to include a ring topology of connected modules. (3) Autonomous Momentum Management Techniques - The development of adaptive momentum management concepts will be expanded to large systems with earth-fixed and space-fixed elements. (4) Space Station/OMV Rendezvous and Docking - The previously developed techniques will be expanded to deal adaptively with changing mass properties and configurations.

W85-70189 **506-57-20**
National Aeronautics and Space Administration, Washington, D.C.
HUMAN FACTORS IN SPACE SYSTEMS
Melvin D. Montemerlo 202-453-2784
(505-34-40)

The objective of this RTOP is to conduct space operations research with particular emphasis on human capabilities assisted by various levels of automation. The research will be conducted by developing and testing a beam assembly teleoperator (BAT) for use in neutral buoyancy tests. Also tests will be conducted of closed cabin free flyers, head up displays for control of maneuvering units, simulation of telepresence technology, investigation of the human function in supervisory control and the investigation of expert system for task assignment and housekeeping aboard a space station. This work will be carried out under a grant to MIT. The second task in this RTOP is a one year contract with the National Research Council to assess research needs in the area of astronaut/crewstation interaction for space station.

W85-70190 **506-57-21**
Ames Research Center, Moffett Field, Calif.
SPACE HUMAN FACTORS
Joseph C. Sharp 415-965-5100
(199-22-62; 505-35-11; 481-50-71)

Future manned space systems may place the operators in a

position of having more autonomy and relying less on ground control. These missions will involve highly trained astronauts as well as other flight crew members and scientists. Maximum benefit from these future space systems will accrue where the abilities of the humans are fully exploited and their performance maximized with their errors reduced to a minimum. The objective of the RTOP is to develop an understanding of the causes of human error which appropriately addresses the unique aspects of both individual and team operation in space. The program will focus initially on gaining the maximum benefit of past experience with space operations in addition to operations in other stressful environments which have similar characteristics to those encountered in space. Particular emphasis will be placed on bringing together current knowledge regarding operational problems. Using this knowledge, the first step in developing reliability model(s) for human operators in these future space systems will be initiated.

W85-70191 **506-57-23**
Langley Research Center, Hampton, Va.
MANNED CONTROL OF REMOTE OPERATIONS
A. J. Meintel, Jr. 804-865-2489
(506-54-63; 506-64-23)

The objective of this plan is to study, synthesize, and optimize an efficient man-machine interface to remote systems and to apply advanced technology to achieve and enhance man's supervisory control of remote automated systems. The research will be conducted using a reconfigurable remote control station coupled to a software/laboratory-hardware simulation representing the remote system. Experimental studies will be carried out to determine human capabilities/limitations in teleoperation at increasing levels of automation of the remote task. The remote station will be reconfigured as required to evaluate controls, displays, and other system interface elements.

W85-70192 **506-57-25**
Jet Propulsion Laboratory, Pasadena, Calif.
TELEOPERATOR HUMAN INTERFACE TECHNOLOGY
A. K. Bejczy 818-354-4568
(506-57-22; 506-54-65; 906-75-06)

The general objective of the RTOP is to develop a data base and models for quantifying human performance in sensor and computer augmented information and control environment of space teleoperator systems in order to advance the state-of-the-art currently represented by the Shuttle RMS baseline technology. This objective includes the classification, measurement and evaluation of human performance parameters related to: (1) kinesthetic proprioceptive man-machine coupling; (2) analog and symbolic man-machine communication; (3) perceptive/ cognitive processes involved in on-line decision making as a function of alternative presentations of a given control task. The FY-85 objectives are: (1) investigate the effects of alternative visual systems and system components on human performance in teleoperator control. Coupled TV and graphics systems are included in this investigation; (2) investigate the effects of shared or traded human and computer control of visual systems on human task performance in generic space teleoperation tasks; (3) refine the previous control experiments on the effects of simulated zero-g on the operator's performance in force reflecting manual control. The refinements will involve the use of improved experimental hardware and computer control system and will include short time delay conditions. The general approach is experimental. It creates, maintains, upgrades and utilizes experimental capabilities at the JPL teleoperator laboratory to generate the necessary data. Function allocations between man and machine will be studied for various operational constraints, including time delays. New system and subsystem concepts will be developed and breadboarded when necessary. Cooperation with other NASA centers and universities will be maintained or established as appropriate.

W85-70193 **506-57-26**
Goddard Space Flight Center, Greenbelt, Md.
GROUND CONTROL HUMAN FACTORS
W. F. Truszkowski 301-344-9261

The objective is to contribute to the development of a technology base to better enable the allocation of command, control, analysis, planning, scheduling and monitoring functions among men and automated computer systems. To accomplish this objective guidelines for man/machine interfaces and interactions will be documented; a modeling technique for the study of human factors issues associated with man/machine interactions will be proposed and tools for the analysis of automated ground control systems for spacecraft from a human factors point-of-view will be developed.

W85-70194 **506-57-27**
Lyndon B. Johnson Space Center, Houston, Tex.
HUMAN FACTORS FOR CREW INTERFACES IN SPACE
J. L. Lewis 713-483-4161

The objective of this RTOP is to develop technologies which will increase the effectiveness of man-machine interactions in space. Specific tasks include development of guidelines for man-machine interfaces, development of models of human motion and strength and collection of data for these models, and development of specific productivity aides for use in Extra Vehicular Activity (EVA). The guidelines for man-machine interfaces will address the assignment of tasks to humans or to automation, the suitability of new technology for controls and displays in space, and other aspects of the interface such as habitability which are important for safe, efficient operations in space. The EVA tools under development include a glove end effector to increase the manual operations a crewmember can perform; a generic work station and restraint system; and a helmet-mounted heads-up display to increase the information available to an EVA crewmember. The models of human motion and strength will be integrated into the Graphics Analysis Facility at JSC to provide design engineers with quantitative information early in the design cycle. The multi-view laser based anthropometric measurement system will be developed to provide much of the needed data for these models. Existing facilities that will be utilized include an avionics test bed, the Operator Station Design System and data base, and the Anthropometric Measurement Laboratory data base and equipment.

W85-70195 **506-57-29**
Marshall Space Flight Center, Huntsville, Ala.
TELEOPERATOR HUMAN FACTORS
W. O. Frost 205-453-1413

This RTOP defines the requirements for a teleoperator human factors research program and implements selected elements of the requisite teleoperator test/experiments/analyses. Empirical methods are used to derive data/knowledge/conclusions characterizing the capabilities/limitations of the remotely-located human operator of a teleoperations system as a function of system/ subsystem/ technology alternatives. The tests are selected and planned to effectively augment and enhance the current data/ knowledge base in Teleoperator Human Factors.

Space Data and Communications Research and Technology

W85-70196 **506-58-10**
National Aeronautics and Space Administration, Washington, D.C.
ERASABLE OPTICAL DISK BUFFER
Kenneth R. Wallgren 202-453-2868

The objective of this RTOP is to develop an erasable optical disk buffer device capable of storing and retrieving up to 10 to the 12th power bits of information at rates up to 1.66IGA bits/second. Laser/optical disk technology will be employed in concert with advanced laser diode arrays to achieve high performance.

W85-70197 **506-58-11**
Ames Research Center, Moffett Field, Calif.
ADVANCED TECHNOLOGIES FOR SPACEBORNE INFORMATION SYSTEMS
T. L. Grant 415-965-6526
(506-54-61; 481-50-81)

Advance the state-of-the-art in data network technology through analysis of general concepts and the implementation of software simulation to define, develop and evaluate detailed concepts, including promising coding designs. The emphasis in this technology development is on both reduced system complexity for data networks and on increased reliability while providing the flexibility to expand data capacity as processing requirements increase. The development of network concept and protocol models primarily uses the Ames Research Center computational facilities. It will provide a common tool for developing and evaluating detailed designs in coordination with other centers as well as augmenting the theoretic analysis of general concepts. An additional objective is the development of an architecture for a spaceborne symbolic processor required for subsystem automation and implementation of expert systems for the Space Station. Use of Very High Speed Integrated Circuits (VHSIC) technologies will be included in the development with eventual feasibility demonstration conducted by JSC in their data management system test bed.

W85-70198 **506-58-12**
Langley Research Center, Hampton, Va.
A VERY HIGH SPEED INTEGRATED CIRCUIT (VHSIC) TECHNOLOGY GENERAL PURPOSE COMPUTER (GPC) FOR SPACE STATION
Harry F. Benz 804-865-3535
(541-58-13)

A combination of new device technologies and architectures are required to meet the computing needs of the space station and related future NASA projects. Current space-qualifiable computer systems and integrated system development tools have neither the versatility nor throughput to encompass the anticipated applications in data and communication systems, guidance, navigation and control, embedded instrument controllers and processing for related payloads. There is a need for applicable fault tolerance, built-in test, and self-reparability. Fulfilling these needs with demonstrated hardware and development tools is the objective of this work. The DoD Very High Speed Integrated Circuit Technology address throughput directly with increased speed, but also enable increased versatility through technology transparent upgradability, and well as compact, efficient design. The principal objective of this RTOP is introduction of this technology in both the hardware and software systems into NASA programs. Parallel investigation of compatible but more mature device technologies will also be considered to bolster introduction of new computing capability into the initial space station program. Architectural advances will introduce the benefits of parallel computing into space programs. The objective is to provide tailored incremental growth in throughput, adjustable levels of fault tolerance, and ease of application software development. Selection and demonstration of an architecture best suited for the space station will be performed early in the program, including the provision of design and simulation tools to augment applications. Software languages and development tools to support the new system will be provided. A joint LaRC/JPL approach will be pursued, culminating in a contractor assisted demonstration of breadboard hardware in 1986 and brassboard hardware in 1988.

W85-70199 **506-58-13**
Langley Research Center, Hampton, Va.
DATA SYSTEMS RESEARCH AND TECHNOLOGY - ONBOARD DATA PROCESSING
N. D. Murray 804-865-3535

The objectives of the Data Systems Research and Technology activity are to investigate, research, and develop key technologies for the following: (1) real time, very high speed data and information processing onboard spacecraft; (2) high density, high speed data storage for onboard spacecraft; and (3) network architectures, optical nodes, and fiber optics to attain high performance processing, communications, and distribution of information onboard a space station. To address the processing, video image processing in real time is being investigated and developed. The thrust of the onboard data storage activity is the development and demonstration of an advanced memory architecture breadboard for fast access, high density semiconductor memory technology. The network activity is oriented to the development and demonstration of adaptive, high performance network architectures using hybrid optical nodes and fiber optics/wavelength division multiplexing.

W85-70200 **506-58-15**
Jet Propulsion Laboratory, Pasadena, Calif.
INFORMATION DATA SYSTEMS (IDS)
D. B. Smith 213-354-4480
(481-50-85; 506-54-55; 506-64-45)

The objectives of the information data systems RTOP are to develop and validate advanced information technology; develop special purpose, high performance processors; develop advanced high-capacity, high-data storage systems for space and ground systems; and establish and maintain JPL as a center of expertise for information technology systems through infusion of state-of-the-art industrial and DOD technology. In order to implement these objectives, JPL will: work with LaRC, DOD, and industry to deliver a Very High Speed Integrated Circuit (VHSIC) technology general purpose, high speed processor for the core data management system on space station; work with LaRC and industry to develop an all optic node and a 500 mb/sec module for space station fiber optic interfacing to onboard processors; work with DOD and industry to complete research analysis and prototype development of a fault tolerant processor system with high immunity to single event upsets; work with ARC, LaRC, DOD, and industry to develop a symbolic processor and a programmable array processor with one or more giga floating point operations per second for space sensor data processing using wafer scale packaging and VHSIC Phase 2 technology; initiate the development of ultrahigh density storage devices with industry and DOD for onboard and ground data storage applications; work with industry to develop a 6 giga flops advanced digital SAR processor for VRM, Shuttle, and Space Station.

W85-70201 **506-58-16**
Goddard Space Flight Center, Greenbelt, Md.
DATA SYSTEMS INFORMATION TECHNOLOGY
R. W. Nelson 301-344-7809
(506-54-56; 656-20-26)

The data systems information program develops and validates the systems technology which will substantially increase the capability of onboard and ground-based data systems in response to requirements for future NASA missions. Elements of the ongoing program include defining methodologies for the assessment of alternative data system architectures, developing a high-speed optical data bus with flight qualified fiber optic components, advancing the state-of-the-art in onboard smart sensor image data processing and storage with gallium arsenide integrated circuit technology, and extending and applying the high volume data processing capabilities of the massively parallel processor.

W85-70202 **506-58-17**
Lyndon B. Johnson Space Center, Houston, Tex.
DEVELOPMENT OF A MAGNETIC BUBBLE MEMORY SYSTEM FOR SPACE VEHICLES
Peter N. Poulos 713-483-2801

This continuing RTOP effort will evaluate the compatibility of magnetic bubble memory component technology for space vehicle mass memory systems which are presently implemented with electromechanical magnetic tape units. The effort will investigate and resolve system development issues related to multifunction application, systems interfacing, performance capabilities, and space environment compatibility. The activity will utilize the Shuttle/Orbiter magnetic tape mass memory to establish initial system requirements which include a one-for-one replacement that is totally transparent to the Orbiter software system as well as

the electrical and mechanical interfaces. The development effort will be accomplished with the services of an in-house contractor who will deliver a breadboard package for Orbiter integration and functional verification and a flight prototype package that will be utilized in the in-house Space Station test bed for functional and system requirements verification.

W85-70203 **506-58-18**
Lyndon B. Johnson Space Center, Houston, Tex.
TESTING AND ANALYSIS OF DOD ADA LANGUAGE FOR NASA
J. Garman 713-483-2851

This proposal is to establish a joint effort between the Lyndon B. Johnson Space Center (JSC) and the High Technologies Laboratory of the University of Houston at Clear Lake City (UH/CLC) to perform studies and analysis of the software technology products being produced by the Department of Defense (DOD) under the name ADA, A registered trademark of the United States Government (ADA Joint Project Office). The objective of this effort is cooperating with the Department of Defense in their request for NASA participation in their field test efforts with ADA, and, in support of NASA Headquarters to produce a plan for agency transition to the ADA technologies in future NASA projects. The effort proposed is an integral part of several advanced program activities being pursued or undertaken at JSC. This effort involves both the use and evaluation of ADA compiler systems, and the planning and evaluation of their applicability and implementation in NASA flight systems as a standard.

W85-70204 **506-58-19**
Marshall Space Flight Center, Huntsville, Ala.
DATA SYSTEMS TECHNOLOGY PROGRAM (DSTP) DATA BASE MANAGEMENT SYSTEM AND MASS MEMORY ASSEMBLY (DBMS/MMA)
D. T. Thomas 205-453-0677

The objective of this RTOP is to develop a ground data base management and archival system to demonstrate high-rate data ingest, automatic cataloging, and real-time archiving of large volumes of packetized sensor data. The catalog, sensor data, and other on-line space information would be available to local and remote users in near real-time. High rate ingest, up to 50M bits/second, is achieved by the use of a fiber optic data bus driven by laser diodes and an architecture that bypasses conventional computer channels. The on-line archival system is an optical disk recorder/reader capable of recording and reading digital data at 50M bits/second and storing 8 x 10 to the 10th power bits per fourteen inch disk with a total volume of 10 to the 13th power bits. Recording at high density is achieved by the use of a laser as the energy source.

W85-70205 **506-58-22**
Lewis Research Center, Cleveland, Ohio.
SATELLITE COMMUNICATIONS RESEARCH AND TECHNOLOGY
R. E. Alexovich 216-433-6689
(506-54-12; 650-60-20; 650-60-21; 650-60-22)

The objective is to provide (through research, design, and experimental tests) the components, subsystems and enabling technology required to support NASA satellite communications systems. To achieve this objective, advanced research and development programs will be conducted to identify, produce, and demonstrate critical components, techniques, and subsystems required for complete communications systems. Principal emphasis will be directed toward spacecraft microwave electron beam amplifiers with increased power output, linearity, efficiency, high frequency capability, and long life; multi-frequency, multibeam antennas providing increased frequency reuse at higher frequencies; and solid state materials and component technology for high frequency spacecraft applications, such as switching, power amplification, and beam forming.

W85-70206 **506-58-23**
Langley Research Center, Hampton, Va.
MULTIPLE BEAM ANTENNA TECHNOLOGY DEVELOPMENT PROGRAM FOR LARGE APERTURE DEPLOYABLE REFLECTORS
Thomas G. Campbell 804-865-3631
(506-62-43)

The overall objective of this RTOP is to specifically address the development of multiple beam antenna technology and analysis methods that are critically related to the technology development activities for large space antenna concepts presently funded by OAST. The development of multiple beam feed technology that is specifically related to the large aperture antenna development will eventually provide NASA the capability of predicting the total antenna system performance characteristics for a wide range of mission applications (communication, radiometer, and radio astronomy). Primarily, this activity shall provide a top level basis for determining the effectiveness of large offset reflector systems (with up to 200 beams) that are presently being considered for communications and radiometer near-term and far-term missions. Tasks to be accomplished include: (1) the development of the feed requirements for communication and radiometer missions for multiple beams and multiple apertures; (2) antenna configuration design for the point design; (3) multiple beam antenna feed point design; and (4) derivation of secondary illumination and multiple beam contour for co-polar and cross-polar plots, spherical near-field testing using subscale models.

W85-70207 **506-58-25**
Jet Propulsion Laboratory, Pasadena, Calif.
DEEP SPACE AND ADVANCED COMSAT COMMUNICATIONS TECHNOLOGY
J. F. Boreham 818-354-4107
(650-60-15)

This RTOP represents two major technology areas in the space communications development effort, namely: (1) Deep Space Communications Technology (DSCT); and (2) Advanced Communications Satellite Technology (ACST). The objectives are to develop communications system components technology to support Earth-Space-Earth data distribution/transfer requirements of NASA's future deep space missions and advanced Comsat type missions to insure the continued U.S. preeminence in space communications. The objectives in the DSCT area center around the development of 3 to 10 watt X- and Ka-Band Solid State Power Amplifiers and new technology for the X-Band Transponder; while in the ACST area they center around large multibeam antenna technology development. Specifically, during FY-85/FY-86 a new design and engineering model of the X-Band Solid State Power Amplifier (XSSPA) will be developed. A redesign has been necessitated by changed first user (MMII) objectives (5W output vs. 10w) and the failure of the previously selected FETs to meet flight quality and reliability standards. The major X-Band Transponder development, partially supported under this RTOP, involves the development and transfer of certain new technology items such as a custom LSI digital phase lock loop and dielectric resonator stabilized, phase locked, high order multipliers. These items will be completed and demonstrated in a verification breadboard transponder in FY'85. In the ACST area, specific objectives include: continued software development for identification and compensation methods for reflector surface errors; continue development of antennas and feeds for multibeam applications; develop ground and in-flight RF measurement techniques for large spaceborne antennas; and develop low sidelobe dual shaped reflector systems.

W85-70208 **506-58-26**
Goddard Space Flight Center, Greenbelt, Md.
LASER COMMUNICATIONS
J. B. Abshire 301-344-8948
(506-58-26; 650-60-26)

This RTOP will develop and demonstrate advanced transmitter and receiver technology required for high performance laser communication systems. Such systems will be required for future

high speed intersatellite communication. This program has two specific objectives. The emphasis of the effort is on the development of high performance laser transmitter modules, which are suitable for use in high data rate communication systems. In a parallel effort, research will also be carried out in advanced receiver technology. Both advanced solid-state detectors and optically coherent communications will be addressed, since both can significantly increase system detection sensitivity. The high-power laser research will concentrate on the development of phase-locked laser diode arrays. Research will primarily address improving the far-field beam quality under modulated conditions. Other promising approaches, such as large optical cavities, non-absorbing mirrors, and external resonators will also be pursued. In the receiver area the emphasis will be on developing advanced low noise avalanche photodetector and preamplifier combinations. A parallel effort will investigate the performance versus complexity tradeoffs and the current state-of-the-art in optically coherent communications.

Chemical Propulsion Research and Technology

W85-70209 **506-60-10**
National Aeronautics and Space Administration, Washington, D.C.
CHEMICAL PROPULSION RESEARCH AND TECHNOLOGY INTERAGENCY SUPPORT
F. Stephenson 202-453-2860

The primary objective of this activity is to maintain a continuous up-to-date information gathering capability on the nation's total chemical propulsion technology efforts as an aid in planning and implementing the NASA program. In addition, joint interagency tasks are undertaken when appropriate, such as publishing handbooks, manuals or computer models, that will be beneficial to the propulsion community as well as other potential users. The approach is to share support of the Chemical Propulsion Information Agency (CPIA), which supplies information gathering and dissemination services, with the DOD agencies through the Joint Army, Navy, NASA, Air Force (JANNAF) Interagency Propulsion Committee. For special interagency tasks, funding is transferred to the agency designated as responsible for the procurement action and contract monitoring.

W85-70210 **506-60-12**
Lewis Research Center, Cleveland, Ohio.
EARTH-TO-ORBIT PROPULSION LIFE AND PERFORMANCE TECHNOLOGY
S. H. Gorland 216-433-5113
(553-13-00)

The driver for future Earth-to-orbit launch vehicles will be advanced high pressure liquid rocket engines used for the main propulsion system. These propulsion systems will have to provide the lowest possible life cycle costs while meeting the needs of all potential users. The objective of this program is to extend the existing technological base established by the SSME and older hydrocarbon fueled engines to provide the knowledge for reusable, long life, serviceable, high performance engine systems using either hydrogen-oxygen or hydrocarbon oxygen. This effort will concentrate on thrust chamber cooling and life enhancement, critical turbomachinery components including bearings, seals, turbine blades, rotordynamics, diagnostic techniques, and improved materials. This work will be accomplished through studies, analytical models, fundamental subscale testing, and correlation of all inputs.

W85-70211 **506-60-19**
Marshall Space Flight Center, Huntsville, Ala.
REUSABLE HIGH-PRESSURE MAIN ENGINE TECHNOLOGY
S. F. Morea 205-453-3710
(506-60-12)

The objective of this RTOP is to investigate advanced reusable booster engines required for Earth-to-Orbit application. The overall objectives are to advance the technology base for future oxygen/hydrocarbon and oxygen/hydrogen booster engines and advance the technology in support of future Space Shuttle Main Engine (SSME) improvements. Technology for advanced high-pressure oxygen/hydrocarbon rocket engines for booster application is being pursued and includes single-fuel, dual-fuel and dual nozzle concepts. These activities include engine power cycle synthesis, parametric data generation, component performance prediction and evaluation, and combustor cooling investigations. These efforts include a data screening, analysis, computer modeling, hardware design and fabrication, data evaluation and test. As the SSME program approaches operational status, specific technology activities are required for resolution of persistent trouble areas and for improving life and reducing operating cost. The effort necessary to accomplish these objectives is defined in the Advanced Research and Technology Plan, rev. TBD. The areas of investigation are basic in nature and are supportive of future SSME uprating and definition of advanced lox/hydrogen engines.

W85-70212 **506-60-22**
Lewis Research Center, Cleveland, Ohio.
ONBOARD PROPULSION
S. H. Gorland 216-433-5113

The objective of this effort is to provide advanced component and systems technology for onboard propulsion applications such as the space station, and space platforms, as well as spacecraft and vehicle auxiliary propulsion systems. The accomplishment of this objective would provide the Agency with auxiliary propulsion systems that would meet the performane requirements while minimizing propulsion system mass or reduce propellant resupply. These propulsion systems would also minimize potential contamination of other onboard subsystems and/or scientific instruments and operate intermittently and reliably for many years. The systems to be investigated will be analyzed to determine the appropriate concept for each application and to define the technology requirements. Consideration will be given to evolution potential and to benefits from integration with other onboard subsystems. Multi-use components will be designed, fabricated and tested for long life reliability, maintainability and broad operating range. Health monitoring and diagnostics will be included at both the component and systems levels.

W85-70213 **506-60-42**
Lewis Research Center, Cleveland, Ohio.
VARIABLE THRUST ORBITAL TRANSFER PROPULSION
S. H. Gorland 216-433-5113

The objective is to provide technology for improving performance, life and reusability of future highly versatile liquid chemical rocket engines in order to greatly extend mission capability and flexibility in performing orbital operations reliably and at reduced operating costs. The propulsion systems that will be investigated include a highly versatile, space based, throttled, reusable, and maintainable high thrust rocket engine and a high performance low-thrust expendable rocket engine. Emphasis of the work will be on: combustion, cooling and heat transfer; performance enhancements; long life bearings and seals; lightweight reusable components; small high performance combustors and pumps; high expansion area nozzles; and propellant management.

W85-70214 **506-60-49**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED ORBITAL TRANSFER PROPULSION
R. J. Richmond 205-453-3710
(506-60-42)

The objective of this RTOP is to investigate advanced reuseable oxygen/hydrogen engines required for future orbit-to-orbit vehicles. The activities described include high area ratio nozzle technology identification and acquisition and component and system performance prediction model improvement. These efforts include concept definition, preliminary design, analysis, computer modeling, hardware fabrication, test and data evaluation.

Spacecraft Systems Research and Technology

W85-70215 **506-62-21**
Ames Research Center, Moffett Field, Calif.
SPACECRAFT SYSTEMS ANALYSIS - STUDY OF LARGE DEPLOYABLE REFLECTOR
B. L. Swenson 415-965-5705
(159-41-01; 506-54-21; 506-53-41)

The objective of this RTOP is to carry out systems studies, analysis, and trades and simulations, both in-house and under contract to support NASA space science objectives in astrophysics and planetary probe/penetrator missions. In particular, current emphasis will be placed on the refinement and development of concepts for a large deployable reflector (LDR) in space. The LDR will be a free-flyer with an aperture greater than 10 m to support astrophysical and astronomical investigations in the infrared and submillimeter wavelength regimes. The effort supported by this RTOP is aimed at providing the preliminary systems analysis and programmatic planning preparatory to a major LDR technology initiative by OAST, planned to be started in FY-87. The effort involves two major contracted studies, jointly supported by OSSA, to examine many overall system and subsystem issues; define representative design concepts; assess the readiness of technology to support the implementation of LDR by 1990; and develop a technology development plan to remedy major technology deficiencies to allow implementation of LDR with confidence and minimum risk. Concurrent with those studies, complementary efforts will be supported at other Centers where particular expertise resides.

W85-70216 **506-62-22**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATION SATELLITE SPACECRAFT BUS TECHNOLOGY
K. A. Faymon 216-433-5241

The objective of this RTOP is to identify, assess, and prioritize high-leverage enabling and enhancing technologies for communication satellite spacecraft buses of the mid 1990's; and to formulate a long-range technology development plan which defines enabling technology appropriate for development by NASA. The approach provides for a LeRC in-house effort to establish advanced spacecraft bus requirements, identify concepts and technologies to meet these requirements and conduct system and discipline trade studies in order to assess/evaluate potential payoff of identified technologies. Contracted studies will be conducted to verify and augment in-house studies. The results from the above efforts and recommendation of industry will be used to develop a long range technology development plan. A forum for a continuing government/industry dialog on enabling technologies will be established.

W85-70217 **506-62-23**
Langley Research Center, Hampton, Va.
ADVANCED SPACECRAFT SYSTEMS ANALYSIS AND CONCEPTUAL DESIGN
L. S. Keafer 804-865-3666

The technical objectives are to continue research to define requirements and to quantify concept performance of advanced large space systems, to develop plans for an initiative in spacecraft technology and to ensure portability of IDEAS capabilities by updating computer programs and data bases. The approach toward each objective involves in-house leadership in focusing large space systems and spacecraft research and in defining analysis tasks, contractor system studies and detailed analysis and conceptual design support, and complementing in-house analyses, conceptual designs, comparisons, and evaluations.

W85-70218 **506-62-25**
Jet Propulsion Laboratory, Pasadena, Calif.
PLANETARY SPACECRAFT SYSTEMS TECHNOLOGY
Kerry Nock 818-354-2153

The objective of this RTOP is to identify, refine and evaluate the spacecraft systems requirements for planetary missions with emphasis on sample return missions. The aproach will be to update and expand the planetary technology initiative material prepared in FY '84 (Planetary Technology, JPL Document D-1537, dated June 6, 1984) and the joint OSSA/OAST planetary technology plan concentrating on technology requirements for sample return missions. Established elements will be built upon, (particularly studies of Mars Sample Return and rover, and other sample return missions), generate quantitative technology performance requirements for sample return missions. Various concepts for comet nucleus sample acquisition and preservation will be evaluated. The ability of various technological approaches to meet the technology performance requirements in terms of mission risk (e.g., resilience to off-nominal conditions), development risk (e.g., current status vs. eventual needs), and cost (non-recurring and recurring) will be assessed. Specific technologies to be addressed include: sample identification, acquisition, cataloging, preservation and handling for Mars surface, and comet nucleus.

W85-70219 **506-62-26**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED EARTH ORBITAL SPACECRAFT SYSTEMS TECHNOLOGY
P. A. Studer 301-344-5229

The objective of this program is to identify, coordinate, and organize technological advances which will achieve and enhance future Earth orbital mission objectives. The needs of planned and projected missions will be reviewed and compared on a time-line basis with the development cycles of emerging technologies with identifiable potential and applicability to space operations. Cross-fertilization of technological skills and techniques from areas of subsystem expertise will be promoted. Technological advances within and outside the Agency will be tracked and transmitted between subsystem disciplines. Included is the definition and progressive updating of a system technology development plan. An interdisciplinary total spacecraft systems approach to development tasks is the goal. The approach will be to work basically from future mission requirements. Vital technology needs areas will be identified, the state and pace of their development charted, and results directed to parallel subsystem developments and eventually flight programs in their earliest phases. This approach will avoid duplication and more efficiently utilize resources by transfer of developments and techniques between on-going subsystem specialists and through the communication of accomplishments from research centers to flight system designers. The impact of upcoming technology advances on future mission planning will be assessed and communicated to minimize the lag in systems development and deployment. The primary focus will be on generic elements with broad and continuing functional applications of value to NASA, other government agencies, and the United States aerospace industry.

W85-70220 **506-62-42**
Lewis Research Center, Cleveland, Ohio.
SPACECRAFT TECHNOLOGY EXPERIMENTS (CFMF)
E. P. Symons 216-433-6736

The broad objective of the Cryogenic Fluid Management Program is to provide the technology base to enable the design of efficient systems for the management of cryogenic fluids in the space environment including storage, acquisition (positioning) and fluid transfer. This RTOP covers only the Cryogenic Fluid Management Facility (CFMF) which will be developed as a reusable test bed to be carried into space in the STS Orbiter Payload Bay on an MDM Pallet. Plans are to develop the CFMF for seven mission life. The CFMF will consist of two tanks: a storage and supply tank and one of two different size receiver tanks depending upon mission. The two tanks are connected by a transfer line and the operations are normally controlled by a preprogrammed dedicated on-board microprocessor. Other elements of the total Cryogenic Fluid Management Program are being performed at JSC, MSFC, and GSFC and this work is described in RTOP 506-64-42.

W85-70221 **506-62-43**
Langley Research Center, Hampton, Va.
SPACE TECHNOLOGY EXPERIMENTS-DEVELOPMENT OF THE HOOP/COLUMN DEPLOYABLE ANTENNA
T. G. Campbell 804-865-3631

The overall objective of the RTOP is to specifically address the technology development of large deployable reflector technology through the development of the hoop/column antenna concept. The technology development activities will reach a significant milestone as the 15-meter model of the hoop/column concept will be completed in FY-85. This model will then serve as a structural kinematics model and provide verification of the design in terms of deployment kinematics, deployment, reliability failure modes investigation, surface interaction, manufacturing tolerances and scaling. This model will also permit the comparison of a manufactured surface shapes with the prebuilt analytical projection of that surface shape. In addition, the 15-M model will be used in a RF test in a planar near field facility.

W85-70222 **506-62-45**
Jet Propulsion Laboratory, Pasadena, Calif.
LARGE SPACE STRUCTURES GROUND TEST TECHNIQUES
R. E. Freeland 818-354-3540
(481-50-35)

The long-range objective of this RTOP is to develop new techniques for ground based testing of large, very flexible space structures. The technical approach is to utilize the extensive data base developed during the design, fabrication, assembly and ground based testing of the full-size hardware models for the wrap-rib antenna concept development. The results of current static and dynamic testing for a number of different boundary conditions for the same basic antenna structure will be correlated with analytical predictions to determine the extent of testing required to adequately characterize this class of large space hardware. Additionally, the manufacturing variations on full-sized, lightweight space hardware which have been experimentally determined, will be used analytically to establish the sensitivity of hardware deviations on structural system performance. The activities in this RTOP will be coordinated with NASA Headquarters, other NASA centers, the NASA Space Station Technology Steering Group, the Space Systems Technical Advisory Committee (SSTAC), the NASA Space Station Test Bed activities at MSFC, and the NASA LaRC Space Technology Experiments Program (STEP).

Transportation Systems Research and Technology

W85-70223 **506-63-23**
Langley Research Center, Hampton, Va.
TECHNOLOGY REQUIREMENTS FOR ADVANCED SPACE TRANSPORTATION SYSTEMS
J. P. Arrington 804-865-3911
(506-51-13)

The objective of this RTOP is to identify, justify, and prioritize high-leverage enabling and enhancing technologies for both current evolutionary and future new space transportation systems. This includes the projection of future transportation needs, the characterization of potential future mission and economic capabilities based on the design of advanced concepts, and the assessment of technology impacts on desired transportation attributes. The approach focuses on the total transportation system, including both Earth-to-orbit and orbital transfer vehicles, which operate primarily within the geosynchronous sphere. The intent is to build on the Space Shuttle technologies which enhance the current Space Transportation System (STS) and enable new systems which have significant cost and/or capability advantages when they will be required as a second generation STS. Technology areas of particular interest include: composite and thermal protection materials, propulsion systems, structural design, aerothermodynamics, design integration, advanced flight control, and automated operations. This activity will be pursued through in-house system studies, selected in-house assessments, contracted system assessments, and intercenter reviews. This RTOP also supports the continuing enhancement of in-house computer-aided design systems that provide the ability to assess alternative approaches for transportation systems through conceptual design studies.

W85-70224 **506-63-24**
Langley Research Center, Hampton, Va.
ENTRY RESEARCH VEHICLE FLIGHT EXPERIMENT DEFINITION
J. P. Arrington 804-865-3911
(506-63-23; 506-51-13)

The objective of this RTOP is to develop the technical advocacy for an entry research vehicle flight experiment program. This is envisioned as a joint NASA/Air Force program with NASA using the flight experiment to advance technology for future space transportation systems and the Air Force using the experiment to demonstrate an operational capability. The flight experiment definition will require the identification of experiments that will provide the technology base for the development of future transportation systems and the definition of the flight center responsibility for the entry research vehicle flight experiments. The Langley Research Center has the lead center responsibility for the entry research vehicle flight experiment program with support from the Ames Research Center in the TPS and aerothermodynamics areas. The program definition activity will be coordinated with the Air Force Flight Dynamics Laboratory to develop a joint NASA/Air Force advocacy. The entry research vehicle flight experiment will provide flight data to advance technology for the development of future entry vehicles capable of maneuvering in the atmosphere. Availability of entry flight data will allow reduction of vehicle design margins enabling the development of an operational vehicle with maneuvering entry and atmospheric plane change capability. A multidisciplinary analysis will be made to identify technology deficiencies for the development of future space transportation systems and to identify flight experiments which will provide data necessary to establish technology readiness for these systems. Once the high payoff experiments have been identified in the aerothermodynamics, structures, TPS, flight control, navigation and guidance technology areas, trajectory will be made. Results from the experiment definition will be used to define a flight research vehicle capable of accommodating the experiments and demonstrating viability of advanced vehicle design features. The entry research vehicle program will be defined in sufficient detail to accurately estimate DDT & E costs.

W85-70225 **506-63-29**
Marshall Space Flight Center, Huntsville, Ala.
CONCEPTUAL CHARACTERIZATION AND TECHNOLOGY ASSESSMENT
R. E. Austin 205-453-0162

Transportation systems technology will be evaluated to focus and analyze technology requirements for advanced transportation systems, Earth launch vehicles, orbit-to-orbit vehicles, etc. Aeroassist is a technological capability that has a potential ranging from significant mission enhancement (Orbit Transfer Vehicle-OTV) to mission enabling (some planetary orbiters and DOD). Prior studies have shown that significant performance benefits can be realized by using an aerodynamically assisted insertion into an orbit (planetary and low Earth). This RTOP covers a multi-year aeroassisted system technology activity that will evaluate generic aeroassisted OTV system concepts and a focused OTV technology readiness program for the initial system that has a target completion in FY-88. During the initial period of the development of the Aeroassist Flight Experiment, critical technology risk areas require detailed definition and approaches for their resolution.

W85-70226 **506-63-31**
Lyndon B. Johnson Space Center, Houston, Tex.
OEX (ORBITER EXPERIMENTS) PROJECT SUPPORT
J. D. Harris 713-483-5814

The program objective is to collect data in the technology disciplines that will augment the research and technology base

for future spacecraft design utilizing the Space Shuttle as a research vehicle. Flight data relative to these disciplines will be collected by utilizing the currently planned TFI/MADs configuration, by modifications and/or augmentations to the DFI baseline instrumentation and by development of unique experiments compatible with the operational capabilities for flight on the Orbiter. Studies will be conducted to determine the optimum method of utilizing the Shuttle system to conduct research and technology. These studies will be augmented by investigations to develop experimental programs that would obtain research and technology data in flight regimes applicable to advanced space transportation systems. The primary goal of these studies is more efficient utilization of the STS capabilities to obtain data required to advance the current state of spacecraft technology. This RTOP includes the effort associated with overall project management, project support, experiment development initiation, experiment compatibility assessments, experiment integration activities and integration hardware development initiation. The experiment development efforts is the subject of additional RTOP's from the appropriate NASA Centers.

W85-70227 **506-63-32**
Langley Research Center, Hampton, Va.
SHUTTLE ENTRY AIR DATA SYSTEM (SEADS)
P. M. Siemers 804-865-3984
(506-51-13)

The purpose of this RTOP is to extend the knowledge of aerodynamics, aerothermodynamics and basic fluid mechanics into flow regimes previously inaccessible to the investigator through extraction of flight data during routine operation of the Shuttle Orbiter. This knowledge will be applied to verify and increase the reliability of sophisticated computational prediction codes, to develop procedures to extrapolate wind-tunnel data to flight conditions, to improve the performance and operational capability of the STS, and to prove a data base for studies of future aeronautical and aerospace vehicles. The design, development, calibration, and demonstration of the flush orifice Shuttle Entry Air Data System will be accomplished through inhouse (LaRC) analysis and test programs, and contracted studies. A retrofitted instrumented nose cap, incorporating the flush orifice Shuttle Entry Air Data System, will obtain flight data which, when reduced, will produce the required air data parameters for each orbiter flight.

W85-70228 **506-63-34**
Langley Research Center, Hampton, Va.
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING (SILTS)
E. V. Zoby 804-865-2707

The goal of this RTOP is to extend the knowledge of the basic aerothermodynamics of leeside flow fields and heat transfer on large lifting vehicles into flow regimes which are inaccessible to investigations in ground facilities through sensing with an infrared scanner of leeside surface temperatures during Shuttle Orbiter entry. These data will permit development of improved leeside flow-field and heat-transfer prediction techniques which are required to reduce considerably the weight and cost of thermal protection systems on the leeside of future space vehicles. The SILTS experiment will be flown on a number of orbiter flights beginning this fiscal year.

W85-70229 **506-63-36**
Goddard Space Flight Center, Greenbelt, Md.
DYNAMIC, ACOUSTIC, AND THERMAL ENVIRONMENTS (DATE) EXPERIMENT (TRANSPORTATION TECHNOLOGY VERIFICATION--OEX PROGRAM)
W. F. Bangs 301-344-7669
(323-52-42)

The DATE Experiment, one of the OAST OEX (Orbiter Experiments) group of STS flight experiments are: first, the development and validation of advanced technology for prediction of dynamic, acoustic, and thermal environments and associated payload responses in cargo areas of large reusable space vehicle; and the second is providing data for immediate application in payload design and verification activities. DATE plans to use environmental data from approximately 15 early Shuttle flights in support of these technology efforts. The early Shuttle flights represent an unusual opportunity to obtain the particular types and quantities of data that are suitable for implementing the DATE Program, but would not be included in the environmental data normally acquired for operational purposes. Repeated measurements are necessary to account for payload, orbiter, and launch site variations. DATE has accomplished its partial objectives with flight experimental data obtained and reports generated from flights STS-1 through STS-5 and an OASIS system ready for integration. In FY-85, the objectives will be to continue integration support of calibrated qualified instrumentation, data analysis, and generation of flight reports for flights of opportunity. Funding resources and programmatic considerations will determine types and number of flights (but planning is based on 4 for FY-85. This program is planned to be a joint funded effort between OAST and USAF.

W85-70230 **506-63-37**
Langley Research Center, Hampton, Va.
SHUTTLE UPPER ATMOSPHERE MASS SPECTROMETER (SUMS)
R. C. Blanchard 804-865-3984

The primary technological objective is to provide flight data for advances in the prediction of aerodynamic behavior throughout the high-speed flight regime, including the free molecular flow and the transition into hypersonic continuum. This objective will be achieved through shuttle orbiter flight instrumentation, including a Shuttle Upper Atmosphere Mass Spectrometer (SUMS). The specific objective of the SUMS system is to provide in situ high altitude atmospheric data, primarily neutral atmospheric mass density measurements. A spare Viking flight-qualified mass spectrometer will be modified to provide atmospheric data in the rarefied flow flight regime. These data, coupled with data from other proposed experiment systems, will provide aerodynamic information on a winged entry vehicle in flight regimes heretofore unobtainable and will augment ground-based test facilities. In addition, experiment results on the shuttle will provide a benchmark from which to evaluate additional entry technology research. The design, construction, and system tests of the prototype Shuttle Upper Atmosphere Mass Spectrometer (SUMS) and the supporting analysis on the SUMS system design and implementation will bring the experiment to the flight readiness state.

W85-70231 **506-63-39**
Ames Research Center, Moffett Field, Calif.
OEX THERMAL PROTECTION EXPERIMENTS
H. E. Goldstein 415-965-6103
(506-53-31; 506-51-11; 506-51-41)

The overall objective of these experiments is to obtain a better understanding of thermal protection system (TPS) reentry heating effects that may permit TPS cost and weight reductions for the current Shuttle and for advanced aerospace vehicles. Three separate experiments will be flown as test panels or tiles replacing baseline TPS on the Shuttle Orbiter on operational flights. These experiments will take advantage of the actual entry heating environment that cannot be fully simulated in ground facilities to investigate TPS heating effects and to demonstrate advanced TPS materials for possible Orbiter retrofit and for application to advanced vehicles. Data will be obtained with existing and follow-on Orbiter instrumentation. Baseline TPS procedures and tooling will be used to the maximum practical extent, and none of the experiments will impact Orbiter operations. The experiments will be designed, developed and fabricated through both in-house and contracted efforts, and experimental hardware will be provided as government furnished equipment.

W85-70232 **506-63-40**
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE ORBITER FLYING QUALITIES CRITERIA (OEX)
D. T. Berry 805-258-3311

The objective of this RTOP is to use experience with high-

performance aircraft to establish handling qualities criteria, for the atmospheric flight phases of Space Shuttle. With the opportunity of test data from the Orbiter flights, the adequacy of the existing criteria can be evaluated to establish validated criteria to support the development of second generation Orbiters, and other advanced aerospace vehicles. Pilot comments and ratings will be obtained for essential tasks throughout the reentry and landing phases of the Orbiter flight tests, and correlated with vehicle characteristics obtained from analysis of stability and control maneuvers. These data will be used to validate simulation and analytical studies.

W85-70233 **506-63-43**
Langley Research Center, Hampton, Va.
HIGH RESOLUTION ACCELEROMETER PACKAGE (HIRAP) EXPERIMENT DEVELOPMENT
R. C. Blanchard 804-865-3984

The primary objective is to provide accurate measurements of low level aerodynamic acceleration along the shuttle orbiter roll, pitch, and yaw axes in the rarefied flow flight regime. This flight data supports advances in the prediction of aerodynamic behavior of winged entry vehicles in the high-speed, low density flight regime, including the free molecular flow and the transition into the hypersonic continuum. The data provides for the direct measurement of the lift-to-drag in the rarefied flow flight regime. An orthogonal triaxial set of linear accelerometers is mounted on the existing Orbiter Experiment (OEX) ACIP/PCM mounting shelf. Hardware development and integration aspects are accomplished by NASA/JSC, OEX Project Office under a modification to current ACIP-I development. Studies under this RTOP will be performed to support modification to the design, and calibrations of the HiRAP in order to achieve experiment objectives. In addition, data reduction algorithms will be designed, tested and applied on multiple flights of the HiRAP.

W85-70234 **506-63-44**
Jet Propulsion Laboratory, Pasadena, Calif.
SHUTTLE PAYLOAD BAY ENVIRONMENTS SUMMARY
D. Kern 818-354-3158

The objective of this task is to validate STS payload bay dynamic and thermal environments prediction models and test methods to provide the STS payload community with the basis for derivation of realistic dynamic and thermal environments design and test criteria for STS-launched payloads. The approach will be to conduct engineering analyses of the STS payload bay flight dynamic and thermal data; summarize the data; publish the summary and conclusions reports at appropriate intervals; and obtain, reduce, and evaluate the flight data from the low and mid frequency response accelerometers for the Galileo spacecraft.

Platform Systems Research and Technology

W85-70235 **506-64-12**
Lewis Research Center, Cleveland, Ohio.
SYSTEMS ANALYSIS-SPACE STATION PROPULSION REQUIREMENTS
Martin E. Valgora 216-433-6983
(506-50-42; 506-55-22)

The objective of this effort is to define and develop system level technology requirements for advanced chemical and electrical propulsion systems and define power system impacts on propulsion applicable to the space station mission including the core station, platforms, free flyers and service vehicles. These studies will develop a generic technology/benefits data base to assist in guiding decisions on which propulsion technologies have the highest potential with emphasis on the growth/evolutionary Space Station. These studies will determine major propulsion drivers; performance requirements; identify system constraints; estimate cost, weight and size of potential propulsion systems; identify new technology needs; determine benefits and provide data to identify priorities of proposed technology programs.

W85-70236 **506-64-13**
Langley Research Center, Hampton, Va.
TECHNOLOGY SYSTEM ANALYSIS ACROSS DISCIPLINES FOR MANNED ORBITING SPACE STATIONS
L. J. DeRyder 804-865-2486

The objectives of this effort are to develop capabilities for and to conduct system optimization trade studies crossing subsystems in order to determine the maximum system-level improvements that could result from alternative designs, components, and advanced technologies for permanently orbiting space stations. System analyses and interdisciplinary interaction sensitivity studies will be performed in order to identify technology drivers and priorities for high leverage technology programs. Techniques of analysis and optimization identifying advanced technology satisfying modular, evolutionary, on-orbit growth and the national need for improved performance and reduced life cycle costs will be developed along with emulation/simulation models for providing early functional knowledge of critical input/output parameters and system failure modes leading to improved design and reduced costs. Finally, analytical capabilities to assess life cycle cost benefits derived from improved technology options will be developed.

W85-70238 **506-64-15**
Jet Propulsion Laboratory, Pasadena, Calif.
AUTONOMOUS SPACECRAFT SYSTEMS TECHNOLOGY
Philip R. Turner 818-354-5643
(506-64-18)

This RTOP will concentrate upon the system-level technology and methodology of autonomous control of spacecraft, with the Space Station as the primary example mission. System control architectural concepts and related technology areas identified in FY-84 will be a point of departure for the continuing effort. Efforts will concentrate on the following major lines of investigation: (1) The architectural concept developed for autonomous control will be examined for specific applications of space station interest. Particular attention will be applied to identifying potential applications of automation/autonomy that would benefit from machine intelligence/expert systems technology. Additional work will address the differentiation between conventional control system design and changes needed to accommodate autonomy/automation. (2) The man/machine trade-off methodology effort of FY-84 will be extended with conceptual design efforts applied to selected functional areas. The design efforts will clarify some specific implementation methods and develop specific cost estimates for comparison with projected productivity benefits. (3) A proposed methodology for implementation of expert systems as a

combination of hardware logic co-processor and firmware/software will be examined for potential benefits in autonomous control applications. (4) Autonomous rendezvous guidance technology will be developed as an application. (5) Software technology applicable to autonomous control will be examined for significant impacts on the design and implementation of operational systems.

W85-70239 **506-64-17**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION DATA SYSTEM ANALYSIS/ARCHITECTURE STUDY
William E. Mallery 713-483-3066

This task will develop system architecture design and implementation strategies for the Space Station data system (SSDS). This will be accomplished through a system design process consisting of: (1) the definition and characterization of Space Station information system (SSIS) functions in sufficient depth to identify SSDS requirements; (2) the identification and evaluation of technology, design, and management options; and (3) trade studies which investigate the inter-relationships between major SS programmatic issues and options, program goals and objectives, and technology and design options. The derived system design and implementation planning will be periodically updated in response to programmatic developments, requirements changes, and other development information which occurs during the contract period of performance.

W85-70240 **506-64-19**
Marshall Space Flight Center, Huntsville, Ala.
SPACE SYSTEMS ANALYSIS
R. E. Jewell 205-453-0436
(506-62-49; 542-03-04)

This RTOP is comprised of two tasks, each addressing specific target areas within the Space Systems Analysis objective, described below. Task 01, System Trade Analyses, is a systems analysis effort to define technology to enhance the performance capability, reduce the development, and lower the cost of the early and the advanced space stations. Specifically, the effort consists of system trade analyses of selected areas of the space station which offer high potential for cost effective improvements. Task 02, Solar Array Flight Experiment (SAFE) Dynamics Augmentation Experiment (DAE), is to develop and demonstrate the technology readiness of on-orbit remote sensing of large space structure dynamic response and the analysis of the response to obtain the structural dynamic characteristics of frequency, damping, and mode shapes.

W85-70241 **506-64-23**
Langley Research Center, Hampton, Va.
ON-ORBIT OPERATIONS MODELING AND ANALYSIS
A. J. Meintel, Jr. 804-865-2489
(506-54-63; 506-57-23)

The objective of this effort is to develop modeling and simulation analysis tools for the evaluation of on-orbit space station operations. One simulation will determine the viability of reducing space station on-orbit operations costs by developing an operations simulator capable of both analyzing the interaction among crew activities, performance, and automation and predicting the associated manpower and resource costs. The second simulation analysis tool will evaluate teleoperator and robotic systems capable of remote space operations. It will allow evaluation at the systems level, subsystems and components and identify high leverage areas requiring research to enable remotely controlled manipulator systems which outperform direct human manipulation. An operations simulation model and data base for space station on-orbit operations man power and resource assessment will be developed, installed and evaluated. The model will include the capability of evaluating the impact of subsystem design and operational requirements on long-term operational costs. A Teleoperator and Robotic System Simulation (TRSS) has been implemented and coupled to a manned control station for system level integration and analysis of remotely-controlled vehicles capable of space operations. The output of TRSS will supply specifications for the design, construction and testing of remote systems.

W85-70242 **506-64-25**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED THERMAL CONTROL TECHNOLOGY FOR CRYOGENIC PROPELLANT STORAGE
D. G. Elliott 818-354-3486

The objective of this RTOP is to determine what technology is needed for the long-term storage of cryogenic propellants in space, and to outline a technology program for improvement of passive and active refrigeration methods for space station cryogenic storage. The FY-85 objective is to analyze the size, weight, and power requirements of alternative refrigeration methods, including passive methods, and determine the benefits of possible technology improvements. The cryogenic storage capability potentially available from passive and active cooling methods will be calculated from basic characteristics of insulation materials, refrigeration methods, and space station environment. The capability of present insulation and refrigeration methods will be reviewed. Key technology improvements needed for long term cryogenic storage will be identified. The required elements of a technology program for improving passive and active cooling methods will be determined.

W85-70243 **506-64-26**
Goddard Space Flight Center, Greenbelt, Md.
IN-SPACE FLUID MANAGEMENT TECHNOLOGY - GODDARD SUPPORT
Allan Sherman 301-344-5405

The objective of this RTOP is to provide technical consultation on the supply tank system of the cryogenic fluid management facility. All facility specifications and design concepts will be informally reviewed, analysis will be checked, and the final design will be reviewed. Suggestions for modification or design improvements shall be transmitted in a timely manner to the Principal Technologist.

W85-70244 **506-64-27**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION OPERATIONS TECHNOLOGY
W. K. Creasy 713-483-2561
(506-53-57)

The objectives of this RTOP effort in the area of construction/docking technology are (1) establish system design requirements and operating procedures for docking/berthing maneuvers required for construction, assembly, and satellite servicing tasks, (2) identify component technology needs and systems design drivers through analysis of the projected program requirements, including requirements for minimum disturbance soft docking/berthing, and (3) demonstrate validity of system and component design and operational concepts through full scale ground tests of development hardware. This will be achieved by developing requirements, performing conceptual design studies, performing parametric trade studies, and developing prototype hardware for proof of concept systems ground tests. One additional objective in the area of cryogenic fluid management is to identify and evaluate attractive technical concepts for a liquid hydrogen quantity gauge for zero-gravity use in support of the Lewis Research Center's Cryogenic Fluid Management Facility. As an additional task, technology will be developed to make effective use of the Space Station flight crew and support cost effective operations of the Space Station.

W85-70245 **506-64-29**
Marshall Space Flight Center, Huntsville, Ala.
TELEOPERATOR AND CRYOGENIC FLUID MANAGEMENT
W. O. Frost 205-453-1413

This RTOP includes three areas of activities relating to Platform Systems Operations: (1) Teleoperations, (2) Cryogenic Fluid Management, and (3) Simulation/Emulation. (1) Task 01, Teleoperations, investigates key technology issues, evaluates system concepts/alternatives and defines overall capabilities/limitations involved in remotely controlled space systems. (2) Task 02, Cryogenic Fluid Management, assesses thermodynamic and fluid mechanic interactions between subsystems and components within a liquid hydrogen management breadboard for orbital propulsion

and investigates reusable insulation technology for Earth-to-orbit transport. Applications include the OTV, Space Station, and orbital cryogen management in general. (3) Task 03, Simulation/ Emulation, develops math models, user documentation, and configuration management for a data base of space subsystems.

W85-70246 **506-64-31**
Ames Research Center, Moffett Field, Calif.
PLATFORM SYSTEMS RESEARCH AND TECHNOLOGY CREW/ LIFE SUPPORT
J. C. Sharp 415-965-5100
(481-50-40; 481-50-41)

The objective of this program is to develop crew/life support technology in air revitalization, water reclamation, and solid waste mangement to support the establishment of permanent human presence in space. This program objective includes technology development to support the initial Space Station and for later Space Station growth. The Long range program goal is to achieve a technology ready condition for regenerative life support system technology and extravehicular activity (EVA) technology for the initial Space Station and improved process efficiencies, increased system closure and additional personal accommodations for Space Station growth. The specific technology areas in this RTOP include: electrochemical depolarized carbon dioxide concentration; static feed water electrolysis oxygen generation; nitrogen generation; solid amine carbon dioxide concentration; integrated air revitalization; supercritical water waste oxidation; environmental control life support system (ECLSS) control/monitor instrumentation; advanced water reclamation process technology; and advanced space suit joints and gloves.

W85-70247 **506-64-37**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED LIFE SUPPORT SYSTEMS TECHNOLOGY
F. H. Samonski 713-483-4823

The objective of this RTOP is to develop the life support systems technology for the space station program which will enable an orderly growth in both size and capability. The tasks included within this RTOP are consistent with the recommendations of the Crew and Life Support Working Group and are generally directed at improving process efficiencies and attaining a higher degree of system closure. Particular emphasis will be placed upon the development of advanced processes to accomplish the functions of atmosphere revitalization, water reclamation, and waste management. Companion development efforts for automated control systems and process monitoring instruments will also be pursued.

Interdisciplinary Technology

W85-70248 **506-90-21**
Ames Research Center, Moffett Field, Calif.
INTERDISCIPLINARY TECHNOLOGY – FUND FOR INDEPENDENT RESEARCH (SPACE)
David J. Peake 415-965-5113
(505-90-28)

The object of this RTOP is to support innovative and high-risk basic research in areas related to space. The program pursues basic investigations of new technologies in fundamental science and engineering needed to satisfy NASA's requirements in space including the technical fields of lasers, cryogenics, materials, applied mathematiics, superconductivity, chemistry and physics, human factors, and life support systems. The Ames Basic Research Council accepts unsolicited proposals from universities and judges these on the basis of the degree of innovation and the capacity to complete the task.

Space Systems Technology Programs

Chemical Propulsion Systems Technology

W85-70249 **525-02-12**
Lewis Research Center, Cleveland, Ohio.
HIGH-PRESSURE OXYGEN-HYDROGEN ETO ROCKET ENGINE TECHNOLOGY
S. H. Gorland 216-433-5113
(506-60-12)

Evaluation and validation of technological advances in high pressure, oxygen-hydrogen earth-to-orbit rocket engines will be accomplished in a test engine environment. The overall goals are to: (1) test and evaluate the output from the Advanced High Pressure Oxygen-Hydrogen Program to extend component/ subsystem life, reduce operational cost and improve performance; (2) enhance the transfer of the emerging technology items to the development program; and (3) allow for more intensive and comprehensive testing than can be accomplished in a schedule driven flight engine program. The specific objectives are to: (1) develop an environmental map of the engine operating characteristics and define the loads that influence useful life; (2) evaluate the technology features incorporated in new component designs; (3) define and evaluate advanced control systems to relieve or eliminate the adverse transient conditions that limit life; and (4) define and evaluate health monitoring systems which can detect and identify marginal engine components. The test program will provide basic data to validate new and existing models, subject potential component advances to the engine environment prior to committing the advancement to the engine development program and provide the opportunity to define new control and health montioring systems.

W85-70250 **525-02-19**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED SPACE SHUTTLE MAIN ENGINE (SSME) TECHNOLOGY
A. L. Worlund 205-453-3624

The evaluation and validation of technological advances in high-pressure, oxygen-hydrogen Earth-to-orbit rocket engines will be accomplished in a test bed engine environment. The overall goals are to: (1) test and evaluate the advancements of the Advanced High-Pressure Oxygen-Hydrogen Program to extend component/subsystem life, reduce operational cost and improve performance; (2) enhance the transfer of the emerging technology items to the development program; and (3) allow for more intensive and comprehensive testing than can be accomplished in a schedule-driven flight engine program. The specific objectives are to: develop an environmental map of the engine operating characteristics and loads that influence useful life; evaluate the technology features incorporated in new component designs; and (3) define and evaluate advanced control systems to relieve or eliminate the adverse transient conditions that limit life and define and evaluate health monitoring systems which can detect and identify marginal engine components. The test program will provide basic data to validate new and existing models, subject potential component advances to the combined engine environments prior to committing the advancement to the engine development program, and provide the opportunity to define new control and health monitoring systems.

Space Flight Systems Technology

W85-70251 **542-03-01**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF A SHUTTLE FLIGHT EXPERIMENT: DROP DYNAMICS MODULE
T. G. Wang 213-354-6331

The principal objective of this RTOP is to design, fabricate, and test an acoustic positioning and manipulation module to utilize it to perform the experiment Dynamics of Rotating and Oscillating Drops and Bubbles as part of the NASA Spacelab III and subsequent missions. This acoustic positioning and manipulation module will allow us to utilize the unique zero-g environment provided by a Shuttle/Spacelab flight to perform drop and bubble dynamics experiments that are impossible to perform in a gravitational field. Examples are: (1) study experimentally the equilibrium figures and the bifurcation process of a rotating spheroid; (2) investigate the nonlinearity in the resonant frequencies as a function of oscillation amplitude; and (3) understand the fission and fusion processes in drops that pertain to other disciplines. The scope of this work is twofold: to fabricate a flight unit, and to perform the experiment Dynamics of Rotating and Oscillating Drops and Bubbles as part of the NASA Physics and Chemistry in Space Program. The scientific community will be invited to participate in experiments informally through international symposia and colloquia. Some scientists will participate with JPL as science associates and consultants.

W85-70252 **542-03-06**
Goddard Space Flight Center, Greenbelt, Md.
SUPERFLUID HELIUM ON-ORBIT TRANSFER DEMONSTRATION
M. J. DiPirro 301-344-6766

The objective of this RTOP is to solve the limitations of many current and proposed spaceflight projects including detectors, instruments, (AXAF, COBE, LDR) and facilities (IRAS, SIRTF, GP-B) as stored helium is depleted. A solution to this problem is to replenish the liquid helium supply during refurbishment in space. The feasibility of the transfer of superfluid helium under zero-g conditions with an STS flight demonstration using the Hitchhiker-G configuration of the Shuttle Payload of Opportunity Carrier (SPOC) is proposed. The method to be used involves a porous plug thermo-mechanical pump--a simple electrically operated device that works because of the unique properties of superfluid helium. The principle involved is the same as that used by the IRAS and COBE porous plug to contain supefluid helium within a dewar in zero-g. This Shuttle experiment will demonstrate fluid management techniques within the supply and receiver dewars to both contain the liquid helium as well as provide a continuous supply of liquid to the thermomechanical pump for transfer. An option to demonstrate quick-disconnect couplings on the transfer tube of the type to be used on actual resupply and reciever dewars in space, with an additional option of an EVA to mate and demate these connectors is proposed.

W85-70253 **542-03-13**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACELAB 2 SUPERFLUID HELIUM EXPERIMENT
P. V. Mason 213-354-4056

The objective of this RTOP is to investigate the properties of superfluid helium in zero gravity for flight on Spacelab 2 in early 1983, now rescheduled for flight in April, 1985. The experiment will determine the mechanical and thermal properties of superfluid helium in sufficient detail to enable the design of high-performance, space-qualified superfluid cryogen systems. A companion experiment will study the properties of low velocity capillary waves in thin films of supefluid helium. These waves cannot be observed in the Earth's gravity. Their study will increase scientific understanding of the interaction of normal and superfluid helium. The experiment will consist of an instrumented cryostat, an experiment package mounted inside the cryostat, and an electronics control and data processing electronics package which will be mounted on a Spacelab pallet, and will interface with the Spacelab command and data management system. Interactive control with experimenters on the ground will permit optimization of scientific results by real-time modification of experimental conditions and parameters.

W85-70254 **542-03-14**
Langley Research Center, Hampton, Va.
FILE/OSTA-3 MISSION SUPPORT AND DATA REDUCTION
W. E. Sivertson 804-865-3666

The objective of this RTOP is to support Feature Identification and Location Experiment (FILE) flight experiment activity and the advancement of feature classification and cloud detection technology. Work will include in-house and contract effort as required to support the FILE/OSTA-3 mission and post mission data reduction. Flight hardware will be evaluated. Flight data will be processed and evaluated. Results from this effort will focus on providing new knowledge required for autonomous cloud detection, pointing, and tracking instruments for future space missions.

W85-70255 **542-03-43**
Langley Research Center, Hampton, Va.
SPACE FLIGHT EXPERIMENTS (STRUCTURES FLIGHT EXPERIMENT)
J. L. Allen 804-865-3661
(506-53-43)

The objective is to conduct space flight research focusing upon structural performance, dynamics, and control of flexible, low frequency space structures utilizing a deployable, joint-dominated truss beam as the test article. Through the selection, fabrication, and test (ground and space-based) of a large space system structural section, the structural and dynamic boundaries of flexible, efficiently designed space systems will be explored and defined. The test article, being retractable, may be used repeatedly as the host for a series of research flights from the Structures Technology Experiment Platform (STEP) experiment carrier.

W85-70256 **542-03-44**
Langley Research Center, Hampton, Va.
SPACE FLIGHT EXPERIMENTS (STEP DEVELOPMENT)
J. E. Harris 804-865-3661

The objective of this RTOP is to define and develop a low-cost, reusable Shuttle-borne Structures Technology Experiments Platform (STEP) to be used in conjunction with the Shuttle as a space testing facility to accommodate flight experiments primarily in the structures, structural dynamics, and structures/controls interaction research disciplines. The approach will be to form a project office and an in-house design team augmented with contract feasibility and system definition studies, develop a project plan and necessary project documentation to initiate project implementation, and manage the project development.

W85-70257 **542-03-51**
Langley Research Center, Hampton, Va.
IN-SPACE SOLID STATE LIDAR TECHNOLOGY EXPERIMENT
Richard Nelms 804-865-3745
(506-54-23)

The objective of this technology experiment is to develop the technology base and measurement techniques necessary in order to operate a solid state laser lidar system from a spaceborne platform. The approach will be to space harden, with minimum change, existing lidar components technology developed under the OAST Sensors Program and measurement capabilities proven in previous aircraft and ground based programs. The initial space experiment will utilize a Nd:YAG laser lidar in a multimode single wavelength autonomous operation. This type system has been shown previously to make important atmospheric aerosol and cloud measurements. The system will be designed in a modular concept for easy reflight to develop technology for other potential solid state laser systems.

W85-70258 **542-03-53**
Goddard Space Flight Center, Greenbelt, Md.
CAPILLARY PUMPED LOOP/HITCHHIKER FLIGHT EXPERIMENT (TEMP 2-A)
Roy McIntosh 301-344-6071
(506-55-86)

The objective is to develop a flight experiment to verify the operation and aero gravity priming of the capillary pumped loop (CPL) using the Hitchhiker-G carrier to provide real time data and command capability. The approach is to: (1) modify existing CPL experiment developed as a get away special (GAS) payload for flight aboard the Hitchhiker-G carrier; (2) Design and fabricate an electronics box to interface the CPL/GAS experiment to the Hitchhiker-G command and data handling system; (3) integrate the experiment with the Hitchhiker-G carrier; (4) actively monitor and support the experiment during the flight; and (5) recover the experiment and reduce and analyze the flight data.

W85-70259 **542-03-54**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE FLIGHT EXPERIMENT (HEAT PIPE)
W. E. Ellis 713-483-2351

The objective of this RTOP effort is to provide flight hardware for a Shuttle Orbiter experiment to demonstrate the inflight thermal performance of a large heat pipe radiator element. The experiment will verify the technology of a large capacity, extended length heat pipe radiator that can be constructed and maintained under zero-gravity operating conditions. The experiment will fully verify proper operation, including passive operation capability, insensitivity to the micrometeoroid environment, insensitivity to the gravity field, and adequacy of the relatively small capillary and surface tension forces critical to proper operation. The relatively large size of the experiment will require that it be carried in the Orbiter payload bay. However, since the experiment can be made long and narrow if desired, it can easily be packaged in one of the RMS envelopes and thus be carried with minimal impact on other Orbiter payloads. The hardware to be flown is directly related and in fact is a direct outgrowth of the ongoing R&T program in Space Power Systems and planned Space Station Advanced Development Activities. The flight test will provide the 'transfer function' for R&T heat pipe radiator technology into the Space Station development program.

W85-70260 **542-04-13**
Langley Research Center, Hampton, Va.
LONG DURATION EXPOSURE FACILITY
Leo P. Daspit, Jr. 804-865-3704

The broad LDEF Project objectives are the following: (1) to develop the Long Duration Exposure Facility (LDEF); (2) to develop and perform a first set of experiments on the LDEF; and (3) to broaden the operational STS user community. The LDEF, a shuttle transported, reusable unmanned, low-cost free flying structure on which many different experiments can be mounted, will be developed and manufactured in-house at Langley. The experiments, many of which are completely passive with active data measurements being made in the laboratory after recovery, will be solicited from all NASA Centers, other governmental agencies, industry, and foreign countries. The STS user community will be broadened by the LDEF providing a unique, simple, low-cost approach to perform large numbers of needed long duration technology and science experiments. The establishment of a continuing program to provide for LDEF reflights after the first LDEF mission with the operational STS is a part of this RTOP. The implementation of the established follow-on program is not.

W85-70261 **542-05-12**
Lewis Research Center, Cleveland, Ohio.
FLIGHT TEST OF AN ION AUXILIARY PROPULSION SYSTEM (IAPS)
Louis R. Ignaczak 216-433-6652

A major goal of the OAST-LeRC electric propulsion effort is to achieve technology readiness and user acceptance of a high performance, long life mercury ion auxiliary propulsion system. This goal depends on attaining the following objectives: (1) conducting a flight test of a mercury ion auxiliary propulsion system; and (2) providing engineering information on the system performance and system interfaces with the spacecraft. The approach is to conduct a space flight test of an ion auxiliary propulsion system operated for time duration and duty cycle representative of potential operational missions. The flight system uses two 8 cm diameter mercury ion thrusters operating at one millipound thruster level. The experiment will be flown aboard an AF spacecraft. The program also includes a ground test program to provide data on system performance and interfaces and a principal investigator function to technically guide the program and interact with potential users.

OFFICE OF THE CHIEF ENGINEER

Standards and Practices

W85-70262 **323-51-03**
Jet Propulsion Laboratory, Pasadena, Calif.
HERMETICALLY-SEALED INTEGRATED CIRCUIT PACKAGES: DEFINITION OF MOISTURE STANDARD FOR ANALYSIS
R. F. Haack 818-354-6568

The overall objective of this RTOP is to provide the technology base for a package moisture standard for the mass spectrometric method for determining the moisture content in integrated circuit packages. Presently, state-of-the-art permits only inletting of a calibration gas. A standard package could be analyzed in an identical manner as that used for the packages. For water in the gaseous state, the type of transfer mode(s) is extremely critical and therefore any calibration method should approximate the analysis of the package as closely as possible. The availability of such a standard is vital to the credence of results from laboratories verifying the moisture content of packages as outlined in Mil Std 883B for ensuring functional reliability of integrated circuits. The approach will involve two phases. The first phase will determine the effect of surface treatment and carrier gas upon the available moisture as measured by the mass spectrometric method. These results will be compared to those from earlier tests for which moisture level variation was less than optimum. Phase 2 will consist of analyses of standard packages having given volume, carrier gas, surface treatment and expected moisture at the 5,000 ppm (volume/volume) level. Selected laboratories will perform this analysis in order to determine the applicability of the standard.

W85-70263 **323-51-05**
Marshall Space Flight Center, Huntsville, Ala.
COMPUTERIZED MATERIALS AND PROCESSES DATA BASE
C. F. Key 205-453-1296

The objective of this research is to develop, operate and maintain a comprehensive user friendly, computerized materials and processes data base system utilizing state-of-the-art technology. The data base will be accessible NASA wide and will include a materials selection guide, material properties data base, an electronic bulletin board, materials application for STS, test data, specifications, foreign/U.S. cross references and a list of specialists. Prior to becoming operational, user instructions/documentation will be prepared and the system will be demonstrated to the community.

W85-70264 **323-51-66**
Langley Research Center, Hampton, Va.
NON-DESTRUCTIVE EVALUATION MEASUREMENT ASSURANCE PROGRAM
Joseph S. Heyman 804-865-3036

The objective of this program is to improve the state-of-the-art in quantitative nondestructive evaluation (NDE) with particular emphasis on composite materials. Probing energy will include sonics and ultrasonics, thermal waves, and electromagnetic sources to examine material properties. The results of this research will ensure that material and fabrication specifications can be nondestructively verified and that degradation of material in use can be quantitatively documented. Novel and promising NDE technologies will be developed and applied to materials of critical

interest to NASA. In particular, sound waves and thermal waves, both phonons, will be applied to composites to evaluate the material physical properties (e.g., voids) and internal geometrical properties (e.g., fabrication). Measurements will include elastic constants, attenuation, propagation vector measurements and diffusivity. In addition, ultrasonic scattering and thermal propagation will be used to assess material damage especially from impact sources. Development of a fully automated computer controlled robotic scanner/receiver will permit significantly improved data for quantitative NDE interpretation.

W85-70265 **323-51-90**
Jet Propulsion Laboratory, Pasadena, Calif.
NASA CENTERS CAPABILITIES FOR RELIABILITY AND QUALITY ASSURANCE SEMINARS
James A. Roberts 213-354-5418

The objective is to provide R&QA seminars on a semiannual basis on topics to be agreed upon between the NASA centers, and Headquarters; to provide management of hands on training for all NASA centers, as well as syllabuses and training films; to library both A and B activities at JPL for access of all centers.

W85-70266 **323-52-60**
Langley Research Center, Hampton, Va.
DEVELOPMENT OF THE NASA METROLOGY SUBSYSTEM OF THE NASA EQUIPMENT MANAGEMENT SYSTEM
Frederick A. Kern 804-865-3745

The objective of this RTOP is to develop a metrology control subsystem to be used by NASA Center metrologists which will include standardized historical and calibration recall programs consisting of calibration data, recall data, calibration interval data, calibration and repair labor, and parts costs. The requirements will be developed by the NASA Center metrologists through the Metrology and Calibration Workshop. The development of standardized input data formats, flow charts, transaction specifications, complete programs, standardized information data reports, and a user manual will be accomplished on contract. This subsystem, following development at LaRC, will be implemented concurrently with NEMS at the other field centers.

W85-70267 **323-53-08**
John F. Kennedy Space Center, Cocoa Beach, Fla.
NASA STANDARD INITIATOR (NSI) SIMULATOR
R. Wright 305-867-3402

This RTOP discusses continuous passive monitoring of ordnance electrical circuits. Detection of extraneous energy on an ordnance circuit, and recording the time of event and the magnitude of the event are necessary to ensure the integrity of the ordnance system. Because this type activity, as performed today on other missile programs, is inherent with cumbersome equipment (i.e., cable harnesses, power supplies, computers, electrical support equipment), there is a need to develop a small, self-contained simulator that will perform as many of the above-listed desirable functions as possible. The approach will be through a development process that will concentrate on using techniques similar to those used in wristwatch design. The results should produce a useful NSI simulator that would be connected to the STS ordnance circuits during hangar/buildup/test periods. The simulator must be capable of performing a PIC load test, PIC resistance test, and record the time, magnitude and duration of any extraneous transient that may inadvertently appear on the lines.

W85-70268 **323-53-50**
Wallops Flight Center, Wallops Island, Va.
ENVIRONMENTALLY PROTECTED AIRBORNE MEMORY SYSTEMS (EPAMS)
P. J. Alfonsi 804-824-3411
(323-53-50; 505-45-13)

The objective of this RTOP is to investigate the requirements for and potential configurations of an Environmentally Protected Airborne Memory System (EPAMS) for the NASA Automated In-Flight Data Acquisition System. This latter device which was designed and implemented as the result of past NASA RTOP activities (323-53-50, 505-45-13-03) provides a state of the art data acquisition/processing capability featuring solid state digital memory, microprocessing, and data compression capabilities which can be adapted to acquire, analyze and record virtually any aircraft in-flight operation or environmental parameter. This RTOP proposes to review and identify the important prameters required for accident investigation and define the capacity and configuration of a crash survivable, retrievable memory module to record and retain this data. The state of the art in fire and shock protective techniques will be reviewed to define an optimum crash survivable configuration for the retrievable memory module.

W85-70269 **323-53-80**
John F. Kennedy Space Center, Cocoa Beach, Fla.
AGENCY-WIDE MISHAP REPORTING AND CORRECTIVE ACTION SYSTEM (MR/CAS)
J. Wortman 305-867-4888

The KSC is developing an agency-wide MR/CAS which will serve both the NASA Centers and NASA Headquarters' needs for mishap data collection, analysis, and eliminate the need for written reports currently provided on a quarterly and annual basis. The system will allow a real time exchange of mishap data, hotline information, and lessons learned on a center to center basis and a center to headquarters basis. The system, when implemented, will be a direct effort in accident prevention throughout NASA. The KSC will identify the computer hardware architecture necessary for agency-wide automation, develop all necessary software, initiate a prototype program utilizing old/new software programming, coordinate and consult with other centers and headquarters for a gradual but total implementation of the Program.

W85-70270 **323-54-01**
Lyndon B. Johnson Space Center, Houston, Tex.
LUNAR BASE POWER SYSTEM EVALUATION
M. B. Duke 713-483-4464

The objective of this RTOP is to provide an analysis of the competing concepts for providing power for a lunar base. Ranges of power requirements between 100KW and several Megawatts will be considered. These are expected to include several of the following types of approaches: nuclear power, solar-thermal, solar-photovoltaic, and solar-dynamic systems. An evaluation will be made of which approaches can take optimum advantage of the utilization of indigenous lunar materials, to minimize the amount of mass that would have to be transported to the Moon. A model will be developed that will allow alternate concepts to be tested for cost effectiveness and to identify major areas of technology which need to be investigated.

OFFICE OF SPACE SCIENCE AND APPLICATIONS

Global Scale Atmospheric Processes

W85-70271 **146-66-01**
Jet Propulsion Laboratory, Pasadena, Calif.
METEOROLOGICAL PARAMETERS EXTRACTION
M. T. Chahine 818-354-2433
(146-72-06)

The main objective of the proposed investigation is to develop rapid retrieval algorithms for accurate interpretation of remote sounding radiance data measured by the various NASA and NOAA weather satellites. The components of the retrieval algorithms will consist of individual numerical methods to: eliminate cloud effects using 3 FOV approach; refine quality control criteria; adapt results to GLAS GCM - 100 by 100 km grid; and improve accuracy of atmospheric transmission functions.

W85-70272 **146-66-02**
Jet Propulsion Laboratory, Pasadena, Calif.
GLOBAL SEASAT WIND ANALYSIS AND STUDIES
P. M. Woiceshyn 213-354-5416

The objectives of this global meteorological research with high

resolution surface wind data from spaceborne instruments are to conduct meteorological analyses and produce an adequate data record of unique wind vectors from the SEASAT scatterometer (SASS) raw geophysical wind data record, which includes alias solutions, i.e., multiple ambiguous wind directions (up to 4); to generate associated kinematic and climatological statistics of the dealiased wind fields over the oceans; to perform global and regional meteorological research using the dealiased wind fields; and to investigate the method and use of high resolution SASS wind data in oceans. Specifically the research tasks are: (1) analyses or SASS1 speed, direction, and dealiasing errors. This includes internal consistency checks as well as discrepancies with in situ observations; (2) correction of the SASS wind errors by the construction of a modified and improved backscatter-to-wind function, validated by a two week reprocessed SASS wind record; (3) development of statistics of meteorological parameters of importance in the global circulation of the atmosphere, including spectral statistics and empirical orthogonal function analysis; and (4) study of special meteorological situations (e.g., storms and the interaction of the equatorial divergence zone and the intertropical convergence zone and the synoptic climatology in regions of very sparse in situ data, such as the tropics and Southern Hemisphere. This would include comparisons and analysis with two SEASAT instruments, SASS and SMMR.

W85-70273 **146-72-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE PRESSURE SOUNDER
D. A. Flower 818-354-4151

This RTOP supports the completion of the second phase of the microwave pressure sounder (MPS) research program, the objective of which is to develop an instrument for the remote measurement of atmospheric pressure at the Earth's surface. Design studies showed that differential absorption measurements in the wings of the 60 GHz oxygen absorption band are potentially capable of providing surface pressure observations with the accuracy and coverage suited to applications in global weather research and operational weather forecasting. The specific objectives of this phase of the investigation are: characterization of the performance of an aircraft version of the MPS; modification of the instrument to obtain optimum performance; verification of the pressure measuring concept using data from test flights of the instrument on the NASA CV-990 aircraft. The approach will be to use data from previous test flights with the instrument on the NASA CV-990 aircraft, together with the results of laboratory tests to characterize the instrumental performance. These tests will be used to define modifications to the instrument so that its long term stability is optimized. The modified instrument will be further tested in the laboratory and then used in a series of test flights on the CV-990 aircraft. Data from these flights will be analyzed and the results applied to previously developed optimization procedures for the selection of operating frequencies of a satellite MPS.

W85-70274 **146-72-02**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED MOISTURE AND TEMPERATURE SOUNDER (AMTS)
M. T. Chahine 213-354-2433

The ultimate objective of this effort is to develop an infrared advanced moisture and temperature sounder (AMTS) which meets the requirements of the numerical weather prediction models of the 1990s. These models require global atmospheric temperature profiles with an accuracy of 1K and with a vertical resolution comparable to that of radiosondes. This accuracy and vertical resolution requirement, which is not satisfied by current sounders, is achievable with the AMTS concept by careful choice of narrow band infrared channels utilizing the dependence of the absorption coefficients on pressure and temperature. Improvements in the vertical resolution of tropospheric temperature profiles to meet numerical weather prediction requirements are obtained from measurements with a resolution of 2/cm in high J-lines of the R-branch of the 4.3 micron CO2 band. A complementary set of 15 micron channels with a spectral resolution of 0.5/cm is used to sound the upper troposphere and stratosphere. Elimination of the effects of clouds is accomplished by taking simultaneous measurements in the 4.3 micron and 15 micron bands. During the past years conceptual designs for a 'stand alone' all infrared AMTS for a low-Earth orbiter (LEO) have been developed. In FY-84 a new Baseline V AMTS Study Report was written which includes the results of system interaction studies performed to date. During FY-85 an instrument cost model will be developed and an AMTS shuttle mission will be defined. The results of the Baseline V system study and the hardware constraints imposed by the shuttle will be used to define an AMTS shuttle experiment with the optimum scientific return. A cost model will be developed by the AMTS team and key personnel in specific technical disciplines.

W85-70275 **146-72-04**
Jet Propulsion Laboratory, Pasadena, Calif.
WIND MEASUREMENT ASSESSMENT
R. T. Menzies 818-354-3787

The objective of this program is to evaluate certain aspects of an active laser technique for global measurement of tropospheric wind fields. This technique, based on long range Doppler lidar using pulsed lasers, has the potential for providing global wind data from an orbiting platform. Several types of remote measurement of atmospheric wind velocities have been analyzed, e.g., passive microwave, millimeter wave, infrared radiometry, and active visible and infrared range-gated lidar, with the results indicating that the Doppler lidar technique (using CO2 lasers or others with similar characteristics), is the superior technique for tropospheric wind field measurements. During FY-85, the work will continue on an experimental study of vertical profiles of atmospheric backscatter at various CO2 laser wavelenghts in the 9 micrometer to 11 micrometer region. This study will be conducted using an existing TEA CO2 lidar facility, employing a single-longitudinal-mode (SLM) injection-controlled TEA laser transmitter and a heterodyne receiver. A new TEA laser transmitter will be installed which will allow operation at higher pulse repetition frequencies. This will prevent an opportunity to assess the design parameters of an injection-control system for operation at a pulse repetition frequency approximately equal to that required or an Earth-orbiting Doppler lidar.

Upper Atmospheric Research Program

W85-70276 **147-11-00**
Goddard Space Flight Center, Greenbelt, Md.
UPPER ATMOSPHERE RESEARCH - FIELD MEASUREMENTS
William S. Heaps 301-344-5106

To determine specific local chemical and physical interactions in the atmosphere using coordinated in-situ measurement campaigns from balloon platforms, specifically with respect to the OH radical, and related species. 1) To develop a balloon borne LIDAR system for the measurement of trace species, especially OH and ozone. 2) The direct measurement of photolysis rates of importance in the atmosphere. 3) Develop a balloon-borne cryosampling system for the detection and measurement of low molecular weight hydrocarbons.

W85-70277 **147-11-05**
Lyndon B. Johnson Space Center, Houston, Tex.
IN-SITU MEASUREMENTS OF STRATOSPHERIC OZONE
D. E. Robbins 713-483-2956

The objective is to continue developing the ultraviolet absorption photometry technique for making in-situ measurements of stratospheric ozone for the purposes of understanding the ozone chemistry, validating solar and backscatter ultraviolet or other operational satellite instruments, and providing an independent technique for detecting a trend in stratospheric ozone caused by manmade chemical compounds. Improvements will be made in an existing UV absorption photometer that employs the Dasibi technology. These changes will improve its performance in the

altitude region above 40 km and allow measurements up to 45 km with a precision of about 1.5%. The precision at 40 km will be 0.8%. Tests will be conducted on the ground, either at Harvard University or at the University of Minnesota, under conditions of pressure and ozone densities observed in the upper stratosphere to resolve the unproven hypothesis of ozone loss on system walls. As in previous years there will be from four to six balloon flights made as a piggyback experiment to intercompare with other techniques and to study chemistry of specie groups related to ozone. One flight will be made to prove instrument performance over the 35 km to 45 km range where maximum reduction in ozone is predicted.

W85-70278 **147-11-07**
Jet Propulsion Laboratory, Pasadena, Calif.
BALLOON-BORNE LASER IN-SITU SENSOR
C. R. Webster 818-354-7478

The primary objective is the collection of reliable data on the concentrations, distributions, and variabilities of the minor and trace species in the stratosphere through the use of the Balloon Laser In Situ Sensor (BLISS). These data are to be used by modelers and dynamicists to assess and predict the effects of change in the chemical content of the upper atmosphere due to anthropogenic activity. The BLISS instrument uses tunable diode lasers (TDLs) to measure the absorption due to selected species between the balloon gondola and a lowered retroreflector which defines a 1-km absorption path. The TDL beam in use is stabilized onto the lowered retroreflector by use of an optical tracking system. Several species can be measured simultaneously to the 0.1 ppbv level in sensitivity, throughout a diurnal cycle, and with the additional possibility of altitude profiling.

W85-70279 **147-12-99**
Ames Research Center, Moffett Field, Calif.
AIRBORNE IR SPECTROMETRY
J. F. Vedder 415-965-6259

The objective is to obtain information on the spatial and temporal distribution of stratospheric constituents, for use in testing current theories of stratospheric chemistry, especially ozone depletion. Infrared absorption and emission spectrometers will be flown on balloons and aircraft in coordination with other experimenters. Constituents will be identified and concentrations will be inferred from the spectra obtained.

W85-70280 **147-14-07**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE TEMPERATURE PROFILER FOR THE ER-2 AIRCRAFT FOR SUPPORT OF STRATOSPHERIC/TROPOSPHERIC EXCHANGE EXPERIMENTS
B. L. Gary 213-354-3198
(505-45-15)

The objective of this RTOP is to construct an airborne microwave radiometer that can be installed in the NASA ER-2 aircraft for the purpose of measuring altitude temperature profiles, so that 'potential vorticity' of the air can be determined. Potential vorticity will be used by other investigators of the Stratosphere/Troposphere Exchange Project for the study of processes of exchange of air across the tropopause. A passive microwave radiometer is under construction for installation in NASA's ER-2 research aircraft. Brightness temperature measurements at 57.3 and 58.8 GHz will be made at a selection of elevation angles for the purpose of deriving plots of air temperature versus altitude regime that is 8,000 feet thick (centered on the aircraft altitude). This instrument is an improved version of the 'airborne microwave radiometer' which JPL constructed and installed in the NASA C-141 aircraft for 'clear air turbulence' studies. Atmospheric temperature lapse rate, which will be derived from the altitude temperature profiles, will be combined with onboard wind vector measurements in order to calculate potential vorticity. Potential vorticity will be used (by other investigators) as a tracer for stratospheric air, during the course of special flight missions designed to study stratospheric/tropospheric exchange processes.

W85-70281 **147-14-99**
Ames Research Center, Moffett Field, Calif.
UPPER ATMOSPHERIC MEASUREMENTS
P. Russell 415-965-5404

The overall goal of this program is to advance the understanding of the mechanisms that transport gases and particles between the stratosphere and troposphere and within the lower stratosphere, and to quantify the rates of exchange on local and global scales. Specific aims are to: (1) determine whether cumulus towers and their cirrus anvils are a net source or sink of stratospheric water vapor, and understand the detailed mechanism; and (2) quantify the mass exchanged across the cloud free tropopause, and determine transfer times. A working group formulates investigation guidelines. With this guidance missions are planned, organized, and conducted using suitable aircraft and satellite platforms. Results are reviewed and used by the working group, made available to other scientists, analyzed, and published. Examples of missions are U-2 studies of midlatitude tropopause folds and ER-2 studies of cirrus anvils. Publications include special issues of journals and NASA TMXs.

W85-70282 **147-16-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTI-SENSOR BALLOON MEASUREMENTS
W. T. Huntress 818-354-8275
(147-12-05; 147-12-06; 147-12-08)

A continuing series of stratospheric balloon flights is conducted to measure the abundance and altitude distribution of key chemical constituents in the upper atmosphere. A modular gondola system is used to carry a multi-instrumented package consisting of several JPL remote sensing instruments, or instruments from other institutions in the U.S. and aboard, configured for a particular scientific purpose for any one flight. Data are obtained on the altitude profiles for a number of chemically coupled species all at the same time and in the same air mass for instrument intercomparison purposes and for the validation of atmospheric chemical models.

W85-70283 **147-21-03**
Jet Propulsion Laboratory, Pasadena, Calif.
CHEMICAL KINETICS OF THE UPPER ATMOSPHERE
W. B. DeMore 818-354-2436

The objectives are to obtain direct measurements of rate constants and temperature dependences for reactions of HOx, NOx, ClOx, BrOx and ROx in stratospheric chemistry, and to develop techniques for laboratory study of relevant transient species.

W85-70284 **147-21-09**
Jet Propulsion Laboratory, Pasadena, Calif.
ROLE OF THE BIOTA IN ATMOSPHERIC CONSTITUENTS
M. N. Dastoor 213-354-7429
(199-30-20)

The objective is to acquire a data base for pertinent global environmental parameters through the quantification of the contribution of biota. The recognition of living organisms as global homestatic control factor can be attributed to the fact that even though biological reactions allow for extremely high chemical fluxes globally, such fluxes are characterized by high turn over rates and in some instances, are thus masked by what appears to be a very modest net synthesis on a global scale. Due to the restricted elemental make-up of biological systems, the possible chemical transformations that are directly mediated by the biota are limited in number and are dominated by the elements: carbon, hydrogen, oxygen, nitrogen, phosphorus and sulfur. The halocarbons are known to be a significant modulator of the ozone layer in the upper atmosphere and it is the intent of this RTOP to verify the source and global flux of the halocarbon cycle.

W85-70285 **147-22-01**
Jet Propulsion Laboratory, Pasadena, Calif.
PHOTOCHEMISTRY OF THE UPPER ATMOSPHERE
W. B. DeMore 818-354-2436

The objective of this RTOP is to conduct laboratory studies of stratospheric photochemistry, including photolytic quantum yields, reaction rates and mechanisms, product distributions, and absorption cross sections.

W85-70286 **147-22-02**
Jet Propulsion Laboratory, Pasadena, Calif.
ATMOSPHERIC PHOTOCHEMISTRY
M. J. Molina 213-354-5752

Laboratory studies will be conducted to elucidate the photochemistry of the Earth's atmosphere. Measurements will include reaction rate constants of the hydroxyl radical with various polar molecules over an extended pressure and temperature range, absorption cross sections as a function of wavelength and temperature, and Fourier Transform Infrared (FTIR) spectra of reaction intermediates.

W85-70287 **147-23-08**
Jet Propulsion Laboratory, Pasadena, Calif.
INFRARED LABORATORY SPECTROSCOPY IN SUPPORT OF STRATOSPHERIC MEASUREMENTS
R. A. Toth 818-354-6860
(147-22-18)

The program involves the acquisition of laboratory spectra and the analysis of molecular spectral parameters which are required for the interpretation of data from stratospheric measurements. The laboratory spectral measurements will be conducted specifically in support of the JPL infrared interferometers. These instruments have requirements relative to spectral regions of operation, spectral resolution, and molecules for which they are best suited. Emphasis is placed on accuracy of line frequency, line width, and line strength measurements, in order to take full advantage of spectroscopic techniques for quantitative atmospheric species measurement. A large portion of the spectral data will also be of value to other groups who use spectroscopic instruments for atmospheric measurements.

W85-70288 **147-23-99**
Ames Research Center, Moffett Field, Calif.
QUANTITATIVE INFRARED SPECTROSCOPY OF MINOR CONSTITUENTS OF THE EARTH'S STRATOSPHERE
Charles Chackerian, Jr. 415-965-6300

Remote detection and measurement of stratospheric minor constituent species via spectroscopic techniques are being routinely employed to develop a better understanding of this portion of our atmosphere and man's effect upon it. Proper interpretation of these measurements relies strongly on having the correct molecular parameters. The objective of this work is to obtain laboratory measurements of basic molecular parameters, such as rotational line intensities and half-widths, absorption band intensities, vibrational and rotational constants, vibration rotation interaction constants, and line position measurements including pressure induced shifts. The determination of these parameters, and their dependence on pressure and temperature, will be obtained by using long path gas cells, cooled cells, high resolution interferometers, and tunable diode laser spectrometers.

W85-70289 **147-51-02**
Jet Propulsion Laboratory, Pasadena, Calif.
DATA SURVEY AND EVALUATION
W. B. DeMore 818-354-2436

The objective is to identify gaps and inconsistencies in the data base pertaining to stratospheric kinetic and photochemical reactions. The corrected data will be used by atmospheric modelers.

W85-70290 **147-51-12**
Jet Propulsion Laboratory, Pasadena, Calif.
INTERDISCIPLINARY SCIENCE SUPPORT
M. T. Chahine 818-354-2433

The objective of this RTOP is to support the NASA Earth Sciences and Applications Division in the development and application of remote sensing techniques to study land surface processes and their interactions with the atmosphere. The science support to the NASA Earth Systems Science Program will be provided through the assistance of Professor R. Goody and Professor S. I. Rasool.

Planetary Geology R&A

W85-70291 **151-01-20**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY GEOLOGY
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface processes is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data, as well as place boundary conditions on planetary evolution. The study of appropriate analogues not only places boundary conditions on the evolution of other planets such as Mars, but also permits the evaluation on Earth of the characteristics of planetary surface instrumentation. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogues of Martian surface material. Specific objectives are: (1) to determine through detailed grain-by-grain studies of several terrestrial soils the processes and history that can be deduced through such data, (2) to characterize the gases released by thermal decomposition of Martian surface analogue materials and evaluate the feasibility of accomplishing such analyses in situ, (3) to map the volcanic stratigraphy on the surface of Io, and (4) to determine the thermochemical properties and kinetics of potential regolith material on Mars and Venus.

W85-70292 **151-01-60**
Ames Research Center, Moffett Field, Calif.
PLANETOLOGY: AEOLIAN PROCESSES ON PLANETS
B. F. Smith 415-965-5515

The objective of this research is to determine the parameters governing aeolian (wind) processes for appropriate planetary objects (Earth, Mars, Venus, possibly Titan) using wind tunnel simulations, laboratory experiments, Earth analog studies, theoretical studies, and analyses of spacecraft data. The approach is to conduct experiments using wind tunnel and other laboratory apparatus under simulated Earth conditions, check the results in the field on Earth, then repeat the experiments in a simulated, extraterrestrial environment (e.g., Martian), in order to learn about: (1) conditions for the initiation and sustainment of particle movement, (2) erosion of various materials, and (3) surface textures produced by wind abrasion under planetary conditions. Field experiments will be conducted to determine threshold conditions under natural conditions and to determine aeolian patterns around full-scale landforms. A field-portable anemometer will be used for studying the dynamics of particle motion and bedform development. Long-term field experiments will continue on the rate of aeolian erosion under natural conditions to provide a check for the laboratory experiments. Spacecraft data from the Viking and Venera missions will be analyzed to interpret aeolian processes on Mars and Venus.

W85-70293 **151-01-70**
Jet Propulsion Laboratory, Pasadena, Calif.
PROGRAM OPERATIONS
D. B. Nash 213-354-4154

This RTOP supports overall goals of the Geochemistry and Geophysics Research and Analysis Program at JPL. Specifically, it will provide discretionary funds to the program manager to support special needs that may arise in various tasks in the program. These needs may include supplemental salary support for tasks and purchase of key items of experimental equipment in order to upgrade JPL's ability to conduct relevant and timely experiments with state-of-the-art equipment.

W85-70294 **151-02-50**
Goddard Space Flight Center, Greenbelt, Md.
SMALL MARS VOLCANOES, KNOBBY TERRAIN AND THE BOUNDARY SCARP
Herbert Frey 301-344-5450

The objectives are: (1) develop an understanding of the nature and origin of small scale volcanic structures and their relation to knobby terrain and the boundary scarp which separates the cratered highlands and northern plains; (2) determine the variable characteristics of knobby terrain, detached plateaus, and other structures which characterize this boundary scarp; and (3) develop a model for the formation of small scale volcanic structures in the region of the boundary. Photogeologic study of the distribution and characteristics of subkilometer and larger (1 to 10 km) volcanic cones located near the boundary scarp and of other features (knobby terrain, detached plateaus, incomplete and partially buried craters) commonly found near the scarp will be conducted. The areal frequency of these features along profiles every 5 degrees in longitude will be mapped, and the change in areal extent will be compared with changes in topography, plains forming units, and occurrence of depositional units. The longitudinal variation of these comparisons will be determined to characterize the nature of the boundary scarp in terms of the dominant processes responsible for its development, the role of mega-impacts in this development will be examined, and the nature of the scarp to possible extra-martian analogs will be compared.

W85-70295 **151-02-60**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF PLANETARY BODIES
J. B. Pollack 415-965-5530

The purpose of this research is 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 the origin of the solar system. This research will be accomplished 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 structures. Analysis and interpretation of the results of these model calculations are applied to such topics as wind-blown surface features and climatic changes on Mars, and aeolian phenomena on Venus and Titan.

W85-70296 **151-02-60**
Ames Research Center, Moffett Field, Calif.
FORMATION, EVOLUTION, AND STABILITY OF PROTOSTELLAR DISKS
P. M. Cassen 415-965-5597

The objectives of this research are: (1) to obtain an understanding of the solar nebula and proto-stellar disks in general by analysis of theoretical models based on hydrodynamic and thermodynamic principles, and to relate these models to processes of planetary formation. The optical and infrared appearance of proto-stellar accretion disks and circumstellar dust disks are studied and the results applied to observations of solar-type, T-Tauri, and other stars in young clusters; (2) to examine the stability of proto-stellar disks against gravitational condensation, and to explore the role of instabilities in disk evolution and planetary formation; (3) to analyze the possible roles of gravitational and magnetic interactions between protostars and their disks. Results will be analyzed in the light of observations of the solar system and astronomical objects identified as protostars.

W85-70297 **151-02-60**
Ames Research Center, Moffett Field, Calif.
THE STRUCTURE AND EVOLUTION OF PLANETS AND SATELLITES
R. T. Reynolds 415-965-5532

The objective is to better understand by means of theoretical investigations employing the results of spacecraft and Earth based experiments, selected problems pertaining to the composition, structure, and evolution of planetary bodies and their satellites. Further, the implications of those studies for the origin and evolution of the solar system are to be considered. Theoretical knowledge, physical insight and mathematical modeling techniques are used, together with geophysical and astronomical data to construct self-consistent mathematical descriptions of planetary processes and structures. Analysis and interpretation of the results of these model calculations are applied to such topics as the structure and evolution of the satellites of the outer planets, the internal structure of Uranus and Neptune, and the accretion of planets and satellites.

W85-70298 **151-02-60**
Ames Research Center, Moffett Field, Calif.
NASA-AMES RESEARCH CENTER VERTICAL GUN FACILITY
F. J. Centolanzi 415-965-5269

The Ames Research Center Vertical Gun Range is a ballistic facility used to simulate and study the physics and mechanics of planetary impact cratering phenomena. Ballistic technologies, utilizing light gas and gun powder, enable acceleration of projectiles up to 2 centimeters diameter at relative velocities of approximately 8 km/sec. By varying the gun's angle of elevation with respect to the target vacuum tank, impact angles from 0 degrees to 90 degrees with respect to the gravitational vector are possible. In conjunction with the Lunar and Planetary Institute, Ames Research Center (ARC) operates the Ames Vertical Gun Facility as a national facility. ARC's responsibility is to manage the Vertical Gun Facility operations, including manpower, expendables, targets, etc., maintain equipment and provide for facility modification and upgrading as needed. ARC operates the facility in such a manner as to provide maximum support to the scientific community in the studying and understanding of impact processes in planetary formation and modification.

W85-70299 **151-05-60**
Ames Research Center, Moffett Field, Calif.
STUDIES OF PLANETARY RINGS
J. N. Cuzzi 415-965-6343

The objectives of this research are to obtain theoretical understanding of the processes which determine the structure of planetary rings, and to explore hypotheses for the origin and evolution of the systems. To this end, both ring structure and ring particle properties must be analyzed. In addition to theoretical studies, analysis and interpretation of ground-based observations will be employed.

W85-70300 **151-05-80**
Ames Research Center, Moffett Field, Calif.
GEOLOGIC STUDIES OF OUTER SOLAR SYSTEM SATELLITES
S. W. Squyres 415-965-5491

The purpose of this research is to obtain a better understanding of selected problems pertaining to the solid bodies of the outer solar system, including the satellites of Jupiter, Saturn, and Uranus. The problems included deal with the origin and evolution of surface features and internal structures of these bodies. A variety of techniques is used to investigate the problems under consideration. These include geologic mapping and interpretation, quantitative analysis of digital spacecraft images, and use of geophysical and astronomical data to construct numerical models of surface processes and internal evolution. Examples of problems to be considered include geologic mapping of Ganymede, quantitative characterization of the morphology and distribution of tectonic features on Ganymede, study of regolith evolution on small satellites, and study of very recent geologic activity on Europa.

Planetary Materials

W85-70301 **152-11-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: MINERALOGY AND PETROLOGY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to learn the pressure, temperature and chemical composition of distinct mineralogic phases at the time of their formation. Textures, structures and chemical composition of minerals found in samples of the Moon, meteorites (asteroids, comets), cosmic dust (comets, asteroids) and the Earth will be measured using optical and electron microscope and electron microprobe techniques. Comparison of these results with those from laboratory calibration experiments and theoretical models will lead to pressure, temperature and history information for parts of Solar System objects.

W85-70302 **152-12-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: EXPERIMENTAL STUDIES
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to execute laboratory experiments and develop theoretical models which aid the understanding of the crystallization behavior of rock-forming minerals in a wide variety of environments. Mineral systems similar to those found in samples from the Moon, meteorites (asteroids, comets), cosmic dust (comets, asteroids) and the Earth will be studied experimentally by observing the products of crystallization from experimental charges of known composition cooled under known pressure and temperature conditions. Comparison of these results with the mineralogy of naturally-occurring samples will lead to pressure-temperature and history information for parts of these Solar System objects.

W85-70303 **152-12-40**
Goddard Space Flight Center, Greenbelt, Md.
A LABORATORY INVESTIGATION OF THE FORMATION, PROPERTIES AND EVOLUTION OF PRESOLAR GRAINS
B. Donn 301-344-6859
(188-41-51; 154-75-80)

The objectives of this program are: (1) to perform experiments to determine the mechanism by which refractory materials condense from the vapor and the relative importance of the factors which control the rate of cluster formation and growth for astrophysically relevant species; (2) determine the structure and composition of solids condensed from cosmically abundant refractory mixtures; (3) monitor changes which occur in these materials as the result of thermal annealing, hydration and exposure to cosmic rays. The results will be a major contribution to characterizing the nature of grains present in the primitive solar nebula prior to its collapse. Objective 1 will be investigated using a cluster beam apparatus. The equilibrium composition and size distribution of clusters as a function of temperature will be monitored via a quadrupole mass spectrometer. These data will yield the concentration and stability of pre-condensation clusters as a function of composition. Objectives 2 and 3 require a separate flow system, designed to produce grains rather than clusters, and able to produce large amounts of multicomponent grains. The structure and composition of these initial grains will be determined via X-ray and electron diffraction studies. The infrared and UV/visible spectra will be obtained and the particle morphology will be studied in SEM and STEM. Samples of these materials will be annealed at controlled temperatures for various times, and exposed to either liquid or gaseous water or a 1 MeV proton beam. The changes thus induced will be studied by the techniques mentioned.

W85-70304 **152-13-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: CHEMISTRY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is measure the concentration of selected chemical elements (major, minor, and trace) in rock samples of interest. Data obtained supplement, and are often combined with, petrologic studies to yield bounds on thermodynamic parameters at the time of rock origin. Rock samples from the Moon, meteorites (asteroids, comets), cosmic dust (comets, asteroids) and the Earth will be analyzed using a variety of sophisticated techniques, including neutron activation analysis (NAA), X-ray fluorescence, atomic absorption spectrophotometry, gamma-ray spectrometry, and proton-induced X-ray emission. Relative abundances of trace elements in different samples place bounds on the characteristics of the sources from which the rock-forming materials are derived.

W85-70305 **152-13-60**
Ames Research Center, Moffett Field, Calif.
PLANETARY MATERIALS-CARBONACEOUS METEORITES
S. Chang 415-965-6206

The objective of this research is to understand the processes involved in the origin and early evolution of solid bodies in the solar system through the study of meteorites. The approach taken to meet the objectives focuses on the chemical and mineralogical-petrographic analyses of meteorites. The abundance, isotopic composition and distribution of selected elements are measured; and the occurrence and distribution of various mineral phases are determined. Systematic searches for elemental, isotopic and mineralogic-petrologic correlations between meteorites and within a meteorite will be made so as to elucidate physical-chemical relationships in the meteorite population. From these relationships will be deduced the nature of the processes that were involved in the origins, accretion and distribution of these objects and their components in the early solar system. In turn these processes are modeled by laboratory or computer experiments from which the chemical and mineralogical outcomes can be determined. Findings from meteorite analyses and model studies are then compared for self-consistency.

W85-70306 **152-14-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: GEOCHRONOLOGY
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to determine the absolute time when a particular event, such as the eruption of a volcano or the formation of a large impact crater, occurred. The concentrations of radioactive decay products and the corresponding parent isotopes will be measured in carefully selected rock samples using mass spectrometric techniques. With knowledge of the decay constant (half life) for the radioactive element, and assuming a closed chemical system, the time since system closure may be deduced. Systems currently in use are: K-Ar, Rb-Sr, Sm-Nd, Lu, Hf and U-Th-Pb. Study of extinct radioactive nuclides, such as Pu, leads to information on the interval of time between the formation of the nuclide and its incorporation into a solid.

W85-70307 **152-15-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: ISOTOPE STUDIES
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to determine the isotopic composition of selected elements in planetary materials. Isotopically distinct material, which cannot be understood as the product of known fractionation processes, may indicate the presence of pre-solar material. Light elements are studied to learn more about fractionation processes. A secondary objective is to develop an ion microprobe which will provide easier

analysis and increased spatial resolution and sensitivity for isotopic composition measurements. Samples of moon rocks and meteorites will be analyzed using mass spectrometric techniques to learn isotopic compositions, mainly of noble gases, hydrogen, carbon, oxygen and nitrogen. Theoretical calculations will be made to relate the expected products of nucleosynthesis to observations of anomalous material in meteorites. A commercially purchased ion microprobe is being upgraded in the laboratory of G. J. Wasserburg, C.I.T.

W85-70308 **152-17-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: SURFACE AND EXPOSURE STUDIES
J. W. Dietrich 713-483-6241

The general objective is to obtain information about the nature, origin and evolution of the Solar System. The specific objective is to learn about the interaction between the space environment, which consists of meteorites, galactic cosmic rays, and solar particles and electromagnetic radiations. Samples of the lunar regolith offer the opportunity to find variations in the intensity of the environmental factors over geologic time. A variety of approaches will be used. The radioactivity of cosmic-ray produced nuclides will be analyzed as a function of sample depth. Surfaces will be studied using electron microscopes. Etchable heavy element ionization damage tracks will be revealed and studied. Solar wind noble gases will be analyzed mass spectrometrically. Multidisciplinary studies will be done using selected samples.

W85-70309 **152-19-40**
Lyndon B. Johnson Space Center, Houston, Tex.
EARLY CRUSTAL GENESIS
W. C. Phinney 713-483-3816

If meaningful models are to be developed for the evolution of the solar system, then physical and chemical constraints must be developed for the processes involved in the evolution of the solid objects in the solar system. The specific objectives are: to identify the key physical and chemical processes and the initial conditions for crustal evolution, to understand the evolution of planetary crusts in relationship to the overall history of individual planetary bodies, and to understand the reasons for the differences in evolution among the various planetary crusts. The strategy is to adopt an interdisciplinary and cross-planetary approach to the questions of crustal genesis. The program is a multidisciplinary effort carried out by individual scientists and teams from universities, industries, and government agencies. Major efforts will be devoted to: studying samples that are related to the early formed crusts, searching for early terrestrial crustal units, studying materials from potential terrestrial analogs of early planetary crusts, and modeling crustal evolution.

W85-70310 **152-20-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS: PRESERVATION AND DISTRIBUTION
D. P. Blanchad 713-483-3274

This RTOP provides for maintenance of the Lunar Sample Collection under secure, controlled environment conditions; for the description of samples as new materials are prepared for analysis; for the maintenance of records of the status and distribution of lunar samples; for providing lunar samples to approved investigators and for display purposes; and for technical monitoring of NASA-funded grants/contracts to Extraterrestrial Materials Investigators. Similar functions are provided for the Antarctic meteorite collection, including initial description, processing for distribution to investigators, and maintenance under controlled environment. Information on the meteorite collection is disseminated. Staff members participate in field collection. Cosmic dust samples are collected and characterized using high altitude aircraft for distribution to scientific investigators. Curatorial techniques for, and educational use of, materials from the various collections are developed. Operation, which is undertaken by support contractor personnel, is directed by Civil Servant scientists and administrators. The program provides samples and information for about 65 domestic and foreign lunar sample investigator groups, over 100 meteorite investigtor groups, and six to ten cosmic dust investigators.

W85-70311 **152-30-40**
Lyndon B. Johnson Space Center, Houston, Tex.
PLANETARY MATERIALS - LABORATORY FACILITIES
M. B. Duke 713-483-4464

This plan provides for support by JSC of a general operational nature necessary to the conduct of the OSSA Planetary Materials Program. It provides inhouse laboratory maintenance and Center Operations support for the visiting scientist programs of the NASA and other organizations (National Research Council, Lunar and Planetary Institute, NASA Graduate Intern, etc.) and to the Sample Curator. It provides for modernization of instrumentation to maintain optimum analytical capability for staff and visitors.

W85-70312 **152-30-40**
Lyndon B. Johnson Space Center, Houston, Tex.
JSC GENERAL OPERATIONS - GEOPHYSICS AND GEOCHEMISTRY
M. B. Duke 713-483-4464

General operations support a variety of institutional and scientific support tasks at JSC that are considered essential for the conduct of research and for implementation of the Planetary Geophysics and Geochemistry Program. Center support services such as printing, computer, photographic, and graphics are provided to the Lunar and Planetary Institute through a procedural agreement. Inhouse support provides for co-sponsorship of conferences, laboratory costs required by visiting scientists using existing facilities, and for cost required to operate common laboratory facilities and to provide for support services from other Center elements.

Planetary Atmospheres R&A

W85-70313 **154-10-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY ATMOSPHERIC COMPOSITION, STRUCTURE, AND HISTORY
J. B. Pollack 415-965-5530

Theoretical modeling and spacecraft data interpretation are used to determine the properties and physical processes characteristic of planetary atmospheres. These properties include their temperature structure, aerosols, cloud layers, gaseous constituents, and opacity sources. Emphasis is placed on reducing and analyzing data returned from spacecraft missions, such as Pioneer Venus and Voyager or preparing for data expected from future spacecraft missions, such as Galileo. However, use is also made of relevant ground-based observations. In addition, the origin and evolution of planetary atmospheres and the outer planets are studied by constructing models that are constrained by relevant spacecraft and ground-based data.

W85-70314 **154-20-80**
Ames Research Center, Moffett Field, Calif.
DYNAMICS OF PLANETARY ATMOSPHERES
R. E. Young 415-965-5515
(155-04-80)

The dynamics of the atmospheres of Venus and Mars are being studied using multi-dimensional circulation models. The coupled momentum and energy equations are solved numerically using combinations of finite difference and spectral methods. The principal goals are to compare model results with spacecraft data and attempt to understand the dynamical effects of varying planetary rotation rate, solar energy deposition, infrared opacity, atmospheric mass and composition. In addition to the modeling studies, participation in the French/USSR VEGA Mission balloon experimental studies of the Venus atmospheric structure and dynamics is continuing by Ames scientists working as part of the U.S. Science Team for this Mission. This work includes review of

experimental approach and discussion of improvements thereto, calibration review and analysis, and analysis of the mission data when they are received.

W85-70315 **154-30-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY CLOUDS PARTICULATES AND ICES
O. B. Toon 415-965-5971

The objectives are: (1) to determine the physical and chemical process responsible for the observed cloud structures on Mars, Venus and Titan; (2) to better define the cloud structure on Titan by reanalyzing Voyager data using a multiple scattering code; (3) to provide comparisons between terrestrial and planetary clouds; and (4) to use models to provide a self consistent framework for determining cloud properties. A generalized planetary cloud computer code is being developed which will allow a large variety of problems to be approached from a consistent framework. This new code should simplify future calculations. Currently existing versions of this code are being used to simulate the haze on Titan and Martian dust storms. The chemical clouds of Venus and the condensational clouds of Mars and Titan will be studied in the near future.

W85-70316 **154-40-80**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING OF ATMOSPHERIC STRUCTURES
G. S. Orton 213-354-2460
(154-10-80)

The objective of this research is the development of accurate numerical approaches for the interpretation of infrared remote sensing data obtained under realistic conditions, in the presence of anticipated measurement noise as well as in the presence of clouds and aerosols. Five important problems will be addressed: (1) determination of atmospheric temperature profiles in the presence of clouds and aerosols when cloud cover is uniform or when temperature and cloud variations are highly correlated, (2) determination of both macro- and microphysical cloud properties, (3) determination of temperature in the presence of strong positive temperature gradients, (4) determination of gaseous abundance profiles in the presence of clouds, (5) assembly of requisite molecular spectroscopic data for the application of these techniques in the outer solar system. The approach will use a relaxation technique developed by Chahine, coupled with accurate and efficient radiative transfer algorithms, together with a simultaneous theoretical approach to these problems. Testing of these techniques will be done using numerical simulations of data, comparing the conditions of the generating model with those retrieved by the technique. The model test environments of significance in the near term will be the outer planets and Mars, in support of Voyager and Galileo data analysis and future mission experiment planning.

W85-70317 **154-60-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY AERONOMY: THEORY AND ANALYSIS
R. E. Hartle 301-344-8234

The basic objective is to study the observed properties of the neutral atmospheres and ionospheres of the planets and their satellites, including Earth, in order to identify and interpret the physical and chemical processes governing their behavior, encompassing solar planetary relationships. The motivating philosophy here is that the study of processes occurring in the atmospheres and ionospheres of the planets and their satellites provides important insights into the nature of similar processes operative in the Earth's atmosphere and ionosphere under different parametric conditions and vice versa. The investigations are pursued by analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated. The data are used to determine the various chemical, compositional, dynamical and energetic states of the respective atmospheres and ionospheres, including the transport and deposition of mass, momentum and energy in these regimes. In general, the approach involves the development of empirical descriptions of either global or small scale phenomena using data sets from a variety of spacecraft. These empirical descriptions of the atmospheres and ionospheres are subsequently interpreted using theoretical models developed to deduce the physical and chemical processes involved. Some of the specific phenomena addressed in this investigation include: atmospheric and ionospheric motions on Venus, Jupiter and Earth, interactions of solar wind and/or magnetosphere with atmospheres of Venus, Titan, and Earth, including modification of transport coefficients by instability processes, solar planetary relationships, comparative planetary atmospheres, etc.

W85-70318 **154-60-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY THEORY AND ANALYSIS/COMET MODELS
W. T. Huntress, Jr. 818-354-8275
(154-75-80)

Theoretical chemical models will be constructed of the chemical structure of cometary comae. The first objective is to derive constraints on the initial composition by comparison with observation, and thus make deductions concerning the origin of comets. The second objective is to prepare a model of the ion coma for comparison with Table Mountain Observatory data and to provide a pre-encounter model for the Giotto, ion mass spectrometer team.

W85-70319 **154-75-80**
Jet Propulsion Laboratory, Pasadena, Calif.
AERONOMY: CHEMISTRY
W. T. Huntress, Jr. 818-354-8275
(154-60-80)

The objective of this work is to conduct laboratory investigations of the ion chemistry of planetary atmospheres and cometary comae. The goal of the ion chemistry work is to obtain product distributions and rate constants for ion-molecule reactions important in the atmospheres of the planets, their satellites, and in cometary comae. The goal of this work is to elucidate the chemistry of the Venus atmosphere in the 60-110 km region. The roles of SO2 and HCl in the Venus atmosphere will be studied, with the particular objectives of explaining the photochemical stability of CO2 and the detailed sulfur chemistry leading to cloud formation. Photochemical experiments relevant to hydrocarbon chemistry in the Titan atmosphere will be conducted.

W85-70320 **154-80-80**
Goddard Space Flight Center, Greenbelt, Md.
EXTENDED ATMOSPHERES
H. A. Taylor, Jr. 301-344-6610

The objective of the RTOP is to advance the understanding of comparative solar-planetary relationships. Global characteristics of ionospheric-neutral atmosphere variations are studied, as indicators of energy coupling processes regulating the upper atmosphere in the region extending from cloud levels to the ionopause. By examining the behavior of the ionic constituents at lower altitudes near the exobase and at higher altitudes approaching the ionopause, insight is obtained with respect to collision dominated as well as collisionless processes. Studies of Venus will examine longer term effects, such as the basic planetary atmosphere evolution, as well as short term effects such as the ion and neutral response to variations in solar radiation and in the solar wind. The approach involves the analysis of global sets of planetary and interplanetary satellite data describing the composition, structure, and energetic states of the planetary atmosphere-ionosphere system. The study emphasizes phenomenological data sets descriptive of uniquely varying conditions or events. Results of the empirical studies are assessed in terms of current theoretical models. Comparison of model results for contrasting planetary conditions, e.g., Earth and Venus, are performed to test basic physical concepts.

W85-70321 **154-80-80**
Jet Propulsion Laboratory, Pasadena, Calif.
EXTENDED ATMOSPHERES
Z. Sekanina 818-354-7589

The nature of the cometary nucleus and the ejected dust are investigated by techniques which combine a dynamical approach with photometric considerations. The aim is to interpret a broad range of dust phenomena in the coma and tail, to assess the material strength of the nucleus and the degree of heterogeneity of its surface, to determine the rotation constants of comets, and to examine their nonuniform activity with time, especially the occurrence and distribution of outbursts. The main object of study is the surface morphology of Comet Halley, for which high-resolution photographs from the 1910 apparition are digitized, image processed, and analyzed in collaboration with S. M. Larson, University of Arizona. The overall objectives of this research are to investigate the dynamical response of the dayside Venus ionosphere to changing solar wind conditions and to examine the role that short timescale phenomena play in the observed ionospheric structure. This will be accomplished by modeling observed variations in ionospheric density, temperature, and magnetic field profiles, including ion-neutral coupling effects. In particular, ion-neutral coupling in the main peak region of the Venus ionosphere will be simulated using the coupled continuity and momentum equations, including photoproduction, chemical loss and magnetic pressure. Time scales for ionospheric dynamical processes will also be calculated, including MHD and acoustic-gravity wave propagation, horizontal and vertical advection, chemical loss, MHD instability and turbulence, and the effects of varying upstream conditions on ionopause dynamics. The stability, structure, and dynamics of Kelvin-Helmholtz and turbulence-generated flux ropes will also be simulated.

W85-70322 **154-90-80**
Ames Research Center, Moffett Field, Calif.
PLANETARY LIGHTNING AND ANALYSIS OF VOYAGER OBSERVATIONS AND AEROSOLS AND RING PARTICLES
W. J. Rorucki 415-965-6492

The general objectives of this research are to determine the role of atmospheric electrical processes in the evolution of planetary atmospheres and to delineate the electrical and meteorological processes that give rise to the extreme electric fields required for lightning. The general approach is to use comparative planetology; i.e., to compare the spacecraft observations with terrestrial observations and theory in order to understand the processes occurring on other planets and to check the applicability of the theories that have been developed to explain terrestrial lightning and atmospheric electricity. Efforts will be directed toward determining the location of the lightning activity on Venus and Jupiter and toward determining the roles of condensible vapors and air-mass convergence. The electrical charging of aerosols and droplets will be considered. Images of Titan, Saturn, Jupiter and the rings of Jupiter and Saturn obtained by Voyager are used to determine the properties of atmospheric and ring particles. Radiative transfer programs are used in conjunction with the data to quantify particle characteristics.

Mars Data Analysis

W85-70323 **155-04-80**
Ames Research Center, Moffett Field, Calif.
PHYSICAL AND DYNAMICAL MODELS OF THE CLIMATE ON MARS
R. Haberle 415-965-6364

The climate of Mars is characterized by the seasonal cycles of dust, water and CO2. While the Viking and Mariner 9 spacecraft missions have provided a good first order definition of the amplitude and phase of these cycles, the processes controlling them remain uncertain. The objectives of this work are to understand: (1) how the presence of suspended aerosols (dust or ice) affects the CO2 cycle; (2) what role atmospheric transport plays in the water cycle and how that role changes with the occurrence of global dust storms; and (3) how much dust can be transported into polar regions during global dust storms. The approach is to develop 1-D and 2-D models that numerically simulate the present CO2 and water cycles. The models will include both solar and infrared effects of aerosols, cloud microphysical processes, and the transport of passive and active (radiatively) tracers. The 1-D model will be used to isolate aerosol effects on the CO2 cycle and assess the significance of diurnal variations on the water cycle. Results of the 1-D simulations will then be used to help design the 2-D experiments which will focus on the role of atmospheric transport.

W85-70324 **155-04-80**
Jet Propulsion Laboratory, Pasadena, Calif.
VEGA BALLOON AND VBLI ANALYSIS
R. A. Preston 213-354-6895
(154-20-84)

In June 1985, two balloons will be inserted into the Venus atmosphere as part of a Soviet/French mission to Venus. U.S. scientists are members of the Balloon Science Team. The balloons will float at 55 km altitude near the equator and last 1-2 days. Ground-based VLBI tracking will provide the three components of the wind vector as a function of time. These measurements combined with in-situ measurements of temperature, pressure and relative vertical wind velocity, will allow an analysis of atmospheric transport of momentum and heat by eddy motions. In-situ measurements of cloud density and lightning will also be performed. This task supports management of the U.S. science team, mission planning, and VLBI analysis.

W85-70325 **155-20-40**
Lyndon B. Johnson Space Center, Houston, Tex.
MARS DATA ANALYSIS
W. C. Phinney 713-483-3816

The broad objective of the study of planetary surface processes is to develop a coherent body of data on planetary surface processes which can be used to design planetary missions and to interpret data as well as place boundary conditions on planetary evolution. The study of appropriate analogues not only places boundary conditions on the evolution of other planets such as Mars but also permits, on Earth, the evaluation of the characteristics of planetary surface instrumentation. Future exploration of Mars and other planets includes surface analysis and sample return missions. The development of these missions requires suitable instrumentation for analyses on the surface of Mars and analogues of Martian surface material. The specific objective is: To study the weathering processes that are driven by UV and particulate radiation. The approach will be through use of a simulation chamber that reproduces Martian weathering conditions, and a variety of analytical techniques to study the weathering products.

Halleys Comet Watch/Experiments

W85-70326 **156-02-02**
Goddard Space Flight Center, Greenbelt, Md.
THE LARGE SCALE PHENOMENA PROGRAM OF THE INTERNATIONAL HALLEY WATCH (IHW)
John C. Brandt 301-344-8701

The major objectives of this program are: (1) to construct a worldwide network of observatories with wide field imaging capability for participation in the Large Scale Phenomena portion of the International Halley Watch; (2) to scientifically analyze the imagery obtained from the net using sophisticated state of the art computer image processing techniques; (3) to provide support to the deep space comet Halley missions flown by international space agencies. The International Halley Watch (IHW) is an organization whose steering group is composed of members from many countries and whose purpose and functions--the advocacy of worldwide observations of Halley and the collection and analysis of any data such obtained--has been officially endorsed by the International Astronomical Union (IAU). The present investigator (J. C. Brandt) has been selected as discipline specialist for the Large Scale Phenomena program of the IHW. He and his science team will administer this program via the construction of a worldwide

network for the observation of large scale phenomena such as rapidly variable plasma tail features and similarly wide field dust tail structures. The program's modus operandi requires the forwarding by participating observatories of their best photographic plates (or film copies) to the Science Team for analysis. Individual observatories retain full proprietary rights to the analysis of their own data whereas the discipline specialist and his team reserve the right to analyze the worldwide data as a whole.

W85-70327 **156-02-02**
Jet Propulsion Laboratory, Pasadena, Calif.
INTERNATIONAL HALLEY WATCH
R. Newburn 818-354-2319

The objective of the International Halley Watch is to maximize the scientific value of ground-based observations of Halley's Comet. Important in their own right, such observations will also enhance the value of space observations, setting the brief duration flyby data in the context of the overall apparition, placing the extremely high resolution encounter data into the normal scale of observations, and filling in missing data. Its goals are to standardize observing techniques wherever useful and possible, to coordinate the observing, and to collect and publish all data in a comprehensive Halley Archive. The IHW is designed to avoid the problems of 1910 where the two major monographs on Halley were not published until 21 and 24 years later and where much data remains unpublished to this day. Individual nets of observers worldwide are organized for each observing technique by seven Discipline Specialist teams. Overall IHW coordination internally and with flight projects is the responsibility of a Lead Center Organization (LCO) established in Pasadena, CA, USA and Bamberg, FRG, as is responsibility for IHW publications.

W85-70328 **156-03-01**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO HALLEY MODELLING
R. L. Newburn, Jr. 818-354-2319

The primary objective of this task is creation of detailed, quantitative, environmental models of Halley's Comet to aid in proper design and flight of a spacecraft and of spacecraft instruments. Two efforts are under way to model P/Halley. One aims at understanding the range of physical parameters of normal comets, placing Halley among these by use of its light curve (brightness vs. time) determined in 1910. The other attempts to better understand Halley through study of all available 1910 observations. The general models are advancing toward a self-consistent set of physical parameters, with only a few free parameters to be based upon observation. The 1910 photographic plates are being computer enhanced to aid the second approach. The general theory is being programmed to provide environmental models along any selected spacecraft trajectory.

W85-70329 **156-03-02**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO EPHEMERIS SUPPORT
D. K. Yeomans 213-354-2127

The objectives under this task are to provide the European Space Operations Centre (ESOC) with information, analysis and documented software that will enable them to independently update the orbit and ephemeris of comet Halley in 1985 to 86. The results of this task will be used at ESOC for operational support of the Giotto flight project. The operational ephemeris software will be built from existing research software. Modifications will be made to ensure that the software is state-of-the-art and compatible with existing ESOC hardware. An effort will also be made to improve upon the existing, but imperfect, nongravitational force model for comet Halley's motion. Data processing programs and data transmission techniques will be developed, tested and delivered to ESOC. The Comet Operational Program (COP) and the data processing programs (OBSGEN, OBSTOM, OBSTOC) will be developed, tested, documented and installed on the ESOC IBM compatible computer system. The COP program will be modified to allow error analysis and as comet Halley astrometric data arrives at the headquarters of the International Halley Watch Astrometry Network (at JPL), the data will be verified, weighted, reduced and transmitted electronically to ESOC.

W85-70330 **156-03-03**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO ION MASS SPECTROMETER CO-INVESTIGATOR SUPPORT
M. Neugebauer 818-354-2005

The objectives of this task are to: (1) optimize the design of the Ion Mass Spectrometer based on the High Energy Range Spectrometer (HERS) for use on Giotto, (2) generate an end-to-end computer simulation of the trajectories of ions through the instrument, (3) assist in calibration of the flight and spare instruments, (4) prepare for data analysis, and (5) support the Principal Investigator of this experiment as required. The approach involves both computer simulation of the instrument and participation in instrument calibration. Frequent contact between all team members is maintained to coordinate interfaces and requirements. This task also involves the generation of required documents, development of data-reduction algorithms, evaluation of instrument performance, analysis of flight data, and submission of reduced data to the National Space Science Data Center.

W85-70331 **156-03-04**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO PIA CO-I
Z. Sekanina 818-354-7589

There are three primary objectives under this task. The first is the theoretical support for the PIA experiment (Sekanina, Zook) which includes the study of the dust environment of Comet Halley, the formulation of dust models, and the structure of the surface layer of the comet's nucleus. The second objective is the laboratory support for the experiment (Brownlee, Clark, Utterback) which includes a study of fine-grained extraterrestrial particles by a laser mass spectrometer, by an ion microprobe, and via X-ray microanalysis in the scanning electron microscope; the preparation of test projectile particles; the provision of test results and circuit design information related to the impact light-flash subsystem and the high speed ion sensor subsystem; and the assistance in developing and applying a laser blow-off ion source for particle impact simulation in flight readiness tests. The third objective is the participation in the flight data reduction and interpretation (all co-investigators) which includes the conclusions on the particle composition, mineralogy, dust production, particle-mass distribution, and nucleus structure and evolution.

W85-70332 **156-03-05**
Goddard Space Flight Center, Greenbelt, Md.
GIOTTO, MAGNETIC FIELD EXPERIMENTS
Mario H. Acuna 301-344-7258

We shall participate in the magnetometer experiment for the GIOTTO mission to comet Halley. This experiment will provide rapid (up to 30 vectors/sec), precise (0.1%), accurate and very sensitive (+ or - 0.004 nT) vector measurements over a wide dynamic range (7 ranges from + or - 16 nT to + or - 65536 nT, with the uppermost ranges for easy check-out during S/C integration) of the magnetic fields observed during the GIOTTO encounter of comet Halley in March 1986. Near closest approach we shall be most interested in the possible signatures in the magnetic field of dynamical processes originating near the cometary nucleus and the possibility of an intrinsic cometary magnetic field. The latter objectives would obviously be favored by an encounter as close to the nucleus as possible. Another major objective is the study of the interaction between comet Halley and the solar wind at 0.897 AU. This includes the identification of boundary surfaces such as an expected cometary bow shock and the transition region between a cometary magnetosheath and the cometary atmosphere closer to the comet. In addition, we shall investigate the role of the magnetic fields in the coma and magnetosheath, and dynamical phenomena in the plasma interaction caused by temporal variations of the cometary gas and plasma source.

W85-70333 **156-03-07**
Jet Propulsion Laboratory, Pasadena, Calif.
GIOTTO DIDSY CO-I
Z. Sekanina 818-354-7589

This RTOP covers the activities of two co-investigators on the GIOTTO Dust Impact Detection System (DIDSY) experiment. There are two objectives: (1) theoretical study of the dust environment of Comet Halley, based on 1910 data from Halley and recent data from other comets, prior to the GIOTTO encounter, in order to assist the DIDSY team in experiment definition, flight strategy and data interpretation; (2) participation in the analysis and interpretation of the DIDSY data after encounter, with emphasis on the particle mass distribution, spatial distribution, dust production rate, and relation to the large body of optical and infrared remote sensing data. Models of the dust flux, mass (size) distribution, and potential temporal and spatial variation for Halley's Comet will be developed, based on observed structure in the coma of Halley's Comet in 1910, the orientation of the dust tail, and analysis of the dust thermal emission and optical scattering in recent comets expected to be similar to Halley. The co-investigators will participate in the analysis of the DIDSY data, with emphasis on the mass distribution, spatial and temporal variations, and the relation between the in situ DIDSY measurements and remote sensing optical and infrared data.

Planetary Instrument Definition

W85-70334 **157-01-70**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED CCD CAMERA DEVELOPMENT
S. A. Collins 818-354-7393

A multielement program will be continued to develop the technology which will improve the performance and reduce the costs of imaging systems for future planetary missions. Specific objectives include developing a standard planetary CCD, developing a lightweight optical system, extending system response into the ultraviolet, increasing the system's spectral resolution, and developing the capability to automate exposure and gain selection. The CCD development will be accomplished in conjunction with a contractor while the other tasks will be developed at JPL.

W85-70335 **157-03-50**
Goddard Space Flight Center, Greenbelt, Md.
X-GAMMA NEUTRON GAMMA/INSTRUMENT DEFINITION
J. I. Trombka 301-344-5941

The objective of this investigation is to develop remote sensing and in-situ measurement systems for geochemical and geophysical exploration of the planets, asteroids and comets. These studies will be consistent with the planetary program recommended by the Solar System Exploration Committee (SSEC). The remote sensing X-ray spectrometer study will consider proportional counters, solid state detectors, and imaging systems. Elemental composition for elements with atomic numbers greater than Z=6 (carbon) using X-ray fluorescent spectral measurements are being considered. Both theoretical and experimental studies will be used in the investigative program. Both gamma-ray and X-ray detector systems are significantly affected by the space radiation environment. Both induced backgrounds and radiation damage in gamma-ray detectors (i.e., NaI(Tl), CsI(Na), Ge(Li) and Ge (high purity)) have been studied and methods for predicting the magnitude of these effects are under development. There is not a geat deal of information available on the effects of the space radiation environment on X-ray detectors. Balloon flights of remote sensing gamma-ray and X-ray spectrometer systems will be flown in order to ascertain their sensitivities and the magnitude of the space environment induced activity. For soft landings on planetary, asteroid or cometary bodies, in-situ elemental analysis can be performed utilizing X-ray fluorescence and neutron-gamma-ray techniques. Tests of the laboratory neutron-gamma-ray system will be carried out.

W85-70336 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
SCANNING ELECTRON MICROSCOPE AND PARTICLE ANALYZER (SEMPA) DEVELOPMENT
A. Albee 818-354-4215

The overall goal of the SEMPA instrument definition and development task is to prove the flight readiness of the experiment by demonstrating through development of the breadboard instrument now operating in the laboratory our ability to deliver a functional, reliable flight instrument of acceptable weight and power. Imaging spatial resolution better than 100 nanometers and X-ray energy resolution suitable to resolve magnesium, aluminum, and silicon using a room temperature X-ray detector recently have been demonstrated. The estimated weight and power are considered to be suitable for a Mariner Mark II comet rendezvous mission. Therefore, the primary goal now is to prove that the instrument can be made reliable in the context of a class A instrument. No significant obstacles to this demonstration are apparent. In order to prove that the instrument performance is suitable to meet the requirements of the mission and of the experiment, it is also necessary to demonstrate the required X-ray resolution without the use of a radiative cooler, to achieve the desired imaging resolution, and to breadboard the sample acquisition and processing subsystem necessary for presenting comet dust samples to the electron optical column and detectors. We must also define a number of design features relating to stability and lifetime before entering the flight project. Finally, we will strive to better understand the experiment cost and minimize it.

W85-70337 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED GAMMA-RAY SPECTROMETER
A. E. Metzger 213-354-4017

This RTOP supports the development of a gamma-ray spectroscopy remote sensing space experiment to determine the surface concentrations and distribution of naturally radioactive and cosmic-ray-excited isotopes representing a variety of elements in the surfaces of solar system bodies. The advanced gamma-ray spectrometer utilizes a large high resolution Ge' detector with sensitivity greatly superior to the Apollo instrument. Scientific and engineering studies are aimed at evaluating the capabilities of the system and developing the long-lead technology subsystems needed to demonstrate feasibility. These include thermal and mechanical testing of Ge detector assemblies, study of gamma-ray response characteristics, establishing the influence of heavy ion bombardment, design and fabrication of the radiative coolers and the addition of a neutron mode which will minimize dependence on modeling where ground site validation is unavailable.

W85-70338 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
IN-ORBIT DETERMINATION OF SPACECRAFT AND PLANETARY MAGNETIC FIELDS
E. J. Smith 818-354-2248

There is indirect evidence that Mars is weakly magnetized with surface fields of up to 60 nT, but the other properties of the field are unknown. Numerous scientific disciplines, such as planetary interiors, dynamo theory, geosciences, and solar planetary relations should all benefit from knowledge of Mars' magnetic field. The performance of available space flight magnetometers is more than adequate to meet the scientific objectives. However, the principal limitation will be the ability to separate the magnetic field contributed by the spacecraft from the planetary magnetic field. The techniques used, or attempted, on past missions are inappropriate to a low altitude Mars orbiter. The problem will be aggravated by the procurement of an off-the-shelf spacecraft manufactured by industry without a magnetic cleanliness program. We propose to carry out a systems study of various magnetometer-boom configurations to determine how this separation may be best effected and with what accuracy. Computer simulations and analyses will be combined with studies of various sensor-boom combinations to identify the optimum configuration and the major implications and requirements of

competing designs. The study results will be made available to NASA, the Mars Geochemical Observer (MGCO) project and the Science Working Team through regular contacts, briefings and written reports.

W85-70339 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
DEVELOPMENT OF DUAL FREQUENCY ALTIMETER AND MULTISPECTRAL RADAR MAPPER/SOUNDER
C. Elachi 818-354-5673

The objective of this activity is to define, develop and test the critical elements of a dual frequency (1.2 GHz, 37 GHz) altimeter applicable for the Mars Observer, and a multispectral (1.2 GHz, 8.3 GHz and 25 GHz) radar mapper/sounder applicable to a Titan Orbiter. The emphasis will be on developing the basic radar sensor element which could be applied for multiple missions, in addition to the Mars Observer and Titan Orbiter, such as LGO and other observer or Mariner Mark II missions. The approach is to develop a modular architecture where a large number of the modules are common for both the Mars Observer and Titan radar sensors. These modules will be defined, developed and tested in the laboratory. In addition, some modules which are unique and critical to each sensor, and require technological development, will also be developed.

W85-70340 **157-03-70**
Jet Propulsion Laboratory, Pasadena, Calif.
IR SPECTRAL MAPPER (MCALIS)
J. B. Wellman 213-354-6638

The objective of this task is to define and develop infrared imaging spectrometer designs which will be used on upcoming missions to Mars, Comets, Asteroids, and the Moon. A major goal is to achieve the maximum design commonality for different missions, thus reducing the overall cost. The near term objective is to define the instrument designs for the Mars Geoscience and Climatology Orbiter (MGCO) mission and for the Comet Rendezvous/Asteroid Flyby (CRAF) mission. The first objective of the task is to develop a baseline imaging spectrometer approach, from which specific mission implementations can be derived. Major tradeoffs to be considered include: line array vs. area array detectors, instrument cutoff wavelength, focal plane cooling, and data editing and compression. The baseline instrument is expected to be derived from the Galileo NIMS instrument, with the incorporation of state-of-the-art focal plane technology. The development of instrument concepts and tradeoff will be conducted on a schedule consistent with responding to the Announcements of Opportunity (AO's) for the upcoming MGCO and CRAF missions.

W85-70341 **157-04-80**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY ATMOSPHERE EXPERIMENT DEVELOPMENT
H. B. Niemann 301-344-8706

The objective is to develop practical techniques using mass spectrometers for the determination of the neutral gas and ion composition, both major and minor constituents, in the upper and lower atmospheres of the planets and in the vicinity of comets. A parallel effort in sensor and sampling technique development, support system development and simulation, and calibration equipment design will be pursued. Techniques to measure trace constituents in the parts per million and parts per billion range and isotope ratios will be developed. Chemical enrichment techniques will be utilized to effectively increase the trace constituents concentrations. The chemical enrichment technique involves collecting the trace constituents on various selected sorbents and perferentially releasing them in their concentrated states by elevating the sorbent's temperature. These techniques will be developed for high pressure and rarefied gas environments. Consideration will be given to alternate approaches such as gas chromatography and mass spectrometry. A significant increase in the dynamic range of instruments operating in a high pressure atmosphere can be achieved by ionizing at a higher pressure with more ions available for analysis and detection. At high pressure the mean free path is short compared to source dimensions and ions collide with neutral species before they are extracted into the lower pressure regime of the analyzer section. The improvement is achieved by minimizing the ionization volume, improving the ion extraction efficiency, and at extreme high pressure levels using ion-molecule reactions as an intermediate step before mass analysis.

W85-70342 **157-04-80**
Jet Propulsion Laboratory, Pasadena, Calif.
PRESSURE MODULATOR INFRARED RADIOMETER DEVELOPMENT
D. J. McCleese 213-354-2317

The objective of this task is the development of advanced infrared instrumentation for NASA's program of planetary exploration from spacecraft. The following atmospheric science goals are emphasized: (1) determine the thermal structure and its spatial and temporal variability in the terrestrial and outer planets; (2) map the abundance and vertical, lateral, and temporal variability of key atmospheric species; (3) measure, by direct and indirect means, atmospheric motion; and (4) determine the physical properties of clouds and aerosols. The investigation of surface phenomena is of importance in the development of infrared instrumentation. In particular the objective is the application of infrared remote sensing to the determination of surface thermal balance, thermal inertia measurements, and the mapping of surface morphology. The approach will be to develop in the laboratory the critical hardware for an advanced infrared sounder. During FY-84/FY-85 this task focuses on the definition and development of the Pressure Modulator Infrared Radiometer (PMIRR) for the Mars Geoscience/Climatology Observer (MGCO). The PMIRR employs pressure modulation spectroscopy and narrowband filter radiometry in both limb and nadir sounding to obtain simultaneous vertical profiles at atmospheric temperature, water vapor, dust, condensates, and pressure.

W85-70343 **157-04-80**
Jet Propulsion Laboratory, Pasadena, Calif.
ENERGETIC ION MASS SPECTROMETER DEVELOPMENT
M. Neugebauer 818-354-2005

The High-Energy Range Spectrometer (HERS) currently under development for the Giotto mission to Halley's comet will be used as the basis for designing energetic ion mass spectrometers which meet the needs of planned planetary missions. The following development activities will be carried out. (1) Investigate methods of reconfiguring or redesigning HERS to enable the detection of ions over a large solid angle from a three-axis stabilized spacecraft using different methods of mechanical and/or electrical scanning of a system of electrostatic mirrors and/or electrodes. Computer programs written for HERS will be modified to model the ion optical properties of the most promising approaches. A breadboard of one or more ion optical concepts will then be built and its properties will be measured. The probable effects of cometary dust will be analyzed. (2) Methods of improving the HERS two-dimensional imaging sensor will be investigated. The parameters which determine the polarity of the output pulse from the contact anode used on HERS will be determined. Trade studies will be performed to determine the relative merits of the imaging method designed for HERS versus new methods for obtaining two-dimensional data. The feasibility and probable cost of using sensors larger than the 40 mm diameter HERS sensor will be investigated. (3) The cost and weight impacts of augmenting the HERS design to assure the long detector operating time required for future planetary missions will be investigated. (4) Trade studies involving mass range, mass resolution, sensitivity, dynamic range, field of view, and time resolution will be carried out for several planned planetary missions (with emphasis on the Comet Rendezvous Mission), taking the results of items (1)-(3) above and the planned features of the Planetary Observer and Mariner Mark 2 spacecraft into account.

W85-70344 **157-05-50**
Goddard Space Flight Center, Greenbelt, Md.
PLANETARY INSTRUMENT DEVELOPMENT PROGRAM/ PLANETARY ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-50; 196-41-54; 188-41-55)

This RTOP supports the development of components for advanced generation infrared spectrometers for planetary observations. The development of compact, power efficient infrared hereodyne spectrometer components suitable for eventual phase flight use is addressed. Particle emphasis is placed on developing RF-excited waveguide CO2 lasers, passively cooled photomixers and pre-amplifiers, and integrated acousto-optic spectral line receivers. The development of a long travel, magnetically suspended, cryogenic carriage for the moving mirror of a Fourier Transform Spectrometer is considered. Following verification of the performance of the cryogenic carriage, a brass-board interferometer will be assembled and tested to verify its suitability for future space flight use.

Solar Terrestrial and Astrophysics ATD

W85-70345 **159-38-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR DYNAMICS OBSERVATORY (SDO)
T. E. Thorpe 818-354-3611

This RTOP provides resources for the following activities: (1) An analyzer suitable for a flight Solar Oscillations Imaging Experiment (SOI) will be evaluated. In addition, observations using the selected analyzer together with a large format CCD camera at Mt. Wilson Observatory, optimization of test equipment to support filter design tradeoffs, and intergration of the Galileo telescope with analyzer and SOT camera to demonstrate a breadboard configuration are funded. (2) The SOI conceptual design work will be continued. Systems analyses for a potential flight experiment design will be performed; image stabilizer options, DPU, and in-flight calibration techniques will be reviewed; a functional description of the flight experiment consistent with Solar (SOHO) AO requirements will be provided; spacecraft interface specifications and operating mode requirements will be provided; a T/V test of analyzer stability will be performed; computer model comparisons will be performed with analyzer testing; and an experiment description document will be prepared. (3) JPL task monitoring/selected analyses for SOHO mission, U.S. representation at SOHO (ESA) interface meetings, and the activities of the Science Working Group will be supported.

W85-70346 **159-41-01**
Jet Propulsion Laboratory, Pasadena, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTORS (LDR) FOR ASTRONOMY APPLICATIONS
A. R. Hibbs 213-354-2430

The objectives of this RTOP are to continue advanced studies of problems associated with the design, development, and operation of a Large Deployable Reflector (LDR) Observatory System, and to continue to support science and technology advisory groups. Work under this RTOP will include: (1) studies of specific, focused technical problems such as structural control; (2) continuing system studies of an unfilled aperture configuration for an LDR Observatory System; (3) support of and coordination with the Technology Working Group established by ARC; and (4) administrative support for the NASA Science Advisory Team.

W85-70347 **159-41-01**
Ames Research Center, Moffett Field, Calif.
STUDY OF LARGE DEPLOYABLE REFLECTOR FOR INFRARED AND SUBMILLIMETER ASTRONOMY
R. Bruce Pittman 415-965-5692
(506-62-21)

The objective is to refine and develop concepts for a Large Deployable Reflector (LDR) in space. The LDR will be a free-flyer with a diameter greater than 10 meters to provide access to a broad range of infrared and submillimeter wavelengths and serve a widely based community of scientific users. Work supported by this RTOP can be divided into two parallel and interconnected efforts. The first involves two System Concepts and Technology Definition Studies to examine overall system issues such as the configuration, orbit, and deployment schemes, and to assess the state of technology readiness to implement representative system concepts. The second involves the continued refinement of the scientific rationale and the related set of science requirements developed at the LDR Science/Technology Workshop and the evaluation of specific scientific and technical issues by the science community. These two efforts, together with concurrent technological studies and developments funded by OAST, will ultimately form the basis of an OAST Technology Initiative in order to proceed with LDR with confidence and minimum risk. Work under this RTOP will be done in cooperation and coordination with JPL, LaRC, LeRC, and GSFC.

W85-70348 **159-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
ORBITING VERY LONG BASELINE INTERFEROMETRY (OVLBI)
J. F. Jordan 818-354-7790

The objectives are to delineate the scientific goals and systems for the space applications of VLBI and provide for assessment studies of future space VLBI missions. A joint NASA-ESA VLBI explorer mission has been proposed and assessed. The JPL will continue to provide scientific and engineering support for the mission definition studies being performed jointly between NASA and ESA as well as provide scientific analysis support for a readiness demonstration of space VLBI technologies using the TDRSS. The NSF Astronomy Survey Committee in 1980 specified that a space VLBI mission ranked as a high national scientific priority. The FY-84 pre-phase A level assessment for the QUASAT mission and flight system will continue, there will be coordination compatible with the pre-phase A antenna designs, with the NASA OVLBI technical working group and the ESA QUASAT study group to further refine the QUASAT mission science requirements.

W85-70349 **159-46-01**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF)
C. C. Dailey 205-453-2788

The advanced X-ray astrophysics-facility (AXEF) AXAF is a free-flying observatory featuring a high performance X-ray telescope for use over a 15-year lifetime through STS revisits. The AXAF is now entering the definition phase, aimed at a New Start in FY-87 and a launch in 1991. Due in part to advances in metrology and fabrication technology in X-ray optics, AXAF is expected to be 50 to 100 times as sensitive as its predecessor, HEAO-2. A technology mirror assembly program is aimed at demonstrating the achievability of the AXAF optic goals.

Oceanic Processes

W85-70350 **161-10-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RESEARCH MISSION STUDY - TOPEX
C. A. Yamarone 213-354-7141

The objective is to define a total observational system for the measurement and monitoring of global ocean circulation. This shall be accomplished through the use of an Earth orbiting system capable of providing dedicated high resolution altimetric measurements of ocean surface topography. Specifically, the study will include: (1) the configuration of the mission including precision orbit determination capabilities; (2) the definition of all elements of TOPEX including sensor definition and configuration by the appropriate implementing center; (3) the definition of the interface requirements and integration activities of the major TOPEX elements; (4) the development of a management plan, procurement

strategy, and implementation schedule; and (5) the development of detailed cost information. Science and mission requirements were developed in FY-80 and finalized in FY-81. Mission and satellite concepts were assessed in FY-81 and lower cost mission and systems assessed in FY-82. Limited development of critical sensor elements were initiated in FY-83 along with a further refinement of the configuration of all systems, the management plan, and procurement strategy. A full Phase B Definition effort was initiated in FY-84, including three contractor satellite definition studies and a joint NASA/CNES study of the feasibility of a TOPEX/POSEIDON collaborative mission.

W85-70351 **161-10-03**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED EARTH ORBITER RADIO METRIC TECHNOLOGY DEVELOPMENT
W. G. Melbourne 818-354-5071

The object of this RTOP, begun in FY-81, is to develop a radio tracking system that provides orbit determination of a few cms accuracy for low Earth satellites. In FY-84 it was proposed that a demonstration of precise orbit determination using the Global Positioning System (GPS) be mounted in conjunction with the TOPEX Mission. This RTOP will provide the analysis and development work needed to advance that demonstration. The GPS-based tracking system, called ARTS, involves simultaneous and continuous observations of the 18 Navstar satellites by GPS receivers at approximately six globally distributed unattended ground sites and on the TOPEX satellites. Previous system studies have shown sub-decimeter accuracy can be achieved. A successful ground based demonstration was completed in FY-84. In FY-85 the principal tasks are to refine the TOPEX error analysis to include small but potentially important error sources not examined previously, to finalize the overall system design, to provide analysis support as needed in developing the GPS flight system, to begin the design of the algorithms and the architecture for GPS-based precision orbit determination software, and to develop a plan for the precision orbit determination demonstration to be conducted during the first two years of the TOPEX mission. In FY-84, studies of a GPS flight qualified system for low Earth satellites were begun. In FY-85 a flight system development plan, functional requirements, conceptual design, and cost estimates will be completed. In FY-85 this task will begin the detailed analyses, design, and documentation needed prior to contractor selection and construction of an engineering model will begin. Attention will be given to TOPEX integration requirements such as mass, power, thermal control, and volume limits. Engineering model and prototype development will begin in FY-86 under separate funding provided for the GPS flight demonstration.

W85-70352 **161-30-02**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN PRODUCTIVITY
M. R. Abbott 213-354-4658

The usefulness of satellite imagery of ocean color and the estimation of near surface chlorophyll and primary productivity from such imagery will require an understanding of the effects of vertical variability in chlorophyll content and productivity and the physical and biological processes responsible for such variability. Estimation of chlorophyll and productivity on large horizontal scales will require a similar understanding of the causes of variability, particularly over long time series. Two time series of ocean color and thermal imagery will be developed. There will be collaboration with Dr. K. L. Denman (institute of Ocean Sciences, B.C.) on a time series from the continental shelf off Vanconver Island, B.C., to compare the spatial statistics of CZCS data with the spatial statistics of chlorophyll and productivity field data derived from various vertical integration schemes. Similar statistics of the CZCS and thermal imagery will be compared. Both CZCS and AVHRR imagery will be used to investigate mesoscale phenomena and their relationship to physical forcing and shelf circulation off the northern California coast. Another activity will use shipboard measurements of chlorophyll and productivity to develop relationships between near-surface chlorophyll, as measured by ships and satellites, and water column productivity. This activity is in association with Dr. R. W. Eppley (SIO). A graduate student at SIO will use satellie and ship data to study the effects of tidal forcing on mesoscale variability in the Gulf of California.

W85-70353 **161-30-03**
Jet Propulsion Laboratory, Pasadena, Calif.
SEA SURFACE TEMPERATURES
D. E. Hagan 213-354-7073

The objective of this research is to characterize the variability of the sea surface skin temperature as can be reliably extracted from information in spaceborne mid-infrared radiometric observations. This requires discriminating to high accuracy the absorption and emission effects of the lower boundary atmospheric layer on the surface radiative flux. The approach is to use comprehensive radiative transfer simulations (1) to determine the surface radiance contribution to the measured outgoing flux under a wide range of slightly varying atmospheric near-surface conditions and (2) to evaluate the sensitivity of atmospheric correction schemes which are based on a simplification of the radiative transfer equation.

W85-70354 **161-40-03**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROWAVE REMOTE SENSING OF OCEANOGRAPHIC PARAMETERS
E. G. Njoku 818-354-5607

A workshop activity is in progress to compare and evaluate the accuracies of four satellite techniques for measuring global sea surface temperature (SST). The sensors involved are the AVHRR (NOAA-7), HIRS/MSU (NOAA-7), SMMR (Nimbus-7), and VAS (GOES-East). Sea surface temperature data from these sensors were obtained for common months and are being compared with each other and with in-situ data using facilities of the Pilot Ocean Data System at JPL. Review of the results, and further research, will be undertaken in FY-85. Global-scale analyses of SMMR data from SEASAT and Nimbus-7 are being performed. These will enable the performances of the two SMMR instruments to be compared at both sensor and geophysical levels. Global maps of SEASAT SMMR geophysical parameters were produced, and compared with climatological values and available surface truth. Nimbus-7 SMMR brightness temperatures and geophysical parameters are being generated from the raw data level and analyzed in a manner similar to SEASAT. Long-time-series Nimbus data sets will be used for collaborative studies in global wind analyses (D. Chelton), air-sea fluxes (T. Liu), and sea surface temperatures (SST workshop). The Pilot Ocean Data System (PODS) is entering a new phase of development in anticipation of new satellite data sets for archival in FY-85 and beyond (GEOSAT, SSM/I, NSCATT and TOPEX). Scientific guidance and planning for PODS will be undertaken as part of this RTOP in collaboration with the PODS Project Management and Staff.

W85-70355 **161-40-11**
Jet Propulsion Laboratory, Pasadena, Calif.
ERS-1 PHASE B STUDY
C. F. Winn 213-354-8185

This RTOP covers a study for the acquisition and processing of the synthetic aperture radar (SAR) data from the European Space Agency ERS-1. The data from the SAR will be processed on the ground into images for sea ice, ocean and Earth resources research in Alaska. The science planning for both sea ice, ocean research and Earth resources research will be started. A ground site is required in Alaska to receive and record the wide band SAR data. The requirements for the ground station will be generated for a new system based on a modified LANDSAT ground station. The methods of antenna pointing and the interface with the European Space Agency to obtain the satellite trajectory parameters will be studied. The received SAR data will be shipped to JPL for ground processing in the advanced digital SAR processor (ADSP). Preliminary science plans will be made to allow complete system specifications and plans to be generated. Class A cost will be developed for the new station based on a LANDSAT-D design along with a complete procurement plan that covers the

major procured items. Class A estimates will be generated for the rest of the system. The above will be complete in the first 6 months of FY-85. The remainder of the year will be used in detail planning of the science activities and system design.

W85-70356 **161-50-02**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEANIC REMOTE SENSING LIBRARY
J. E. Hilland 213-354-4787

The library task will acquire, maintain and distribute oceanic remote sensing documents from grey literature. A second goal of ORSL is to distribute an annotated bibliography of papers and reports from open and grey literature. This work is made accessible via computer terminal by the Pilot Ocean Data System. A collection of periodicals and books related to physical and biological oceanography and remote sensing of the oceans comprises the ORSL. Document acquisition, organization, maintenance, distribution and bibliography development are fundamental to the library function.

W85-70357 **161-50-03**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN PROCESSES BRANCH SCIENTIFIC PROGRAM SUPPORT
M. T. Chahine 818-354-2433

The objective of this task is to support the NASA Oceanic Processes Branch in the development and use of remote sensing techniques to study physical and biological oceanic processes and their interactions with the atmosphere.

W85-70358 **161-80-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RADAR STUDIES OF THE SEA SURFACE
R. H. Stewart 213-354-5079

The objective of this research is to investigate the usefulness of SEASAT microwave radiometer data for studies of oceanic rainfall and fluxes of latent heat. Such studies will lead to a better understanding of data to be collected by the SSM/I and to studies of air/sea interaction of use to the Tropical Oceans/Global Atmospheres program. The development of techniques for measuring oceanic rainfall remotely will be undertaken. Noise produced by rain falling on the sea is leading to a new method for calibrating rain rate. The correlation between noise and rain rate will be investigated.

W85-70359 **161-80-15**
Jet Propulsion Laboratory, Pasadena, Calif.
REMOTE SENSING OF AIR-SEA FLUXES
W. T. Liu 213-354-2394

The long term objective is to study atmosphere/ocean exchanges in momentum and energy with spaceborne sensors. The short term objective is to develop and implement remote sensing technique for monthly mean latent heat flux. Case studies completed in FY-84 demonstrate the feasibility of estimating surface layer humidity (required for latent heat flux determination) from columnar water vapor (measured by satellite sensors) to useful degree of accuracy. A universal relation between the two quantities will be developed from archived radiosonde reports. The application of this technique on 1982 NIMBUS-SMMR data in studying the evolution of the warm episode in tropical Pacific will be evaluated. The future intention is to apply this technique to data from DMSP-SSM/I, GEOSAT-ALT and NOAA-AVHRR to study surface water mass formation in tropical Pacific in conjunction with the Tropic Heat/TOGA experiment.

W85-70360 **161-80-37**
Jet Propulsion Laboratory, Pasadena, Calif.
THEORETICAL/NUMERICAL STUDY OF THE DYNAMICS OF CENTIMETRIC WAVES IN THE OCEAN
M. H. Freilich 213-354-6965

The objectives of this work are to: (1) investigate the interactions of centimetric water waves with both the wind field and the long wave field, and to determine the implications of these interactions for the interpretation of scatterometer measurements in terms of surface winds and wind stress; (2) investigate the spatial variability of ocean winds on scales of 200-2000km using vector wind data from the SEASAT Scatterometer (SASS). (1) Current theories of short wave dynamics will be extended to account for the presence of an overlying wind field and an underlying long wave field. A model for direct momentum and energy transfer from winds to short gravity waves will be developed. Dissipation measurements leading to the production of centimetric waves will be examined. (2) Wavenumber spectra of meridional and zonal winds will be calculated. Optimal interpolation techniques will be developed, and full 2d spectra will be calculated if possible. Spectral slopes and total variances will be examined as a function of latitude and ocean basin. Coherences between zonal and meridional components will be used as a partial test of the isotropy of atmospheric motions on 200-2000km length scales. Results will be compared with theories of atmospheric turbulence.

W85-70361 **161-80-38**
Jet Propulsion Laboratory, Pasadena, Calif.
OCEAN CIRCULATION AND SATELLITE ALTIMETRY
L. L. Fu 213-354-8167

The long term goal of the research activities covered by the RTOP is to explore the usefulness of satellite altimetry in observing the general circulation of the ocean and its variability. There are two specific objectives for the FY-85 tasks: (1) Use SEASAT and GEOS-3 altimeter data sets to study the large scale temporal variability of the currents in the equatorial Pacific Ocean and the western North Atlantic Ocean. (2) Use hydrographic data complemented with altimeter data to study the general circulation and heat transport of the South Indian Ocean. A method for constructing time series of sea level variations from crossover differences of altimetric measurements will be applied to the equatorial Pacific and western North Atlantic and the results will be compared with existing in situ observations. Inverse methods and mathematical programming techniques will be used to make inferences from hydrographic and altimetric data about the circulation and heat transport of the South Indian Ocean.

W85-70362 **161-80-39**
Jet Propulsion Laboratory, Pasadena, Calif.
SCATTEROMETER RESEARCH
F. K. Li 213-354-2849
(161-10-08)

The objective of this work is to increase the accuracy of the relationship between microwave radar backscatter from the oceans and basic geophysical quantities of interest to oceanographers and meteorologists such as surface stress and wind velocity. The present geophysical model function relates cross section sigma(0) to neutral stability wind velocity. Comprehensive field data will be acquired to allow sigma(0) to be related directly to wind stress, and to allow the validity and accuracy of the present sigma - velocity model function to be assessed over a wider range of oceanic and atmospheric conditions. Cross section data will be obtained from airborne C- and Ku-band scatterometers. After integration and engineering checkout of the Ku-band scatterometer in FY-85, field data, including measurements of sigma(0), surface wave conditions, surface stress, and other atmospheric and oceanic quantities will be obtained in a subtropical oceanic frontal region in conjunction with the planned FASINEX experiment to be conducted in February, 1986.

Tropospheric Air Quality

W85-70363 **176-10-03**
Goddard Inst. for Space Studies, New York.
GLOBAL TROPOSPHERIC MODELING OF TRACE GAS DISTRIBUTION
David Rind 212-678-5593

The primary objective is to develop a tropospheric model to determine air quality. Contributions towards understanding the

global budgets of the primary trace species and man's potential impact on the trace gas abundances will be examined. Determination of measurement requirements and sampling strategies will be established for tropospheric air quality program, along with measurement interpretation. Three dimensional studies of trace gas distributions will be developed in cooperation with McElroy (Harvard Univ.). A progressive series of studies of trace gases including freons (source known, checks ability to model global transport including stratospheric/tropospheric exchange), methyl chloroform (source known, checks chemistry involving OH), carbon monoxide (sensitive to OH, provides information on sources), and potentially other trace gases will be employed. Three dimensional models will be used to support field programs.

W85-70364 **176-20-99**
Ames Research Center, Moffett Field, Calif.
GTE CV-990 MEASUREMENTS
R. Chan 415-965-6263

The objective of this research is to provide atmospheric measurements on the CV-990 to support the science goals of the Global Tropospheric Experiment (GTE). The emphasis will be to develop instrumentation as necessary, integrate it on the CV-990, operate it in GTE flights, provide data as required by the GTE flights, provide data as required by the GTE Project Office, analyze, interpret, and publish results.

W85-70365 **176-40-14**
Goddard Space Flight Center, Greenbelt, Md.
AIRBORNE LIDAR FOR OH AND NO MEASUREMENT
William S. Heaps 301-344-5106

The objective of this investigation is to develop sensitive and specific instrumentation for measuring the radical species of OH and NO in the troposphere based upon the technique of remote laser induced fluorescence. Improvements in sensitivity by about one order of magnitude from that presently achieved with existing LIDAR systems is the minimum requirement. The approach is to reduce the contribution of interfering fluorescence from various atmospheric species (aerosols, hydrocarbons, etc.) with respect to the species of interest by developing a detector with a very narrow bandpass. Reduction in the background and interference signals should enhance the ultimate sensitivity of the device.

Microgravity Science and Applications SR&T

W85-70366 **179-00-00**
Langley Research Center, Hampton, Va.
PACE FLIGHT EXPERIMENTS
John F. Newcomb 804-865-3968
(506-56-13)

The basic purpose of the PACE (Physics and Chemistry Experiments in Space) program is to facilitate the utilization of space as a laboratory in which to carry out basic research in the areas of physics and chemistry. There are currently 14 experiments in the program in the areas of fluid physics, critical phenomena, combustion, soil mechanics and relativity. The objective of this RTOP is to provide the support to these 14 experiments required to facilitate their development through the conceptual design phase, and to support the necessary Science Peer Reviews.

W85-70367 **179-10-10**
Lewis Research Center, Cleveland, Ohio.
MATERIALS SCIENCE IN SPACE (MSIS)
Fred J. Kohl 216-433-5266

The overall objectives of this effort are to achieve a basic understanding of the role of gravity in the fundamentals of materials science and processing and to define areas of potential applications for low gravity processing using Earth-based or space facilities. Emphasis will be placed on the disciplines of materials science, fluid physics, metallurgy, inorganic and organic chemistry, and high temperature chemistry. Specific thrusts in the FY-85 program will be in the areas of solidification fundamentals, electronic materials, and ceramics along with transport processes and thermo/diffusocapillary flow. The general approach is to conduct both experimental and theoretical research on fundamental materials phenomena in order to define governing mechanisms, validate models, and obtain data unavailable to date because of the limiting and masking effects of gravity. A three-fold effort will be employed: (1) a microgravity materials science experiment definition effort will be conducted in collaboration with the academic and industrial scientific communities, (2) experimental and/or theoretical research projects will be carried out in selected areas utilizing materials research laboratories and the available ground-based reduced gravity facilities, and (3) experimental conceptual designs shall be prepared and experiment apparatus and instrument definition activities shall be conducted.

W85-70368 **179-13-72**
Lyndon B. Johnson Space Center, Houston, Tex.
BIOPROCESSING RESEARCH STUDIES AND INVESTIGATOR'S SUPPORT
Dennis R. Morrison 713-483-5281
(694-01-01)

These research studies are directly related to the Bioprocessing Flight Experiments Program administered under P.O.P. (UPN 694-01-01). These ground based projects are designed with three objectives: (1) to gain a better understanding of basic science questions uncovered by microgravity separations, cell culture, and cell product separation direct from various culture media; (2) to define and screen new candidate cell types or cell products for possible electrophoretic separations or cell culture experiments using the Continuous Flow Electrophoresis System (CFES) or the Cell Culture Bioreactor; and (3) to explore new research applications of the biological target materials and new technology innovation which are developed as part of the NASA Biotechnology program within the Microgravity Sciences and Applications areas. The JSC Bioprocessing Laboratory will coordinate the research among several major universities and medical schools. Access to the Continuous Flow Electrophoresis Ground Research Unit will be provided by the McDonnell Douglas Astronautics Co. and the Texas Medical Center. The JSC will analyze results, coordinate scientific publications, and aid principal investigators in using the information in the conduct of on-going flight experiments. Scientific data will be used to formulate new proposals for flight experiments or ground-based applications of the technology.

W85-70369 **179-14-20**
Jet Propulsion Laboratory, Pasadena, Calif.
GLASS RESEARCH
M. C. Weinberg 213-354-2690

The objective of this RTOP is to establish the scientific framework for the evaluation of flight experiments via the performance of ground-based experiments. In FY-85 work will continue in the areas of gel-derived glasses, nucleation and crystallization of glasses, and gas bubble behavior in glassmelts. The objectives for FY-85 are: (1) to continue study of the surface and internal crystallization of fluoride glass; (2) to study the crystallization behavior of borate compositions prepared by ordinary and sol-gel methods; (3) to perform gas bubble dissolution experiments for single, freely rising bubbles; and (4) to continue study of the phase separation process in gel prepared glasses.

W85-70370 **179-15-20**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTIMODE ACOUSTIC RESEARCH
M. Barmatz 213-354-3088
(179-20-55)

This RTOP will provide fundamental research support for the Advanced Containerless Processing Technology program. New classes of acoustic levitation were discovered at JPL in rectangular, cylindrical, and spherical geometries that may be attained by the excitation of multidimensional acoustic modes (multimodes). These new levitation principles provide us with advanced alternative methods for positioning and manipulating molten materials, which

may lead to rapid cooling, separation of levitation and rotation capabilities, and the selection of arbitrary axes of rotation. The long term objectives of this RTOP are to develop theoretical acoustic models of these levitation classes and to provide experimental validation of these models using research levitation devices. The FY-85 activities will continue to develop a more fundamental understanding of these acoustic levitation properties. The objectives for FY-85 are to: (1) experimentally demonstrate stable acoustic levitation in single mode levitators at moderate temperatures (< or = 750 C), and (2) theoretically investigate capability of very high temperature levitation (< or = 2000 C) using a single mode levitator coupled to a solid state horn. As these new, versatile techniques are verified, they will be incorporated into the Advanced Containerless Processing Technology Program.

W85-70371 **179-20-55**
Jet Propulsion Laboratory, Pasadena, Calif.
CONTAINERLESS STUDIES OF NUCLEATION AND UNDERCOOLING: PHYSICAL PROPERTIES OF UNDERCOOLED MELTS AND CHARACTERISTICS OF HETEROGENEOUS NUCLEATION
E. H. Trinh 213-354-7125
(179-20-56)

The objective of this task is the utilization of the opportunities offered by microgravity and the newly developed containerless materials processing techniques to enhance understanding of the undercooled liquid state, and to perform controlled and reliable solid phase nucleation experimental observations. The deep undercooling of liquid pure metals and alloys, organic compounds, and glass forming substances will be obtained by acoustically suspending droplets of a wide variety of well determined sizes in order to determine the limits of the liquid state and the factors influencing the onset of solidification. Measurements of the surface tension, viscosity, density, sound velocity, and specific heat are to be carried out for deeply undercooled melts and materials undergoing glass transition. The methods used will involve the free suspension of droplets with diameters ranging between 0.001 cm and 1 cm. A structural study of the resulting solid phases obtained from freezing these highly undercooled melts will be undertaken to search for new nonequilibrium structures having desired properties. Facilities necessary for containerless experimentation at high temperatures will be used in laboratory measurements under low gravity, and microgravity instrumentation for the investigation of the appropriate systems of materials in space will be designed. Ground-based experimental systems will be operated up to 1200 C using gaseous as well as liquid immiscible hosts whenever possible.

W85-70372 **179-20-56**
Jet Propulsion Laboratory, Pasadena, Calif.
ELECTROSTATIC CONTAINERLESS PROCESSING TECHNOLOGY
D. D. Elleman 213-354-5182
(674-25-04; 674-26-04)

The primary objective of the Electrostatic Containerless Processing Technology is to develop the science and technology base required for contactless positioning and manipulation of high temperature materials using electrostatic and electrophoretic forces. The user requirements will be identified to aid in the development of the module to assure that the electric field positioning module will be able to satisfy the science requirements of the users in a timely manner. Two different but related techniques are being developed. The electrostatic module utilizes high voltage dc electric fields to position and manipulate samples that have electric charges, either positive or negative, placed on the sample. The electrophoretic modules use high voltage ac electric fields to induce a polarization of the sample so that electric field gradients can be used to position and manipulate the samples. The program includes analytic modeling and experimental verification of these positioning techniques. Tests will be conducted in neutral buoyancy tanks to simulate low gravity in the laboratory and in the KC-135 for brief reduced gravity tests.

W85-70373 **179-20-62**
Lewis Research Center, Cleveland, Ohio.
MICROGRAVITY SCIENCE DEFINITION FOR SPACE STATION
Fred J. Kohl 216-433-5266
(424-84-22; 179-48-00)

The objective of this RTOP is to define the microgravity science requiring the availability of a Microgravity and Materials Processing Facility (MMPF) as part of the Space Station. This definition will focus on crystal growth, solidification fundamentals, ceramics processing, electronic materials synthesis, containerless processing, thermophysical properties research, fluid mechanics, transport phenomena, and combustion phenomena. The results of this work will be a definition of experiments and facilities required for a materials science/fluid physics laboratory aboard the Space Station. This will be followed by the preliminary hardware design of the equipment needed to carry out the experiments. This effort is to be coordinated with Headquarters and a parallel effort at MSFC.

W85-70374 **179-33-00**
Marshall Space Flight Center, Huntsville, Ala.
GROUND EXPERIMENT OPERATIONS
Roger P. Chassay 205-453-1870

This RTOP covers work in the area of defining, developing, and conducting experiments using the low-gravity capabilities of the drop tube, drop tower, KC-135, and F-104 aircraft. Such experiments may be in themselves complete investigations to develop new knowledge or to prove theories, or may serve as precursors for more extensive experiments to be conducted in space. This RTOP also includes studies and experiments to define the effects of various levels and durations of acceleration perturbations on microgravity experiments.

W85-70375 **179-40-62**
Marshall Space Flight Center, Huntsville, Ala.
MPS AR & DA SUPPORT
J. R. Williams 205-453-1872

The objectives of this RTOP are: (1) to provide the necessary management and support manpower to implement the MPS research and technology development effort; and (2) to provide the MPS program with an effective means of interacting with the various scientific communities involved for the purpose of: making them aware of the research opportunities offered by the MPS program; stimulating their interest and active involvement in the program; gauging their response to the scientific results being obtained by the program; identifying research areas in which the program should concentrate; initiating in-house research activities in selected topics pertinent to the MPS program; and evaluating the ongoing research effort. MSFC will ensure the necessary professional and supporting manpower to implement the MPS research and technology development effort. Also, the stated objectives will be met by actively involving the various research communities in the MPS program through working groups, seminars and workshops, science reviews, and a visiting scientist program. In addition, scientific goals and accomplishments of the program will be documented and disseminated to the science communities in the form of a published bibliography and catalog of tasks.

W85-70376 **179-40-62**
Jet Propulsion Laboratory, Pasadena, Calif.
MICROGRAVITY SCIENCE AND APPLICATION SUPPORT
T. G. Wang 213-354-6331
(179-10-62)

The objective of this RTOP is to assist NASA in the development and implementation of program plans for the Microgravity Science and Application (MSA) program. These plans will provide the guidance for initiating ground based experiments to develop a data base for future planning of space operations. JPL has already been working on the first phase of this plan and the effort will be expanded to include university participation. Coordination of the effort will be provided by a detailee from JPL assigned to NASA Headquarters, Office of Microgravity Science and Application.

W85-70377 **179-48-00**
Lewis Research Center, Cleveland, Ohio.
MICROGRAVITY MATERIALS SCIENCE LABORATORY
Fred J. Kohl 216-433-5266

The objective of this RTOP is to establish and operate a Microgravity Materials Science Laboratory (MMSL). This laboratory will support a related effort to define the requirements for the microgravity and materials processing laboratory (MMPF) and the MMPF test bed for the space station. The MMSL will serve as a check out and training facility for science mission specialists for STS, spacelab and space station prior to the full operation of the MMPF test bed. The focus of the MMSL will be on experiments related to the understanding of metal/ceramic/glass solidification, high perfection crystal growth and fluid physics. This ground based laboratory will be used by university/industry/government researchers to examine and become familiar with the potential of new microgravity materials science concepts and to conduct longer term studies aimed at fully developing a 1 g understanding of materials and processing phenomena. Such research will help create new high quality concepts for space experiments and will provide the basis for modeling, theories, and hypotheses upon which key space experiments can be defined and developed. The MMSL will be fully equipped with appropriate materials research facilities and will be supported by the extensive Lewis Research Center materials characterization and computational capabilities.

W85-70378 **179-80-30**
Marshall Space Flight Center, Huntsville, Ala.
CONTAINERLESS PROCESSING
J. R. William 205-453-1872

The objectives of this activity are to explore novel techniques and applications for containerless processing of glasses and refractory materials; understand the limitations imposed by the gravitational field; and evolve meaningful flight experiments which extend processes beyond gravity limitations. Containerless processing in space requires low level levitation forces to compensate for microgravity acceleration and maintain position of the sample. The central reason is the elimination of extraneous effects from contact with solid containment walls. The implementation of appropriate experiments will involve the following: (1) a 31 meter drop tube at MSFC provides 2.6 seconds of free fall for solidifying molten droplets up to several mm diameters; (2) a single axis acoustic levitator has been developed which uses a high-Q driver with a single resonant frequency; (3) a three axis acoustic levitator has also been under development involving three mutually orthogonal drivers which produce a three dimensional sound field (spherical energy well) in a tuned cavity; (4) a 10 kW electromagnetic levitator facility, which by careful coil design maximizes Grad B/B, is in use to levitate samples with a minimum of heating; and (5) aerodynamic levitation using a jet of air from a carefully designed nozzle has been used to suspend highly reactive samples.

W85-70379 **179-80-40**
Marshall Space Flight Center, Huntsville, Ala.
BIOSEPARATION PROCESSES
J. R. Williams 205-453-1872

The long-range objective is to utilize the environment of space to separate and purify biological products. The intermediate objectives are to develop the required technology and to expand the base of knowledge involved with processing biologicals in space; to identify, evaluate and select the most promising processes; and to explore new areas of separation technology. Separation and purification procedures which have been found to produce inadequate results on the ground because of gravity-dependent problems will be evaluated and investigated. More specifically, this program will: (1) determine possible advantages of the low-gravity environment for separation and characterization of biomedical materials; (2) design and conduct experiments in space; (3) apply ground/flight knowledge to the improvement of bioprocessing procedures on Earth; (4) develop broad and strong collaborative interactions with researchers; and (5) identify and explore new techniques of separation or bioprocessing that might be enhanced by low gravity. Research is directed toward determining the extent to which ground-based separation techniques are limited by gravity-dependent phenomena; whether the physical and chemical properties of the separands which allow separation are specifically related to their biological function; and what candidate biological materials are best suited to benefit from this effort.

W85-70380 **179-80-51**
Lewis Research Center, Cleveland, Ohio.
REDUCED GRAVITY COMBUSTION SCIENCE
Thomas L. Labus 216-433-5387
(542-03-23; 694-03-03)

The objective of this effort is to conduct ground based research, develop theoretical models and refine experimental techniques in conjunction with gravity combustion science experiments to be flown within the STS. Work in this RTOP will include an assessment of the science definition activities by a group of recognized experts. Activities will also include analysis of data obtained from ground based reduced gravity facilities and preparation of technical reports. The LeRC will provide the technical and management support to direct all contract and grant activities and provide coordination between government groups, contractors and the scientific community associated with this effort.

W85-70381 **179-80-60**
Marshall Space Flight Center, Huntsville, Ala.
SOLIDIFICATION PROCESSES
J. R. Williams 205-453-1872

Control of the solidification of metals and alloys is keyed to gravitational effects such as buoyancy driven convection. Thus, the objectives of the study are to: (1) identify various aspects of solidification phenomena that may be affected by gravity driven flows; (2) devise and conduct critical experiments in both increased gravity as well as in space; and (3) impact the field of metallurgy by fundamental knowledge through devising better control strategies. Multicomponent metallic systems involve a first to freeze component which nucleates and begins to grow, causing the composition ahead of the solidification front to change dramatically. Where it is infeasible or undesirable to provide controlled gradients for a planar solidification front, dendritic growth results. Thus, concentration is one of the more fundamental problems involved in the formation of dendrites. Directional solidification affords a degree of control because unidirectional thermal gradient can be imposed and growth rate regulated. Another rapid solidification of deeply undercooled melts will be pursued by containerless melting and solidification.

W85-70382 **179-80-70**
Marshall Space Flight Center, Huntsville, Ala.
CRYSTAL GROWTH PROCESS
J. R. Williams 205-453-1872

In any crystal growth system, an important problem is that the compositional and/or thermal fluctuations in the fluid phases cause compositional inhomogeneities and defects in the growing crystal. Where these fluctuations are caused by convection and sedimentation, they can be reduced in low gravity. Therefore, the major objectives of this crystal growth program are to: (1) understand the role of gravity and determine limitations in Earth's gravity; (2) determine and demonstrate advantages to be obtained by growing crystals in space; and (3) apply the findings to help solve problems in the growth of electronic and detector crystalline materials. The types of growth that will be explored in this program include melt, solution, vapor, and float zone growths. Crystal growth by solidification from the melt is the most widely used technique for high technology single crystalline materials. The success of the technique depends on the control of the composition, temperature, and morphology of the solidification interface. Advantages of this technique include the control it provides over the temperature of growth and viscosity. In the vapor approach, there are two distinct mechanisms for growing a crystal: (1) the physical vapor deposition and (2) chemical vapor deposition (CVD). Finally, floating zone crystal growth is accomplished by supporting a polycrystalline rod

at both ends; melting a portion of it with a moving heater, and growing a crystal behind this zone.

W85-70383 **179-80-70**
Langley Research Center, Hampton, Va.
CRYSTAL GROWTH RESEARCH
R. K. Crouch 804-865-3777
(694-80-70)

The objectives of this work are to investigate the growth of new types of compound semiconductor crystals using innovative growth techniques, to gain a better understanding of the growth of crystals by a vapor transport, and to investigate the effects of Marangoni convection on bulk crystal growth as well as techniques for dampening convection on a free surface. Other work areas such as investigating high temperature thermophysical properties of materials will be explored. The ground based experimental and theoretical results of these studies will be used to define and optimize crystal growth techniques in a l-g environment as well as to develop experiments for future microgravity environment projects in the space shuttle and in the space station.

Solar Terrestrial and Astrophysics SR&T

W85-70384 **188-38-52**
Goddard Space Flight Center, Greenbelt, Md.
GROUND-BASED OBSERVATIONS OF THE SUN
Jan M. Hollis 301-344-7591

The major objectives of this program are: (1) to obtain observations of solar velocity and magnetic fields, global oscillations and wave motion, coronal holes, active regions and flares, etc., at wavelengths observable from the ground which complement UV, EUV, X-ray, and gamma-ray experiments on NASA flight missions such as the solar maximum mission (SMM); (2) to support operational planning for spacecraft experiments; (3) to conduct basic research and develop specific instrumentation and observational progress relevant to objectives for future flight missions; (4) to analyze comet tail photographs to determine the velocity field of the solar wind; (5) to analyze comet-tail photographs to determined the three dimensional structure of interplanetary sector boundaries caused by the solar magnetic field. The vacuum telescope at Kitt Peak National Observatory is supported by the Laboratory through its Southwest Solar Facility. High-resolution, full-disk magnetograms and 10830A spectroheliographs are routinely obtained and substantial observing time is dedicated for special-purpose programs of spacecraft support and basic research by laboratory staff.

W85-70385 **188-38-52**
Marshall Space Flight Center, Huntsville, Ala.
GROUND-BASED OBSERVATIONS OF THE SUN
M. J. Hagyard 205-453-0118
(188-38-53)

The objective of this research is a program of ground-based observations for basic research concerning solar vector magnetic fields and for support of NASA solar missions using the facilities of the MSFC Solar Observatory. In the program of basic research, theoretical and observational programs are undertaken to study vector magnetic field structures which are relevant to current problems in solar physics. To support future NASA solar programs, techniques of observation and of data reduction and analysis are developed using the MSFC vector magnetograph. Such techniques will generate guidelines for operations of planned space-based magnetographs, and will provide more focused direction for the research performed with these instruments. Support of ongoing NASA solar missions is provided through daily observations, transmission of magnetograms to P.I.'s and other relevant personnel, and coordinated observing programs associated with collaborative investigations with mission P.I.'s.

W85-70386 **188-38-52**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR WIND MOTION AND STRUCTURE BETWEEN 2-25 R SUB 0
J. W. Armstrong 213-354-3151

The objective of this task is to measure the velocity field and microturbulence density spectrum in the near-Sun (2 to 25 solar radius) solar wind. The approach is to use the interplanetary scintillation (IPS) spaced receiver method to infer the motion of the solar wind from the motion of the IPS diffraction pattern on the Earth's surface. Density spectrum measurements are made by simultaneous observations of the electric field spatial correlation function between antenna pairs.

W85-70387 **188-38-53**
Marshall Space Flight Center, Huntsville, Ala.
LABORATORY AND THEORY
R. L. Moore 205-453-0118
(188-38-52)

The general objective is to determine basic empirical properties of solar magnetic fields and their effects in the solar atmosphere. The general approach is to analyze MSFC vector magnetograms along with complementary data from other observatories and from SMM, and to interpret observed effects with physical models. Electric current and magnetic energy in active regions will be studied including the surface distribution of vertical current and its relation to magnetic structure in the photosphere and chromosphere and to emission features in the chromosphere and transition region, resistive heating of the transition region, and estimates of total magnetic energy and net Lorentz force. The magnetic structure and evolution of active regions will be examined to determine how magnetic flux disappears from the surface of the Sun, field configurations in which flares occur and how these configurations form, short-term magnetic evolution triggering flares, and magnetic structure and dynamic phenomena in sunspots. Magnetic transients in flares to be investigated include Synchronism with impulsive energy release, and location of energy release site within the erupting magnetic field. Statistical properties of the solar cycle, inference of the operation of the solar cycle, and statistical properties of flares and active regions are also of interest. Inhibition of heat conduction into transition region by magnetic constriction, heating of the transition region by fine-scale electric currents, and ephemeral active regions and spicules, and their relation to coronal heating will also be determined.

W85-70388 **188-41-22**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECTRUM OF THE CONTINUOUS GRAVITATIONAL RADIATION BACKGROUND
R. W. Hellings 213-354-3192

The objectives are to provide an interface between theory and experiment in the search for the stochastic background of cosmic gravitational radiation; investigate cosmological models containing strong gravitational waves to determine how much radiation may have been produced at the big bang and what its observational consequences would be; and analyze experimental results to see to what extent they limit the strength of the background. The cosmological models will be based on the metric discovered under this RTOP. Vacuum and matter solutions that relate the current properties of gravitational waves to the structure of the initial big-bang singularity will continue to be derived. Direct experimental limits will come from Doppler tracking of interplanetary spacecraft, analysis of pulsar timing residuals, and analysis of planetary range data.

W85-70389 **188-41-22**
Jet Propulsion Laboratory, Pasadena, Calif.
GRAVITATIONAL WAVE ASTRONOMY AND COSMOLOGY
F. B. Estabrook 818-354-3247

Under this RTOP, research will be conducted in three areas of gravitational physics: gravitational wave detection, cosmology, and theoretical problems in general relativity. The first and major effort is the development of spacecraft Doppler detection of

gravitational waves. In previous work, primary noise problems for Doppler detection have been studied. One result was the identification of the most critical technological advance required: a higher frequency (X-band) carrier signal for Doppler tracking. Concerted efforts to urge this development have followed, and we are now participating in its implementation at JPL. Further investigations will be conducted to determine the best experimental techniques for gravitational wave detection, and to quantify those non-plasma-induced noise problems which are likely to dominate when using X-band. Data reduction techniques and objective filtering algorithms will be devised, based on our derivation of the response of Doppler links to incident gravitational waves. Past theoretical cosmology research led to a proposal from JPL for a microwave radiometer experiment, which is incorporated in the forthcoming COBE mission. More recently sophisticated models of the evolution of the IGM have been developed and used to interpret IUE data. The amounts of background radiation in a number of spectral regions are determined, and comparison with relevant IUE, COBE and X-ray satellite data will be used to discriminate acceptable evolutionary models. Two areas of theoretical research in nonlinear mathematics are proposed, related to understanding the sources and propagation of gravitational radiation.

W85-70390 **188-41-22**
Jet Propulsion Laboratory, Pasadena, Calif.
SIGNAL PROCESSING FOR VLF GRAVITATIONAL WAVE SEARCHES USING THE DSN
J. W. Armstrong 213-354-3151

The objective of this research is to develop optimal signal processing procedures for the detection of very low frequency waves in the presence of propagation and instrumental noises. Long period (approximately 10 to 10(4) second) gravitational waves cause very small perturbations in the Doppler tracking record of a distant spacecraft. The fractional frequency perturbations in the Doppler link (equal to or approximately gravity wave strain amplitude) are expected to be very small (< 10 (-15). Thus careful attention to noise sources and signal processing is required. The approach is to exploit the different response of the Doppler link to gravity wave signals and the various noises. (Gravity waves produce a 3 pulse response in the Doppler time series; propagation and timekeeping noises produce different 2 pulse responses). For gravity waveforms always present in the time series (e.g., gravity wave background or CW sources), spectra of the signal and noise will be used to design optimum linear processors for the data. The performance of these procedures will be evaluated theoretically, via simulations, and on real data. These studies are applicable to gravitational wave searches on all NASA deep space missions.

W85-70391 **188-41-53**
Jet Propulsion Laboratory, Pasadena, Calif.
THEORETICAL INTERSTELLAR CHEMISTRY
S. S. Prasad 818-354-6423

Theoretical studies and numerical modeling will be done to predict the time dependent abundances of atoms and molecules in dynamically evolving clouds. The dynamical evolution of spherically symmetrical model interstellar clouds contracting under gravity will be determined from a one dimensional hydrodynamics code. The hydrodynamics code predicts the evolution of the density and temperature by solving equations of continuity and momentum balance in conjunction with a semiempirical formula which gives temperature as a function of density and visual extinction. Calculations will be done for clouds which started spontaneously without any external trigger, and for clouds whose gravitational contraction was triggered by an initial compression due to passage of shock waves. Chemical rate equations governing the production and loss of atomic and molecular species will then be solved at various evolutionary epochs using the predetermined densities and temperatures for those epochs. Polyatomic organic and organo-nitrogen molecules will be included in our studies, because these molecules are thought to be better tracers of differences in dynamical evolution. Initial chemical compositional condition for spontaneously contracting clouds will correspond to that prevailing in diffuse clouds. In contrast, initial conditions for clouds contracting due to shock compression will correspond to those prevailing in postshock gas.

W85-70392 **188-41-53**
Ames Research Center, Moffett Field, Calif.
THEORETICAL STUDIES OF GALAXIES, ACTIVE GALACTIC NUCLEI THE INTERSTELLAR MEDIUM, MOLECULAR CLOUDS
D. C. Black 415-965-5495

The objective of this RTOP is to conduct theoretical studies on fundamental phenomena associated with continuum spectra, dynamics, and line spectra in active galactic nuclei, the formation and evolution of galaxies and clustrs, random luminosity fluctuations in compact astrophysical objects, molecular cloud formation and evolution, star formation and infrared emission in interstellar shocks. A large fraction of this effort involves computational astrophysics employing a wide variety of numerical codes developed at Ames to treat multidimensional hydrodynamic and magnetohydrodynamic fluid problems, with multidimensional particle problems, and complex radiative transfer problems.

W85-70393 **188-41-55**
Goddard Space Flight Center, Greenbelt, Md.
INFRARED AND SUB-MILLIMETER ASTRONOMY
M. J. Mumma 301-344-6994
(196-41-54; 385-41-01; 154-50-80; 157-05-50)

The objective of this program is to provide better understanding of the current state and evolution of astronomical objects. This is achieved by observations at wavelengths from 1 micron to 1 mm and at spectral resolution (lambda/delta lambda) from 1 to 10 to the 7th power. Since atmospheric opacity and emissivity prohibit or severly limit ground-based observations at certain wavelengths, high altitude observational platforms such as the C-141, balloons, or satellites must be used. High sensitivity composite bolometers are being developed in the far infrared to take maximal advantage of low background conditions achievable at these altitudes. A balloon-borne 1.2m telescope is used to conduct a photometric survey of galactic sources of submillimeter radiation, and at least a partial survey of extragalactic sources at these wavelengths. An infrared sky camera is also used to quickly map various sources. Infrared and submilleter coherent (heterodyne) spectrometers are developed and used to measure completely resolved intensity profiles for neutral and ionized molecular and atomic lines. Correlative studies are made when possible to enable maximum insight into the physics of the medium.

W85-70394 **188-46-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE ASTROPHYSICS AND EXPERIMENT DEFINITION STUDIES
J. F. Ormes 301-344-7793

The objectives are to study the properties of the cosmic radiation in order to understand its origin and propagation and to study the properties of the sites in which element synthesis and acceleration take place. The particles observed are the nuclear and electronic species of the cosmic ray particles--their energy spectra, their charge and isotopic composition, and their distribution in space. Some of these objectives can be met through the imaginative use of short duration observations on balloons and utilizing week long observations on Spacelab. Experiments which must be outside the magnetosphere can be done on Explorer class spacecraft. Many heavier, larger area payloads will require a large space platform. The space station, which will be gravity gradient stabilized, would be an ideal platform. The presence of people to construct experiments in space opens exciting new possibilities. Supporting these objectives is both the development of new detector systems for studying the properties of solar and galactic cosmic rays and the associated development of theoretical studies relating to the sites, origin, models for acceleration and mechanisms for particle transport related to these experiments. The emphasis will be on studying the solar charge composition in the iron to uranium region, on precise measurements of isotopic abundances of solar and galactic cosmic rays, and to accurately

determine the charge composition of galactic cosmic rays at the highest possible energies. New measurements of cosmic ray antiprotons are proposed.

W85-70395 **188-46-57**
Jet Propulsion Laboratory, Pasadena, Calif.
GAMMA-RAY ASTRONOMY
A. S. Jacobson 818-354-6263

This RTOP describes the JPL program in X ray and gamma-ray astronomy. The primary objective of the program is the development of advanced instrumentation to be applied to gamma-ray observations in the energy range of .02 MeV to 10 MeV, with emphasis on position sensitive sensors for use in high resolution imaging spectrometers. The major efforts being brought to completion in FY-84 are investigations into the application of liquid time projection chambers in gamma-ray astronomy and the design and fabrication of a liquid argon ionization chamber as the first step in developing a time projection chamber for imaging gamma-ray spectroscopy. A computer-based data acquisition and analysis system for detector testing is being assembled. In FY-85, the liquid argon detector will be used to study the relationship between impurity concentration, electron drift length, and energy resolution. Studies will be made of recombination processes and scintillation detection. The position sensitive anode array and electronics required for the time projection chamber will be designed and built. The argon detector will be operated in the time projection mode and coded aperture imaging tests will begin. Design of a liquid xenon detector will also begin in FY-85.

W85-70396 **188-46-57**
Goddard Space Flight Center, Greenbelt, Md.
GAMMA RAY ASTRONOMY
C. E. Fichtel 301-344-6281

The technical objective is to develop the most appropriate detector systems for the observation of astrophysical sources of very energetic photons. The first approach was the development of a large, high energy telescope using digitized spark chambers. Many major improvements to this basic telescope system are still being pursued and other approaches to detector systems are now being developed for high energy, intermediate energy, and low energy gamma ray observations. In the high energy region, improvements in the track imaging chamber systems are continuing, and special attention in the track imaging chamber research is now being directed towards drift chambers. At the same time, several approaches are being explored to improve angular resolution, including techniques to concentrate on higher energy photons. Improved attitude and aspect systems are being built. In the 0.5 to 40 MeV region, different interaction processes become dominant and thus new detector techniques are required. A totally new detector is currently near completion based on the Compton interaction process, but including several new concepts which together should increase the sensitivity by a factor of 10. For gamma ray burst studies new detector systems are being developed both for the gamma ray energy range and for detection at other wavelengths. In particular a ground-based system is being developed to detect and precisely locate optical flashes that are likely to occur in coincidence with gamma ray bursts.

W85-70397 **188-46-57**
Marshall Space Flight Center, Huntsville, Ala.
GAMMA RAY ASTRONOMY AND RELATED RESEARCH
G. J. Fishman 205-453-5133

An observational program in gamma ray astronomy and cosmic ray research is being pursued using balloon-borne experiments. Techniques and instrumentation for future space flight experiments are developed concurrently. The following are the objectives of the MSFC research program: (1) to perform new scientific observations in gamma ray astronomy and cosmic ray physics within the limitations of current balloon flight capabilities; (2) to develop new detectors and experimental techniques for future spaceborne, gamma ray astronomy, and high-energy cosmic ray observations; and (3) to study various sources of background radiation, primarily atmospheric gamma ray radiation and activation of detectors and materials in order to increase the sensitivity of gamma ray observations.

W85-70398 **188-46-59**
Marshall Space Flight Center, Huntsville, Ala.
X-RAY ASTRONOMY
M. C. Weisskopf 205-453-5133

This RTOP plans to conduct research in the field of X-ray astronomy in areas related to the astrophysics programs of NASA. Existing satellite and ground-based observations of the time variability of X-ray sources and their optical counterparts will be analyzed and interpreted. Where applicable, auto correlation and cross correlation techniques, shot model, and pulse-shape-innovation techniques will be utilized to determine the underlying pulse shape and stability as a function of time. An advanced X-ray detector will be designed, built, tested, and flown on a sounding rocket. The detector will utilize the fluorescence of atoms in the detector gas to obtain the highest performance. This has implications for imaging, spectroscopy, and polarimetry.

W85-70399 **188-46-59**
Jet Propulsion Laboratory, Pasadena, Calif.
X-RAY ASTRONOMY CCD INSTRUMENTATION DEVELOPMENT
A. S. Jacobson 818-354-6263

Prior tests demonstrated that three-phase and virtual-phase charge coupled devices (CCD) have high spatial resolution, moderate spectral resolution, and high detection efficiency for single X-ray photons. The objective of this RTOP is to develop a CCD-based imaging X-ray spectrometer for X-ray astronomy observations, and to use this instrumentation to study the temperature and abundance distributions as well as the state of ionization of cosmic X-ray sources. The approach for this program consists of two development efforts: (1) using a CCD detector of the type which is available now, a spectrometer will be developed, tested, calibrated, and used at the focal plane of a rocket-borne, grazing-incidence telescope and (2) a parallel detector development program will optimize CCD properties which are required for operation at the focus of advanced grazing incidence X-ray telescopes. This program is a joint effort with Pennsylvania State University (PSU).

W85-70400 **188-78-38**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED MISSION STUDY - SOLAR X-RAY PINHOLE OCCULTER FACILITY
J. R. Dabbs 205-453-3430

Hard X ray imaging (10 - 100 keV) from solar flares will contribute not only to our knowledge of the sources directly associated with the Chromospheric manifestations of flares, but will also help us to explore the corona. A solution to the problem of achieving significantly better angular resolution for hard X rays lies in the Pinhole Experiment concept. An equally important use of the Pinhole satellite will be its application as an external occulter for coronagraph observations of the solar corona. Previous feasibility studies have investigated alternative stabilization techniques and preliminary optical systems design for a long focal length coronagraph which will be flown on a Spacelab mission utilizing a boom deployed occulting and aperture mask. Separations on the order of 30 to 50 meters could afford subarcsecond X ray imaging of the Sun and also provide highly effective occultation experiments in both visible and UV regions. The Spacelab facility is expected to mature into longer focal length facilities either adjunct to the Space Platform or as separate free flyers.

W85-70401 **188-78-38**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED SOLAR PHYSICS CONCEPTS - ADVANCED SOLAR OBSERVATORY
W. T. Roberts 205-453-3430

The objective of this study activity is to establish the scientific potential, the early system concepts and the feasibile approaches for new experimental systems in solar physics. New ideas and

techniques are emerging which must be examined to identify the methods which could accomplish the desired goals. The examination of ideas and techniques, the identification of methods, and the sharpening of science goals must proceed simultaneously and iteratively in a coordinated fashion. A science study team has been formed to address the particular concepts being considered at this early stage.

W85-70402 **188-78-41**
Marshall Space Flight Center, Huntsville, Ala.
GRAVITY PROBE-B
A. K. Neighbors 205-453-5584

The scientific goal of Gravity Probe B is to confirm Einstein's General Theory of Relativity by measuring the relativistic precession of ultra-precise gyroscopes in a free-flying spacecraft in polar orbit about the Earth. This project involves complementary efforts at MSFC, Stanford University and the University of Alabama in Huntsville. The work is a coordinated theoretical, experimental, and engineering program with an in-house MSFC definition phase (Phase B) completed, (FY-81/FY-83) a contracted Engineering Development Phase beginning in FY-85 and culminating in the launch of a shuttle flight test experiment in FY-89, and the beginning of the Science Mission development FY-88. MSFC will have overall project management responsibility for both phases of the GP-B development.

W85-70403 **188-78-60**
Jet Propulsion Laboratory, Pasadena, Calif.
ASTROPHYSICAL CCD DEVELOPMENT
S. A. Collins 213-354-7393

Charge-coupled devices (CCD) offer good sensitivity over most or all of a very broad spectral range (1A - 11,000A) and promise to become key detectors in astrophysical imaging and spectroscopic instrumentation. The objective of this task will be to produce CCDs and CCD designs whose performance is significantly improved over that of current detectors. Specific design modifications, each addressing one or more performance objectives, will be incorporated by a contractor in test CCDs which will subsequently be evaluated at JPL. Test results will be used to fine tune the design features of later test devices. The resulting performance and designs will be documented. Developmental research will be conducted at JPL on candidate concepts to improve quantum efficiency, charge transfer efficiency, noise, and charge confinement to identify those approaches which promise the greatest potential.

Planetary Astronomy

W85-70404 **196-41-51**
Goddard Space Flight Center, Greenbelt, Md.
PASSIVE MICROWAVE REMOTE SENSING OF THE ASTEROIDS USING THE VLA
W. J. Webster, Jr. 301-344-5554

The objective of this research is to infer structure and composition parameters for a selected set of the ten physically largest asteroids by employing microwave remote sensing techniques originally developed for Earth observations. Precise flux density measurements made with the Very Large Array (VLA) of the National Radio Astronomy Observatory will be used to define the microwave continuum spectra of these asteroids. These spectra will be inverted in order to estimate the near surface bulk properties (radii, roughness, composition) independent of previous optical or infrared spectroscopy.

W85-70405 **196-41-54**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED INFRARED ASTRONOMY AND LABORATORY ASTROPHYSICS
M. J. Mumma 301-344-6994
(188-41-55; 154-50-80; 157-05-50)

The objective of the advanced infrared astronomy program is to study the molecular constituents of solar system objects (e.g., planetary atmospheres and comets) through observations of their IR line spectra, and so to further our knowledge about: (1) molecular abundances; (2) kinetic, vibrational, and rotational temperature distributions; (3) kinetic velocity shifts (winds); (4) vertical and horizontal abundance distributions; and (5) ambient gas densities, and to carry out comparative studies of these objects. The approach is to develop and employ coherent detection line receivers for use in the infrared wavelength regions. The instruments use either gas lasers or semiconductor diode lasers as local oscillators, and HgCdTe detectors as photomixers. The intermediate frequency signal is fed into a GSFC standard spectral line receiver which acquires, analyzes, and displays the spectral lines. Initial observations with this system are from the ground, but it is developed with an eye toward flights on spaceborne platforms. Laboratory work on precise line frequency determinations and on pressure broadening effects is also carried out in support of the field experiments.

W85-70406 **196-41-67**
Ames Research Center, Moffett Field, Calif.
PLANETARY ASTRONOMY AND SUPPORTING LABORATORY RESEARCH
F. P. J. Valero 415-965-5510

The composition of planetary atmospheres and surfaces and the abundance, temperature and pressure of certain atmospheric constituents can be determined by spectroscopic observations from ground based and from airborne observatories. Such data are necessary for the preparation of valid model atmospheres. The objectives of this work are to obtain, study and analyze spectroscopic observations of the planets and their satellites; to obtain and analyze, in the laboratory, spectra appropriate for valid interpretation of planetary observations; and to develop the analytical and computational techniques necessary to interpret planetary spectra in terms of real planetary atmospheres and surfaces. The objectives will be pursued by measuring, in the laboratory, basic molecular parameters such as adsorption line and band intensities, band modeling parameters, absorption line half widths, vibration/rotation interaction constants, and line pressure induced shifts and absorption.

W85-70407 **196-41-68**
Ames Research Center, Moffett Field, Calif.
DETECTION OF OTHER PLANETARY SYSTEMS
D. C. Black 415-965-5495

The long range objective of this activity is to develop a comprehensive program to detect other planetary systems. The near term objectives include the funding of selected University researchers to pursue modest exploratory developmental and observational programs as well as theoretical studies directed at identifying optimum techniques for ground based planetary detection systems. The choice of University researchers will be based on a peer review of unsolicited proposals, and it will be guided by the basic recommendations set forth in Volume 1 of NASA CP-2124. Funding will also be used to support in house theoretical research at Ames Research Center related to the detection and study of other planetary systems.

Life Sciences SR&T

W85-70408 **199-11-11**
Lyndon B. Johnson Space Center, Houston, Tex.
CREW HEALTH MAINTENANCE
P. C. Johnson 713-483-5457

The objective of this program will be to solve the known health problems of flight crews and study the precise nature of crew health problems during and following long duration (up to 3 months) flights. It is assumed that the long duration flights will be associated with occupational duties in a space station and are therefore repetitious exposures during a lifetime career. The identified medical problems will be addressed by combinations of prevention and therapies both mechanical and pharmacological. This will be

implemented by a series of continuing tasks to assess and solve the health problems of short term flights which are dominated by space stickness, cardiovascular deconditioning, and the potential problems of EVA. NASA has chosen to study space sickness as a separate identifiable task so that the emphasis here is on cardiovascular phenomena and dysbarism. Altitude dysbarism of EVA is nearly an exclusive NASA problem so the research extends from basic science of in vivo bubble formation to operationally directed prebreathe programs. Particular attention will be given to the mechanism by which bubbles damage tissue and to pharmacological measures to prevent dysbaric damage. Cardiovascular studies have emphasized fluid replacement for the hypovolemic but not dehydrated crewmen returning to G. Future emphasis will be on the cardiac atrophy induced by the microgravity environment. To address long-term flight problems two new tasks proposed by headquarters will be submitted to include health maintenance and crew selection.

W85-70409 **199-11-21**
Lyndon B. Johnson Space Center, Houston, Tex.
LONGITUDINAL STUDIES (MEDICAL OPERATIONS LONGITUDINAL STUDIES)
Edward C. Moseley 713-483-4264

Objectives of this research are to conduct longitudinal, retrospective, and prospective studies of medical data from astronauts, a control group of civil servants, and other JSC employees. The studies covered involve individuals in a relatively closed population in an attempt to relate changes in physiology and/or pathology to specify factors associated with individual traits of the astronauts and occupational exposure. Areas of study and particular interest consist of acute responses and long term adaptive mechanisms to weightlessness, changes observed in complete annual physical examinations, and the effects (if any) of the occupational exposures of crewman to the aging processes and disease incidence. The approach includes (1) input and storage of all astronaut medical exams (annual, flight, and illness exams) in computer data bases, (2) collecting and storing similar information on a control group of civil servants (matched on age, sex, body size and smoking history) and other civil servants, (3) analysis of the longitudinal information comparing these groups, and (4) cumulative evaluation of pre/postflight physiological changes across missions.

W85-70410 **199-21-12**
Ames Research Center, Moffett Field, Calif.
CARDIOVASCULAR PHYSIOLOGY
H. Sandler 412-965-5745

The overall goal of this program is an understanding of the cardiovascular/fluid-electrolyte changes occurring with space flight. Specific aims are to define underlying mechanisms, determine whether specific cardiovascular risks occur with short- and long-term weightlessness exposure, develop appropriate countermeasures for observed changes, improve selection criteria for passengers and crews, develop and implement appropriate space flight experiments. To accomplish this goal, ground-based studies on both human and animal subjects will be carried out. Specific activities will include: (1) determining effects of exercise training; (2) expose humans to horizontal and head-down bed rest and water immersion; and (3) testing procedures, devices, and drugs to prevent and counteract deconditioning. Results should lead to a better understanding of mechanisms of cardiovascular deconditioning, better devices and procedures for modifying deconditioning effects, and specific space flight experiments. Results of proposed studies will improve flight safety and understanding of space flight risks. They will also provide access to flight of a broader segment of population, and will use weightlessness to expand our understanding of cardiovascular/fluid-electrolyte function.

W85-70411 **199-21-51**
Lyndon B. Johnson Space Center, Houston, Tex.
BIOCHEMISTRY, ENDOCRINOLOGY, AND HEMATOLOGY (FLUID AND ELECTROLYTE CHANGES; BLOOD ALTERATIONS)
Nitza M. Cintron-Trevino 713-483-4086
(199-21-10; 199-22-31)

The absence of hydrostatic forces, which results in body fluid shifts, and the absence of deformation forces on normally load bearing tissues, are postulated to cause the principal disturbances found during and after space flight in the fluid and electrolyte, erythropoietic, musculoskeletal, and metabolic systems. These alterations result in a multitude of physiological imbalances such as a reduced body fluid volume with concommitant losses of electrolytes, loss of body calcium stores, skeletal muscle atrophy, and a negative energy balance after prolonged space flight. The purpose of the present program is to study and define at the biochemical and endocrine levels of function the mechanisms operative in the processes associated with the identified physiological responses to space flight. Results of the individual research investigations are anticipated to provide an enhanced understanding of the effects of weightlessness on man and his readaptation to the Earth environment as well as a rationale for countermeasure development for use in future space flight missions. Using principally model systems in human clinical research, investigations will be directed toward the identification of biochemical and neurohumoral agents which are active in the various adaptive phases of space flight. Primary focus will be made in describing the integrated relationship between these substances and those physiological systems which have been identified to be affected by the null-gravity environment.

W85-70412 **199-22-22**
Ames Research Center, Moffett Field, Calif.
NEUROPHYSIOLOGY
N. G. Daunton 415-965-6245
(199-12-51)

Various sensorimotor problems related to the process of adaptation to the zero gravity environment, such as space motion sickness, perceptual illusions, motor performance deficits, and attentional deficits are encountered during and after short- and/or long-term exposure to weightlessness. These problems, which arise from the rearrangement of sensorimotor interactions during exposure to zero gravity, impair the operational efficiency, health, and safety of astronauts. The goal of this program is to identify the exact causes of such problems so that effective countermeasures can be developed. The basic approach involves a broad-based program of interrelated psychophysical, neurophysiological, biochemical, and neuroanatomical studies to determine the role of the vestibular, visual, somatosensory and motor systems and their interactions in the development of space motion sickness and other sensorimotor problems.

W85-70413 **199-22-31**
Lyndon B. Johnson Space Center, Houston, Tex.
BONE PHYSIOLOGY
V. S. Schneider 713-483-5457
(199-21-51)

The objective of this RTOP is to study the regulation of bone integrity and function during space flight and the causes of its apparent demineralization. Overall research goals are to elucidate and define the mechanisms operative in the processes associated with calcium metabolism and bone loss during weightlessness, to develop methods to assess changes more accurately by non-invasive means, and to develop effective countermeasures to these deleterious skeletal changes in order to optimize crew's performance and recovery upon return to a one-g environment. Using ground-based model systems, human clinical and animal basic research to define the mechanisms underlying bone mass regulation and loss will focus on the biochemical, endocrinological, and physico-mechanical levels of function. Preventive and remedial countermeasures will center primarily around mineral supplementa-

tion, drug administration, diet modification, and physical manipulation.

W85-70414 **199-22-32**
Ames Research Center, Moffett Field, Calif.
BONE PHYSIOLOGY
D. R. Young 415-965-5549
(199-40-32)

The overall objectives of this RTOP are: to assess the operational impact of skeletal mass losses on crewmembers for future long duration missions; to develop remedial countermeasures for the prevention of skeletal mass losses; and to develop medical selection criteria for re-exposures of astronauts to weightless environments. The program is implemented through ground-based studies with hypodynamic-hypogravic models. Immobilization studies with human volunteers and experimental animals are performed: to document bone alterations and the recovery processes; to determine degree of involvement and mechanisms of action of calcemic hormones in immobilization-associated osteoporosis; to investigate the role of intestinal absorption as a causative factor in bone loss; to evaluate potential risk factors associated with skeletal mass losses; and to evaluate potential protective countermeasures. Research is conducted at ARC, JSC, JPL, and through various grants and contracts at universities and medical research centers.

W85-70415 **199-22-42**
Ames Research Center, Moffett Field, Calif.
MUSCLE PHYSIOLOGY
S. Ellis 415-965-5757
(199-40-32)

The overall aims of this research program are to determine the underlying causes for the muscle atrophy problem observed in both humans and animals in space and to develop suitable countermeasures. Specific objectives consist of: conducting basic studies into the nature of the biochemical and physiological mechanisms which regulate skeletal muscle mass and properties; developing and validating methods for monitoring the rate of atrophy of skeletal muscle in human subjects and laboratory animals; and investigating possible countermeasures to forestall muscle atrophy. Muscle atrophy will be induced by: immobilization with casts, suspension hypokinesia, nerve paralysis, tenotomy, hormonal manipulation (endocrine organ ablation and hormone replacement), and reversal of hypertrophy by load and/or stretch removal. The possible mechanisms underlying atrophy will be studied with regard to muscle protein synthesis, degradation and regulation by growth factors, steroid hormones, stretch, prostaglandings, and pathways in muscle protein breakdown; and evaluation of possible countermeasures such as exercise, protease inhibitors and other pharmacological agents.

W85-70416 **199-22-62**
Ames Research Center, Moffett Field, Calif.
PSYCHOLOGY
T. A. Tanner 415-965-5185
(506-57-21)

The objectives of this research program are: (1) to increase the data base, where needed, concerning human psychological response to specific stresses related to the space station environment and operation; (2) to develop methods for identification of individual susceptibility to such stresses, and for nonintrusive measurement and prediction of psychological problems and associated performance decrements in the mission environment; and (3) to develop preventative and remedial countermeasures for breakdown in psychological health leading to performance decrement. Individual and group performance will be studied in laboratory and field (real world) situations which simulate one or more of the conditions associated with long-duration manned spaceflight. Personal, group, procedural and situational characteristics which may be predictive of decreases in psychological well-being and related performance will be examined. Work in the various elements of the program will be focused toward the development of a model relating stress, psychological well-being, and task performance.

W85-70417 **199-22-71**
Lyndon B. Johnson Space Center, Houston, Tex.
RADIOBIOLOGY
D. S. Nachtwey 713-483-5281

This RTOP described a long-term program of research to examine the nature of the space ionizing radiation environment and determine its consequences for manned space operations. While currently available information is sufficient for early Shuttle missions, research priorities of the attached program are based on the assumption that long-term plans involve a manned Space Station and manned sorties to geostationary orbit. Based on knowledge obtained from previous research under this RTOP, exposure to ionizing radiation may be the limiting factor in both mission and career durations for space workers. Shielding considerations, based upon radiobiological responses, may influence significantly the detailed design and total mass of a spacecraft, especially for protection from solar particle events. To provide timely solutions to these problems in the mission planning stage, the underlying research must be conducted now. A plan is presented for research in specific areas of radiobiology and radiation dosimetry. Specific attention is given to the effects of HZE particles of space since the problem is unique to NASA. A coordination effort with programs of related government agencies will augment the information required by NASA in its long-term radiation research effort.

W85-70418 **199-30-12**
Ames Research Center, Moffett Field, Calif.
BIOSPHERIC MODELLING
J. G. Lawless 415-965-5220

The objective of the RTOP is to achieve quantitative understanding of the chemical interactions between the biosphere and the atmosphere. This is accomplished through the use of models of gas and particle phase atmospheric chemistry and physics. The fluxes of biologically produced materials into the atmosphere will be quantified and their subsequent conversion rates and removal rates will be determined. In addition the fluxes of atmospheric gases and particles into aqueous and terrestrial reservoirs will be simulated to determine their potential effects on biota. Existing computer models will investigate the chemistry and physics of biologically generated compounds. Emphasis is on quantifying the marine sulfur cycle; examining the interaction of marine sulfur with coastal regions; quantifying the fluxes of compounds from fires, especially particulate carbon; defining the measurement limits on nitrous oxide and other nitrogen fluxes needed to constrain atmospheric budgets. Verifying data on the conversions which occur will be obtained through interaction with experimenters. Chemical species which have biological sources or significant impact on biota have been identified for modelling investigations.

W85-70419 **199-30-22**
Ames Research Center, Moffett Field, Calif.
ATMOSPHERE/BIOSPHERE INTERACTIONS
J. G. Lawless 415-965-5220

This RTOP aims to address the characterization of biologically mediated atmospheric gas fluxes, the identification of biological sources and sinks of atmospheric trace gases, and the elucidation of those factors that influence these biogenic gas flux magnitudes. The influence of biological processes on biogeochemical cycling, atmospheric composition, radiative transfer and climate will be studied. The magnitude of the biogenic component of the sulfur cycle in the coastal marine and nitrogen in the terrestrial environment will be studied. The relationship of the magnitude of these biogenic emissions to regional processes via remotely sensed data will be established. Residence times and coefficients of air-surface and free troposphere-boundary layer gas exchange, which are of critical importance in quantifying atmospheric cycles, will be determined.

W85-70420 **199-30-26**
Langley Research Center, Hampton, Va.
BIOSPHERE-ATMOSPHERE INTERACTIONS IN WETLAND ECOSYSTEMS
Robert C. Harriss 804-865-3237

The object of this research is to bring together a multidisciplinary program to investigate hypotheses concerning the role of wetland ecosystems in the global methane cycle. Wetlands are hypothesized to be a major natural source of methane to the troposphere. Primary objectives in this research include: (1) A detailed investigation of microbiological, ecological, geochemical, and physical factors controlling methane emissions from soil and water interfaces to the atmosphere in wetlands will be conducted. These studies will provide a better understanding of the relative importance of processes which regulate temporal and spatial variability in methane emissions from wetland ecosystems. (2) Methane emissions will be quantified at a wide variety of swamp, salt-marsh, and peat bog sites in eastern North America and Central America. These data will be utilized as input to the development of an improved quantitative global biogeochemical emissions inventory for methane.

W85-70421 **199-30-32**
Ames Research Center, Moffett Field, Calif.
TERRESTRIAL ECOLOGY
J. G. Lawless 415-965-5220
(677-21-31; 656-11-01)

The objective is to characterize the rates and pathways of biogeochemical cycling of the elements N, C, S and P in terrestrial ecosystems, and to model these processes. Remotely sensed data, coupled with ground-based research will be used to improve our estimates of biomass distribution and productivity, as well as nutrient cycling rates and gas fluxes to the atmosphere or aquatic systems. Ground based and remote sensing techniques will be used to relate estimates of vegetation characteristics to net primary productivity, total biomass accumulation, biogeochemical cycling, and the potential for trace gas fluxes to the atmosphere. These relationships in natural, intact ecosystems as well as in systems disturbed by land clearing, fire, anthropogenic nutrient inputs, and/or fertilization will be examined. The results of these studies will be incorporated into predictive models of biogeochemical cycles.

W85-70422 **199-30-35**
National Space Technology Labs., Bay Saint Louis, Miss.
A GIS APPROACH TO CONDUCTING BIOGEOCHEMICAL RESEARCH IN WETLANDS
David P. Brannon 601-688-2043
(668-37-13)

The objectives of this RTOP are to determine the capabilities of TM, MSS, and AVHRR instruments for delineating wetland vegetation types within the context of an hierarchical wetland stratification scheme; to test various classification algorithms as recommended by the Biosphere Research Working group; and to develop and test models (with geographic data bases of selected test sites) for estimating regional methane emissions from wetland ecosystems. FY-85 activities will deal primarily with: (1) examining the TM sensor capabilities to delineate vegetation types within the Everglades National Park test site; (2) testing selected algorithms for discrimination accuracy in wetlands; and developing data bases over wetlands research test site. This task directs efforts toward a data base designed for modeling environmental variables in the Everglades which effect methane emissions.

W85-70423 **199-30-36**
Langley Research Center, Hampton, Va.
TERRESTRIAL BIOLOGY
David S. Bartlett 804-865-4345

The objectives are to investigate remote sensing capabilities in studies of photosynthetic fixation of atmospheric carbon by tidal wetland plants and production and flux of biogenic gases from wetland soils. Assessment of these processes is hypothesized to be accessible by remote measurement of: (1) biomass and productivity of the emergent macrophytic wetland vegetation; (2) canopy characteristics of emergent wetland vegetation and their relationship to production and flux of biogenic gases. In situ radiometry will be used to characterize upwelled radiance of the vegetation canopy in LANDSAT MSS and Thematic Mapper spectral bands. These data will be correlated with concurrent biometric analysis of the vegetation and measurements of methane flux made by the Biogenic Modulation of Tropospheric Methane study group. Computer simulation of radiative transfer in vegetation canopies will supplement field measurements through quantitative examination of relationships observed in the field and through extension of analysis to situations not encountered in the field sites. Digital multispectral image analysis will be applied to available aircraft and LANDSAT scanner data to test assumptions and conclusions derived. Orbital detection of parameters related to methane flux in Florida Everglades will also be assessed.

W85-70424 **199-30-42**
Ames Research Center, Moffett Field, Calif.
OCEAN ECOLOGY
J. G. Lawless 415-965-5220

The objectives are: (1) to determine the coastal zone productivity, biomass pool size, and distribution; (2) to characterize the influence of biological processes on ocean dynamics; and (3) to understand the biogeochemical cycles of carbon and nitrogen in the marine coastal zone. Stable isotopic abundances in contemporary aquatic carbon and nitrogen pools are related to carbon and nitrogen flux, transfer, and storage processes. Stable isotopic abundances in selected sedimentary carbon and nitrogen pools will be related to the history of the biochemical cycling of these elements. The data obtained from these studies will be incorporated into a predictive model of carbon and nitrogen biogeochemistry.

W85-70425 **199-30-52**
Ames Research Center, Moffett Field, Calif.
INSTRUMENT DEVELOPMENT
J. G. Lawless 415-965-5220
(199-50-42; 157-04-80)

The objective is to provide experimental and instrumental capabilities for acquiring specific information on the chemical composition of the atmosphere and the volatiles in surface and particulate matter on the Earth. This information is essential for selecting or devising the most appropriate model for the biogeochemical cycling of the elements S and N, and will further provide a basis for understanding the conditions that mediate these cycles. Improved methods and instrumentation will be developed for in situ chemical analyses of the volatile species contained in the atmosphere, surfaces and particulates. Special emphasis is directed to the development of the gas chromatographic approach applying advanced techniques previously developed for solar system exploration. Improvements in the gas chromatography, such as column technology, detector design, and total system design (including work on other subsystems) will be explored.

W85-70426 **199-40-12**
Ames Research Center, Moffett Field, Calif.
GRAVITY PERCEPTION
M. L. Corcoran 415-965-5574
(199-40-22; 199-40-32)

A broad based basic research program is conducted to identify organisms that exhibit sensitivity to gravity, and to determine the structure and function of their gravity sensing systems. Investigators conduct basic research on the mechanisms of gravity detection, and make meaningful comparisons between species with regard to anatomical similarities and differences in an effort to understand differences in gravity detection and sensitivity. To achieve the above objectives, workshops and symposia are conducted to develop a constituency of competent researchers, define the research effort, identify important scientific questions, develop a research strategy, and establish research priorities. Research proposals will be reviewed for scientific merit, and selected and funded based on their merit and relevance to the stated goals and objectives. Results of scientific studies are

presented in scientific journals, technical communications and at national and international scientific meetings.

W85-70427 **199-40-22**
Ames Research Center, Moffett Field, Calif.
DEVELOPMENTAL BIOLOGY
Kenneth A. Souza 415-965-5251
(199-40-12; 199-40-32; 199-40-27)

Gravity has been an omnipresent force throughout the evolution of life on this planet. Its influence on the processes of reproduction, growth and development is largely unknown. The objectives of this research program are: (1) to identify fundamental questions in Developmental Biology which require the microgravity of spaceflight to answer satisfactorily; (2) to establish a productive cadre of investigators to develop and test experimental hypothesis; and (3) to determine the technology necessary to conduct essential experiments on the ground and in space. To achieve the above objectives the following approach is utilized: workshops and symposia are conducted to identify important areas of research, set research priorities and develop a constituency of competent Developmental Biologists. Research proposals are reviewed for scientific merit and relevance to NASA's goals, and objectives. Selected research is funded for a coordinated program of ground-based and flight experiments. The results of the scientific studies are presented in scientific journals, technical communications and at national and international scientific meetings.

W85-70428 **199-40-32**
Ames Research Center, Moffett Field, Calif.
BIOLOGICAL ADAPTATION
E. M. Holton 415-965-5471
(199-40-12; 199-40-22)

All biological species on Earth have evolved under the influence of gravity. In response to this force, organisms have developed structures to withstand gravity loads, as well as regulatory systems which may be optimized for the terrestrial gravity level (i.e., 1 G). The objectives of this RTOP are: (1) to compare and contrast support structures that living systems have evolved in response to gravity and to understand both structural function and regulation; (2) to determine whether gravity directly affects the cells regulating structural mass or exerts its effect extracellularly and to elucidate the mechanism(s) involved; (3) to determine whether temperature regulation is gravity dependent and if the mechanisms controlling temperature regulation are calibrated for 1 G; (4) to determine if normal terrestrial gravity plays a role in establishing basal metabolic rate and biorhythms; and (5) to use the microgravity of spaceflight to understand how organsims have adapted to gravity during evolution. To accomplish the above objectives, an integrated program of ground-based and spaceflight experimentation is required. A wide range of vertebrate and invertebrate species must be utilized to examine commonality of biological systems and the processes that organisms have evolved to cope with gravity.

W85-70429 **199-40-33**
John F. Kennedy Space Center, Cocoa Beach, Fla.
BIOLOGICAL ADAPTATION
William M. Knott 305-867-3152

The KSC Biomedical Office is assuming responsibility for the botanical portion of the Space Biology-Biological Adaptation RTOP. The objectives of this project are to review the current RTOP descriptions and make suggestions for changes where appropriate, learn management requirements for the RTOP, and develop a plan/schedule for a smooth transition of the program to KSC. The approach will be to review appropriate literature, interact with researchers involved in the program, submit a plan to headquarters for approval, and work actively with headquarter's personnel in transitioning the program. The four T-43's (02-05) submitted with this proposal are outdated and will be updated early in the approach phase. This planning activity will be completed without additional cost to the program.

W85-70430 **199-50-12**
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION
S. Chang 415-965-6206
(199-50-32; 199-50-42)

The objective of research in chemical evolution is to understand the physical-chemical pathways followed by both inorganic and organic matter in the solar system which led, in the case of Earth, to the emergence of life, but which in extraterrestrial environments took divergent paths. The approach taken to meet the objective involves primarily both laboratory and computer experiments designed to simulate various physical-chemical processes that occurred putatively on the primitive Earth or other bodies (e.g., outer planets, meteorite parent bodies) at either macroscopic or microscopic scales. These processes are studied and the chemical outcomes elucidated for the purpose of obtaining data on rates of chemical reactions, abundance of produces, and chemical and physical composition of products. These data provide the input necessary for the development of self consistent models that describe, in a geophysical geochemical context, the pathways by which the molecular constituents necessary for the origin of life and the systems bearing rudimentary attributes characteristic of living systems evolved from abiotic milieux.

W85-70431 **199-50-16**
Langley Research Center, Hampton, Va.
EARLY ATMOSPHERE: GEOCHEMISTRY AND PHOTOCHEMISTRY
Joel S. Levine 804-865-2187

The objectives are to develop a better understanding of the geochemical and photochemical processes that controlled the composition of the atmosphere over geological time. The approach consists of: (1) the development of a geochemical flux model to investigate the transfer of carbon, nitrogen, oxygen, hydrogen, sulfur, and chlorine species between the atmosphere, oceans, solid Earth, and biosphere over geological time; (2) photochemical calculations of the composition of the early atmosphere and its evolution over geological time; and (3) laboratory lightning experiments in various paleoatmospheric gases mixtures in Langley Lightning Facility.

W85-70432 **199-50-20**
Lyndon B. Johnson Space Center, Houston, Tex.
ORGANIC GEOCHEMISTRY-EARLY SOLAR SYSTEM VOLATILES AS RECORDED IN METEORITES AND ARCHEAN SAMPLES
Everett K. Gibson, Jr. 713-483-6224

The goal of this study is to determine the nature of the volatiles present at the time of formation of the meteorites and in Archean rock samples which are the oldest rocks on Earth. These volatiles are trapped in fluid and vapor inclusions in the samples. The recent discovery of fluid inclusions in meteorites, along with the fluid inclusions in Archean rocks, offer the opportunity to directly measure the volatile constituents present at the time of formation of these prebiotic materials. The fluid inclusions in meteorites appear to be mostly water with only trace amounts of C, N, S, and O components. Analysis of the trapped volatiles offer the possibility of directly sampling 4.5 b.y. old volatiles. In the case of Archean samples, measurements of trapped liquids and vapors from the samples of different ages may offer the opportunity to directly measure the changes of early atmospheric and volatile components present during the early history of the Earth. The chemistry of the atmosphere under which life arose is important. Earlier views invoking highly reducing conditions are presently giving way to geochemical evidence for a nearly neutral atmosphere. We are analyzing the fluid and volatile inclusions in a suite of well-characterized Archean samples of different age along with inclusion-bearing meteorite samples in order to directly analyze the early volatile and/or atmospheric composition. From the analysis of the fluid and vapor inclusions in these well-characterized materials, models of the evolution of the Earth's atmosphere are developed along with providing vital information about the conditions under which meteorites formed.

W85-70433 **199-50-22**
Ames Research Center, Moffett Field, Calif.
ORGANIC GEOCHEMISTRY
D. J. DesMarais 415-965-6110
(199-50-12; 199-50-42)

This work seeks to understand the origin and early evolution of life on Earth through studies of organic matter in ancient rocks, contemporary environments, and microorganisms. In practice, the objective is to elucidate the chemical relationships between sedimentary organic matter and the biosphere from which it derives. The specific objective is to understand the origin of stable isotopic patterns in sedimentary organic matter. Because sedimentary stable isotopic abundances are influenced by microbial biochemistry and also are well preserved in ancient rocks, their study complements more traditional methods of early evolution research. Stable carbon and nitrogen isotopic fractionation in microbial metabolism will be examined. Using this knowledge, isotopic fractionation in biogeochemically significant microorganisms will be investigated to learn how they impose their chemical and isotopic signatures upon the organic constituents of rocks. Through field studies, these signatures in contemporary environments will be related to their analogs in ancient fossils and sediments.

W85-70434 **199-50-32**
Ames Research Center, Moffett Field, Calif.
ORIGIN AND EVOLUTION OF LIFE
L. I. Hochstein 415-965-5938
(199-50-12; 199-50-42)

The objectives of this research are to explore the mechanisms, processes, and environments associated with the origin(s) and evolution of life on Earth and to ascertain to what extent they represent constraints within which life can develop elsewhere in the Universe and to utilize such information to design models lending themselves to experimental verification. The origin of life represents a point on a conceptual continuum that characterizes the physical, chemical, and biological evolution of matter. While experimental verification of hypotheses concerned with cosmological and chemical evolution can be carried out on the extraterrestrial stage, studies on the origin and evolution of life are limited to experimental material available, terrestrial life. Several crucial areas of study have been identified for extensive investigation from which first principles can be discerned and applied to the formulation of a theory for the origin and early evolution of life. Two approaches are adopted for studying biogenesis and bioevolution: one is to posit plausible models for relevant processes and environments, and test them either experimentally or by the use of computer simulations; the other is to identify early events and their evolutionary context in contemporary organisms since they are, in fact, repositories of information concerning what took place during the evolution of life.

W85-70435 **199-50-42**
Ames Research Center, Moffett Field, Calif.
SOLAR SYSTEM EXPLORATION
G. C. Carle 415-965-5765
(199-50-12; 199-50-22)

The goal of this study is to provide specific information on the chemical composition of the atmospheres and the volatiles in surface and particulate matter of solar system bodies including planets, their satellites, comets, asteroids, meteorites and dust in space. This information is essential for selecting or devising the most appropriate model for the evolution of the solar system and for each of the investigated bodies, and will further provide a basis for understanding the conditions necessary for the origin of life by comparisons of the evolution and the chemistries of these bodies. Improved methods and instrumentation will be developed for in situ chemical analyses of the volatile species contained in atmospheres, surfaces and particulates. Special emphasis is directed to the development of the gas chromatographic approach since it is now proven to be among the most effective means for measuring complex gaseous chemical mixtures. Improvements in the gas chromatography, such as column technology, detector design, and total system design (including work on other subsystems), will be rigorously explored.

W85-70436 **199-50-52**
Ames Research Center, Moffett Field, Calif.
LIFE IN THE UNIVERSE
J. Billingham 415-965-5181
(199-50-12; 199-50-22; 199-50-32)

The goals are to understand the history of the biogenic elements and their compounds in the galaxy, in the solar system, and during the early evolution of the Earth, to explore ways of investigating these elements and compounds using space telescopes; to study possible evolutionary pathways for complex life; and to examine the influence of astrophysical, stellar, and solar system events on the evolution of complex life on Earth. This RTOP has two distinct parts: the history of the biogenic elements, and the evolution of complex life. In each part a series of Science Workshops has explored the major scientific questions, to determine which are amenable to theoretical, experimental, or observational approaches, and to recommend the major elements of a research program to pursue those objectives. The recommendations of the Science Workshops are now being incorporated into specific research proposals which address high priority scientific questions, and which include one task on the definition of observational science which should be carried out on the biogenic elements and compounds in different locations in the solar system and universe, using space telescopes.

W85-70437 **199-50-62**
Ames Research Center, Moffett Field, Calif.
THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)
B. Oliver 415-965-5181

The SETI program is an R&D effort which has the following objectives: (1) to conduct an extensive five year R&D effort to determine the most cost effective way to do SETI and to carry out limited but significant SETI observations; (2) to design, build, and test a SETI prototype system; (3) to use the prototype at Goldstone and Arecibo for initial SETI observations; (4) to evaluate the SETI system for its value for radio astronomy; and (5) to explore new technologies for SETI. In accomplishing these objectives, telescope-SETI hardware interfaces will be determined, alternative observational techniques investigated and various signal processing and identification methods examined in software and optimized for implementation in hardware. Signals of natural and artificial origin will be sought over portions of the sky between 1 and 10 GHz and selected solar type stars will be searched in the 1 to 3 GHz range. These initial observations are expected to continue through 1987. The plan is divided into six hardware phases, each of which improves the prototype capability.

W85-70438 **199-61-12**
Ames Research Center, Moffett Field, Calif.
CELSS DEVELOPMENT
R. D. MacElroy 415-965-5573
(199-61-22)

This RTOP supports the development of bioregenerative life support systems. Investigations are directed toward the practical use of higher plants, algae, microorganisms and physical chemical devices for two purposes: (1) to produce water, food, and oxygen for crew consumption in orbit or on the lunar surface, and (2) to consume carbon dioxide and other crew and system waste materials. The goal is to insure recycling and regeneration of materials needed for crew support. The control and the efficiency of such bioregenerative systems will also be studied. The approach is to investigate the rates at which organisms or physical-chemical devices produce or consume biomass, food, oxygen, carbon dioxide, potable water, and fixed nitrogen in response to changes in environmental variables such as temperature, atmospheric gas composition, lighting intensity, duration and quality, humidity, wind speed, and the composition of the nutrient medium. Methods of increasing system efficiency, stability, and control

through automated sensing, data collection, and data interpretation will be examined.

W85-70439 **199-61-22**
Ames Research Center, Moffett Field, Calif.
CELSS DEMONSTRATION
R. D. Johnson 415-965-5117
(199-61-12)

Independent investigations of the feasibility and efficiency of using photosynthetic organisms as the basis of a life support system strongly suggest that the concept is practical. However, a demonstration of life support capability for a system of this type must include recycling of essential materials through chemical and physical processes, and include system monitoring, control, and the use of active materials reservoirs. This RTOP is directed to the development and construction of a facility capable of demonstrating that the functions and efficiencies observed in the laboratory are attainable in a coupled system. The approach will utilize the expertise of scientists associated with the Bioregenerative Life Support (CELSS) program to develop a conceptual design of the laboratory complex, and also to establish the general requirements of the equipment that will be used in the complex. Following the definition of scientific requirements, a series of design concepts and cost estimates will be developed by professional engineers. After reviews involving scientific evaluations, a design will be established and facilities will be fabricated.

W85-70440 **199-61-31**
Lyndon B. Johnson Space Center, Houston, Tex.
AVANCED LIFE SUPPORT
C. D. Perner 713-483-3987

The objectives of this program are to define the requirements and specifications necessary for the orderly design and development of spacecraft systems and crew accommodations capable of sustaining long duration human occupancy in an environment which promotes efficiency of task executions and physical and psychological well being. This program includes tasks related to hygiene, waste management, food, clothing, recreation, consumables management, housekeeping, equipment maintenance, living quarters, and mobility aids. A series of continuing tasks will be implemented to identify, assess, develop, and validate technologies involved. Existing tasks in living provisions systems and architecture leading toward systems specifications for use as inputs to space station development will be continued.

W85-70441 **199-61-41**
Lyndon B. Johnson Space Center, Houston, Tex.
EVA SYSTEMS (MAN-MACHINE ENGINEERING REQUIREMENTS FOR DATA AND FUNCTIONAL INTERFACES)
J. L. Lewis 713-483-2368

The objectives of this RTOP are: to enhance human capabilities and human productivity in space; to continue to pursue state of the art technology and to advance that technology for the purpose of creating more effective and efficient man-machine interface for manned spacecraft; to develop models of human performance in space to support the design of spacecraft and mission planning; and to quantify man-machine engineering data, both on the ground and in flight. The approach is to implement a series of continuing tasks to identify and implement workable instrumentation packages for acquiring quantitative man-machine engineering data in one g, simulated zero g, and actual g; to continue those efforts currently defined that lead toward definitive design requirements for use as inputs to the Operator Station Design System; and to pursue feasibility studies of promising new crew interface items.

W85-70442 **199-70-41**
Ames Research Center, Moffett Field, Calif.
EXTENDED DATA ANALYSIS
W. Bush

The objective of this effort is to further analyze data from Spacelab and Cosmos missions beyond that contemplated by the participating life sciences investigators. The results will be available in usable form both to NASA and investigators who might wish to use the information as a basis for future flight experiments. The raw data collected during flight will be stored in a computer at ARC. Software will be developed for formatting and analyzing the in-flight data; it will then be put in the National Data Center for reference. The extended data base will permit analyses not now contemplated but which might become desirable in the future.

W85-70443 **199-70-52**
Ames Research Center, Moffett Field, Calif.
DATA BASE DEVELOPMENT
W. J. Gurney 415-965-6696

The objective of this effort is to construct a common Life Sciences space flight data archive containing non-human data. This data base, in concert with like efforts at JSC and KSC (human data and general/baseline data, respectively) would provide a readily available source of comprehensive space flight data to Life Sciences research investigators. A database working group must be convened among the three Centers to: (1) ensure computer compatibility, and (2) select a database management system capable of supporting this effort.

W85-70444 **199-80-32**
Ames Research Center, Moffett Field, Calif.
VESTIBULAR RESEARCH FACILITY (VRF)/VARIABLE (VGRF) GRAVITY RESEARCH
R. W. Mah 415-965-6538

A vestibular research facility (VRF) Scientific Research Program will be developed which will permit scientists to conduct fundamental vestibular research using a wider range of experimental stimuli and state-of-the-art hardware capabilities not available elsewhere. Current theories in vestibular research are that the vestibular system is intimately involved with space adaptation syndrome, as it is with terrestrial motion sickness. It is believed that a fundamental understanding of the vestibular system is necessary before a satisfactory prevention or cure can be derived. A VRF Science Laboratory is being developed for use by the scientific community. A VGRF hardware design for gravitational research and 1-g control in space using VRF core modules will also be developed. A ground version of the VRF modules will be constructed under the guidance of the VRF Science Advisory Committee. This ground equipment includes many, but not all, of the stimulus and recording modes of the flight version. The Science Advisory Committee for VRF feels that this facility presents a unique opportunity to conduct animal and potentially human research concerning vestibular function.

W85-70445 **199-80-52**
Ames Research Center, Moffett Field, Calif.
LARGE PRIMATE FACILITY
E. W. Gomersall 415-965-5730

The initial objectives of this effort are twofold: (1) to obtain scientific guidance for the conceptual design and development of a Large Primate Facility (LPF) which can be used in the spacelab and long duration missions; (2) to evaluate the feasibility of modifications to the RAHF system to support this type of mission. A group of scientists has been formed to identify science objectives and requirements for a large primate facility. In addition, detailed engineering studies will be conducted on the potential use of the RAHF subsystems in conjunction with existing concepts for primate experimentation in space (e.g., the French MEPP).

W85-70446 **199-80-72**
Ames Research Center, Moffett Field, Calif.
PLANT RESEARCH FACILITIES
E. L. Merek 415-965-6745

The overall objectives are to provide scientific guidance for the design and development of general purpose plant research facilities for spaceflight which can be used for the study of plant development, physiology, and growth in a weightless environment; to establish design requirements for flight plant research facilities compatible with spacecraft; and to identify hardware concepts for such designs. A science advisory group will be organized to identify the science requirements for plant experiments in space. These

requirements will be used by the engineers to develop preliminary hardware designs which will be subject to the review of the science advisory group. A prototype will be fabricated from the approved design, evaluated and tested using procedures also recommended by the advisory group.

W85-70447 **199-90-71**
Lyndon B. Johnson Space Center, Houston, Tex.
INTERDISCIPLINARY RESEARCH
Joseph P. Kerwin 713-483-3503

The Life Sciences Directorate at Johnson Space Center is responsible for the development of a comprehensive biomedical research program in support of manned space flight. This broad, multidiscipline mandate to acquire new knowledge is directed toward the acquisition of definitive data regarding the effects of the space environment on life systems in order to define the critical physiological and psychological variables which must be integrated into the overall considerations of spacecraft designers and mission planners. The objective of the interdisciplinary research RTOP is to provide flexibility in the accomplishment of this goal. The responsibility for planning, implementing, and continually evaluating the life sciences programs at Johnson includes the need to provide support for preliminary investigation of various alternative advanced research and technology efforts which might ultimately become part of an approved programmed RTOP assigned to the Center. An aggressive and responsive attention to alternative advanced programs requires that the Center Director for Life Sciences have some autonomous discretion in the pursuit of tentative investigations.

W85-70448 **199-90-72**
Ames Research Center, Moffett Field, Calif.
AMES RESEARCH CENTER INITIATIVES
J. C. Sharp 415-965-5100

The mission of the Life Sciences Directorate at Ames Research Center is to understand the origin of life on Earth and to search for life-related compounds and life elsewhere in the universe, to understand the effects of space flight upon humans and other life forms, and to provide environments and equipment in spacecraft that will permit crews and passengers to exist safely and perform effectively. The Center Initiatives RTOP provides the appropriate flexibility in the accomplishment of our mission by providing support for preliminary investigation of various alternative life sciences research and technology efforts which may result in formal research proposals ultimately becoming part of an approved RTOP. The Director of Life Sciences, ARC, will review the proposed efforts and select the tasks which will become part of this RTOP. Those tasks which show potential for further research pursuit will subsequently be submitted for future review and approval in the appropriate problem oriented RTOP's.

Data Analysis

W85-70449 **385-38-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR AND HELIOSPHERIC PHYSICS DATA ANALYSIS
M. Neugebauer 818-354-2005

High-time-resolution plasma and magnetic field data are used to study the properties of discontinuities in the solar wind. Special emphasis is given to tangential discontinuities because they do not propagate through the wind and may thus retain some information about conditions at the solar source.

W85-70450 **385-38-01**
Marshall Space Flight Center, Huntsville, Ala.
CORONAL DATA ANALYSIS
E. Hildner 205-453-0123

The objective of this research is to understand coronal mass ejections, both in the solar corona and in interplanetary space, and also to study solar influences on the interplanetary medium. Using SMM Coronagraph/Polarimeter data, correlative data, and numerical modeling. Individual mass ejection events are studied to understand thoroughly the events' creation and evolution and their relationship to other forms of solar activity. The behavior of idealized transients near the Sun are calculated through numerical modeling. Coronal mass ejections are examined in interplanetary space, primarily observationally, and also by numerical modeling. The kinematic and dynamic behavior of the heliospheric current sheet is modeled.

W85-70451 **385-38-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SOLAR IR HIGH RESOLUTION SPECTROSCOPY FROM ORBIT: AN ATLAS FREE OF TELLURIC CONTAMINATION
J. B. Breckinridge 213-354-6785

The objective is to prepare for publication in a standard solar atlas format a spectrophotometric atlas of the solar disk center. This atlas will have some spectral lines identified, have a signal noise ratio greater than 1000 to 1, have a spectral resolution of 0.01 per cm, have a spectral bandpass of 625 to 4,700 per cm and will have no spectral contamination from the Earth's atmosphere. The approach is to use the calibration data recorded during the scheduled flight of the ATMOS interference spectrometer. This 1 meter optical path difference Fourier transform spectrometer will be used to record both stratospheric and solar absorption spectra during sunrise and sunset as observed from orbit. The primary objective of the experiment is to acquire data for stratospheric physics and chemistry. This RTOP is for funds to prepare the solar atlas for use by solar astronomers.

W85-70452 **385-46-01**
Goddard Space Flight Center, Greenbelt, Md.
HIGH ENERGY ASTROPHYSICS: DATA ANALYSIS, INTERPRETATION AND THEORETICAL STUDIES
Stephen S. Holt 301-344-8801

This RTOP is to support laboratory efforts at processing, analysis and interpretation of data involving correlative studies from a variety of spaceflight experiments, and to conduct theoretical studies to support this effort. These theoretical and interpretive studies will lead to the publication of results in the scientific literature and help in the planning of new missions in the areas of X-ray and gamma ray astronomy, energetic particle or cosmic ray astrophysics, and cosmological studies. The approach involves use of multi-satellite data sets such as Voyager, Pioneer, IMP and Helios data for cosmic ray studies and Ariel 5, OSO-8, HEAO-1 and Einstein for X-ray astronomy, and comparisons with data from other observatories, both space and ground based, at other wavelengths. A strong emphasis is placed on creating the theoretical framework for interpreting the results. This RTOP supports graduate student thesis research, research associates and occasionally a senior faculty member on leave from an academic institution. As an example, in the X-ray area we will follow up on the discovery of new temporal and spectral phenomena in sources. The data bases span 5 years and offer complementary information on variability of sources on time scales of milliseconds to years and spectra from 0.5 keV up to MeV. We plan to emphasize spectral-temporal correlations best studied with multiple observations, to study models recommended by recent theoretical work and observations at other wavelengths, and studies which could be followed up by future missions such as XTE.

Solar Terrestrial Theory Program

W85-70453 **441-06-01**
Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLE ACCELERATION IN SOLAR SYSTEMS PLASMAS
R. Ramaty 301-344-8715

The objectives of this RTOP are: (1) to study the acceleration of energetic particles in the solar system; (2) to publish in the scientific literature and to present at professional meetings the significant results of such research; and (3) to collaborate with

and support theoretical research of graduate students, research associates, coinvestigators from other academic institutions who work on the subject matter of the RTOP. Theoretical research on particle acceleration in solar system plasmas is conducted in the Laboratory for High Energy Astrophysics by three civil sevice employees (R. Ramaty, F. C. Jones and T. G. Northrop), two research associates (J. McKinley, D. Ellison and J. Weatherall) and one graduate student (R. Murphy). This research is carried out within the framework of NASA's solar terrestrial theory program. In addition to laboratory for high energy astrophysics personnel, three other Goddard Scientists (C. J. Crannell, R. J. Drachman and M. L. Goldstein) as well as M. Forman (State University of New York) and D. Eichler (University of Maryland) are involved in this program.

Solar Terrestrial SR&T

W85-70454 **442-20-01**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE PLASMA LABORATORY RESEARCH
Andrei Konradi 713-483-2956

A significant laboratory research program in space plasma physics has been in existence at the Johnson Space Center since 1977. Until 1981 all experimental work had been performed in JSC's large vacuum chamber A. Since the decommissioning of that chamber, a small, laboratory sized chamber has been put into operation to continue the research. Specifically the objective is to: (1) Provide support for non-JSC guest experiments using the facility in terms of logistics, laboratory instrumentation, and limited hardware and labor. (2) To continue jointly with Rice University an in-house laboratory research program designed to enhance our understanding of certain plasma phenomena observed in space. The currently available plasma research facility consists of a vacuum chamber with a diameter of 4 ft. and a length of 9 ft. It is surrounded by an electromagnet capable of producing a solonoidal field of 38 gauss. Internal to the chamber is an electron gun, a carbon electron beam collector, and a 3 dimensional traversal system for positioning of diagnostic probes. It is also instrumented for RF/Langmuir probes, photometers and RPA's. The chamber is used by A. Konradi, R. J. Jost of JSC and W. Bernstein of Rice University for research on the beam plasma discharge.

W85-70455 **442-20-01**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO ANALYSIS OF INTERPLANETARY SCINTILLATIONS
R. Woo 213-354-3945

This RTOP provides scientific analysis and interpretation of radio data received from various deep space missions. The radio scattering measurements of the solar wind are conducted with the coherent, monochromatic and point-source signals received from deep space spacecraft. These studies, made possible by recently developed radio scintillation techniques, yield information on electron density fluctuations covering a wider range of scale sizes and heliocentric distances than have ever been possible before. Extensive solar wind velocity measurements are also made in the acceleration region of the solar wind. The spacecraft whose radio signals are used include Pioneer, Helios and Voyager. The scientific objectives are: (1) the study of structure and evolution of interplanetary disturbances (including shock waves and corotating high-speed streams) close to the Sun; (2) the measurement of the solar wind velocity near the Sun; and (3) the measurement of the electron density spectrum in the scale size range of 10 to 1 to the 7th power.

W85-70456 **442-20-01**
Jet Propulsion Laboratory, Pasadena, Calif.
MAGNETOSPHERIC AND INTERPLANETARY PHYSICS: DATA ANALYSIS
E. J. Smith 818-354-2248

The objective is to provide for the analysis and interpretation of scientific data from the Pioneer vector helium magnetometers and from the ISEE-1, -2, -3 plasma wave instruments. In addition, research topics involving the ISEE-3 magnetometer not supported by the project, will be included here. The data have previously been reduced using project funds and are available for more intensive analysis. The following general topics will be investigated: (1) the structure and dynamics of the magnetospheres of Jupiter and Saturn; (2) plasma waves inside planetary magnetospheres, in the magnetosheath, at, and upstream of, the bowshock and in interplanetary space; (3) the heliospheric magnetic field and solar wind including the large scale structure, radial and latitudinal gradients, interaction regions, rarefraction regions, shocks, discontinuities, and waves; and (4) the heliospheric magnetic field and energetic particles including cosmic rays and interplanetary proton streams. Already available data will be supplemented by observations made by other spacecraft as the additional observations are needed. The work will be carried out by members of the JPL Magnetic Fields Group (I. J. Smith, J. A. Slavin, B. T. Thomas, B. T. Tsurutani) in collaboration with investigators from outside the laboratory.

W85-70457 **442-20-01**
Marshall Space Flight Center, Huntsville, Ala.
SPACE PLASMA DATA ANALYSIS
C. R. Chappell 205-453-3036
(442-36-55)

The objective of this RTOP is an adequate understanding of the dynamics of low energy plasma in the Earth's magnetosphere. This research involves the analysis of data from spacecraft and ground based laboratory investigations. This individual RTOP consists of a coordinated set of tasks which includes: (1) analysis of the Light Ion Mass Spectrometer data from the NASA/DOD SCATHA satellite; (2) laboratory simulation of plasma flow around different objects; (3) modeling of thermal plasma processes; (4) analysis of data and development of models relating to the effects of spacecraft plasma sheaths upon low energy charged particle data; and (5) development of multispacecraft merged data sets and advanced display techniques.

W85-70458 **442-20-02**
Goddard Space Flight Center, Greenbelt, Md.
DATA ANALYSIS - SPACE PLASMA PHYSICS
J. K. Alexander 301-344-7110

The basic objective is to study the observed properties of the interplanetary medium and the magnetospheres of the Earth and other planets and to identify and understand the physical processes operating within and between these regimes. This is achieved by processing, analyzing and interpreting experimental data derived largely from flight programs after funding from project offices has terminated, permitting long term phenomenological studies, comparisons of data with new theories and models, correlative studies of data obtained from various satellites and ground based observatories, and the deposition of additional data sets in the NSSDC. The essential data to be used in this investigation include measurements of magnetic fields, plasmas, energetic particles, plasma waves and radio radiation. These data are used to determine the various dynamic and energetic states of the interplanetary medium and the magnetosphere and to assess the transport and deposition of matter and energy within and between these physical regions. These basic properties and processes are then used in the study of specific geophysical phenomena such as interplanetary sectors and flows, energetic particle acceleration, auroral current systems, and magnetic fields and plasma in the plasma sheet and the magnetotail. Basic theory complementary to the data analysis effort is carried out in the areas of kinetic plasma physics and the motion of charged particles in electric and magnetic fields.

W85-70459 **442-36-55**
Marshall Space Flight Center, Huntsville, Ala.
SPACE PLASMA SRT
C. R. Chappell 205-453-3036
(442-20-01)

The objectives of this and another closely related RTOP are to develop space plasma instrumentation for automated spacecraft, sounding rocket, and shuttle payloads. To accomplish these objectives, the following tasks will be performed: (1) upgrade the sensitivity of the differential ion flux probe (DIFP) instrument to be used for the measurement of multiple directed, low energy ion streams. This technique has been applied in laboratory wind tunnel studies and will be used on a future rocket flight into the aurora in 1984. (2) continue the design of an advanced retarding ion mass spectrometer for the measurement of low energy plasma distributions in the ionosphere and magnetosphere. This instrument was flown on a mid-latitude sounding rocket in the fall of 1979 and on a high-latitude auroral rocket in March 1980. The instrument throughput will be upgraded for potential flight on future NASA and DOD satellite missions.

W85-70460 **442-36-55**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLES AND PARTICLE/FIELD INTERACTIONS
Keith W. Ogilvie 301-344-5904

The object of this research is to increase the knowledge and understanding of nonthermal plasmas occurring in the interplanetary medium and magnetospheres of Earth and other planets. This requires continuous improvement of measurement techniques, concentrating on advanced concepts for plasma detectors, mass spectrometers, magnetometers and radio and plasma wave analyzers. Work is also under way to improve the theoretical description of plasma properties, and to improve techniques for the interpretation of the results of space plasma experiments, requiring corresponding improvements in numerical techniques and in methods of data display.

W85-70461 **442-36-55**
Jet Propulsion Laboratory, Pasadena, Calif.
JUPITER AND TERRESTRIAL MAGNETOSPHERE-IONOSPHERE INTERACTION
M. M. Litvak 213-354-7441

Calculations will be done on a pulsed-maser theory of Jupiter and terrestrial pulsed radio emission and on a theory of the interaction with the upper ionosphere of these radio sources lying in the lower magnetosphere. Nonthermal plasma-wave and particle distribution functions will be derived from the theory when predicted and observed burst waveforms and dynamic spectra are compared. Derived wave and particle fluxes will predict auroral image and spectral data. The pulsed-maser theory is based on concepts of maser oscillators that radiate from small regions that saturate at intensity levels set by the pump rate and that pulse due to competition with other stimulated emission effects, particularly stimulated backscatter in the magnetoplasma. The radio intensity of finite pulse-trains will be calculated from rate equations predicting relaxation oscillations of the maser, the generation of soliton-like pulses whose frequency drifts in time, and other nonlinear phenomena. These intensity and frequency characteristics will be compared with those of observations as part of a technique for recovering the particle distribution function. Parameters of the distribution function are evaluated by a numerical, least-squares fitting algorithm. Effects of the derived particle and wave fluxes on the energetics and turbulence of the region below the radio source will be evaluated by means of available excitation cross sections for the particle interactions and the related transport coefficients.

W85-70462 **442-36-55**
Jet Propulsion Laboratory, Pasadena, Calif.
THEORETICAL SPACE PLASMA PHYSICS
B. E. Goldstein 818-354-7366

The objective is to advance our understanding of space plasma physics and to provide continuing theoretical support for observational space plasma programs. Work is to be performed in three areas: (1) magnetohydrodynamic flow modelling of the solar wind interaction with comets and of the solar wind with the interstellar medium; (2) magnetostatic equilibrium modelling to determine the location of the magnetopause for varying geomagnetic conditions; and (3) an investigation of the divergence of solar wind flow from the heliospheric equatorial plane at increasing radial distances. The objectives of the solar wind-cometary interaction study are to investigate plasma-neutral interactions and model small scale structures. The same techniques will be applied to the heliospheric interaction. The objective of the magnetostatic modelling study is to determine the effects of changes in Birkeland currents systems and external magnetic fields upon the configuration of the magnetopause. The extent to which the equatorial divergence of the solar wind is produced by preferential winding up of magnetic field in the equatorial plane or is instead produced by the zones of compression in corotating interaction regions will be assessed. The cometary-solar wind (interstellar gas-solar wind) interaction model is being implemented with a finite difference code including more than one species and a moving mesh. A technique that self-consistently finds the magnetopause location for assumed interior current configurations is used to investigate the effects of changes in magnetospheric current systems from quiet to active periods. Theoretical models of effects due to colliding streams will be compared to Pioneer 10 and 11 observations in the outer solar system.

W85-70463 **442-36-56**
Goddard Space Flight Center, Greenbelt, Md.
PARTICLE AND PARTICLE/PHOTON INTERACTIONS (ATMOSPHERIC MAGNETOSPHERIC COUPLING)
James P. Heppner 301-344-8797

The objective is to develop experimental and theoretical approaches for investigating the processes which provide strong coupling between the neutral atmosphere, the collision dominated ionospheric plasma, and the collisionless magnetospheric plasma. Within the framework of this overall objective, specific subobjectives are identified in terms of having: (1) key significance; (2) goals which are attainable with limited resources; and (3) close ties to future projects and programs. Emphasis is placed on electric field and wind forces and the associated transport and energization of particles that occurs within the Earth's magnetic and gravitational fields. Related topics include: electric fields in the Earth-ionosphere cavity and their relation to weather processes; electric current systems and associated magnetic field disturbances; the generation of thermospheric winds and gravity waves; the transformation of atmospheric ions to trapped radiation; auroral particle acceleration mechanisms; plasma instabilities producing ionospheric irregularities, etc. New instrumentation is being developed for observations of tracer chemicals and for measurements of low energy particles. Properties of double probes in low density plasmas are being studied. Models for the injection, diffusion, and transport of tracer particles are being developed for planning future chemical release experiments.

W85-70464 **442-36-99**
Ames Research Center, Moffett Field, Calif.
MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTION
A. Barnes 415-965-5506

The overall objective is to investigate the solar wind, its origin, termination, dynamics and turbulence, as well as its interaction with planetary obstacles. Theoretical studies will be conducted, aimed at understanding the large-scale dynamics of the solar wind, its acceleration and heating mechanisms, and waves and turbulence in the solar wind. These studies employ known theoretical techniques of plasma physics and magnetohydrodynamics, and also often require extensions of basic theoretical plasma physics. Theoretical developments will be related to spacecraft plasma and magnetic data, as well as to indirect observations of the solar wind. Theoretical studies of possible relations between variations in solar output (radiation and/or charged particles and magnetic fields) and terrestrial weather and climate will be carried out. Theoretical studies of the solar wind-Venus interaction will be conducted.

Sounding Rockets--Solar Terrestrial

W85-70465 **445-11-36**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKETS: SPACE PLASMA PHYSICS EXPERIMENTS
James P. Heppner 301-344-8797

The objective is to perform measurements and experiments that will lead to an understanding of the interactive processes that occur between neutral gases, plasmas, energetic particles, and electric fields in the atmosphere, ionosphere, and near earth magnetosphere. Emphasis is placed on measurements and experiments and experiments that utilize the unique characteristics of sounding rocket trajectories and/or the low cost, quick reaction sounding rocket approach which permits program flexibility. Historically, this approach has logically been extended to include: (1) piggyback experiments on orbiting vehicles; (2) experiments involving sounding rocket flights in association with simultaneous satellite measurements in selected geometrical coincidence between trajectories; (3) flight testing of new instrumentation and measurement techniques; (4) shuttle flights of low cost, rocket type payloads; and (5) investigations of the electrodynamics of middle atmosphere (i.e., below 90 Km) using sounding rockets for deploying payloads which descend via parachutes.

Technical Consultation and Support Studies

W85-70466 **643-10-01**
Lewis Research Center, Cleveland, Ohio.
SPECTRUM AND ORBIT UTILIZATION STUDIES
E. F. Miller 216-433-4000

The objective of this RTOP is to: (1) provide technical consultation services support in the area of space services with particular emphasis on preparing for international meetings relating to the fixed-satellite service (FSS), the mobile-satellite service (MSS) and the broadcast-satellite service (BSS); (2) provide the technical basis and regulatory support needed to obtain sufficient orbit/spectrum to meet current and projected requirements of NASA and the United States; and (3) perform studies, develop analytical methods for spectrum management, conduct evaluations, identify technology status and needs, perform critical technology developments, perform measurements (where necessary) to determine sharing criteria, and evaluate alternatives that result in efficient and cost-effective use of the geostationary orbit/spectrum resource. Specifically, these activities will: (1) support domestic and international preparatons for the 1985/1988 Space Services WARC with primary emphasis on the FSS and the MSS, and secondary emphasis on the BSS; and (2) support domestic and international MSS planning in the 806-890 MHz band. The described activities will be conducted within the framework and schedules of the applicable CCIR Study Groups, the special preparatory committees established in the United States, and the national and international meetings called to support preparations for the Conferences. Efforts planned are a combination of in-house and contract activities.

W85-70467 **643-10-01**
Jet Propulsion Laboratory, Pasadena, Calif.
SPECTRUM AND ORBIT UTILIZATION STUDIES
J. J. Talbott 213-354-5170
(643-10-02)

The objective of this RTOP is to insure the growth of space applications by providing the technical basis, legal authority, and regulatory framework needed to obtain sufficient spectrum and orbital positions to meet current and projected requirements. The result of this work will be used by NASA to help determine its radio frequency and orbital requirements and to secure compatibility between NASA flight programs and other space and terrestrial services. The result will also be used by NASA and other government agencies for the purpose of supporting CCIR and World Administrative Radio Conferences in making decisions on frequency and orbit utilization and earthstation and satellite approvals and in providing for the growth of existing and new multipurpose satellite services. The specific objective for FY-85 is to support NASA headquarters with the analysis of spectrum and orbit issues to develop the domestic and international regulatory framework best to serve the national requirements for fixed and mobile communications and new multipurpose satellite services. The approaches are to participate in studies and analyses leading to advanced planning of the frequency allocation and regulatory framework for space services as well as studies for NASA, CCIR, and Administration Radio Conferences. The studies for specific space programs will include: RFI analysis, transborder frequency sharing, feeder link frequency sharing, feeder link frequency assessment, and regulatory support. The economic/institutional study on the future satellite services will be continued. Studies on the fixed, mobile, broadcasting, and new multipurpose satellite services will be conducted as required.

W85-70468 **643-10-02**
Lewis Research Center, Cleveland, Ohio.
NEW SPACE APPLICATION CONCEPT STUDIES AND STATUTORY FILINGS
J. R. Ramler 216-433-4000
(643-10-01; 650-60-26)

The objective of this RTOP is to: (1) identify and define new applications for communication satellites; (2) define preliminary concepts, configurations, requirements and costs of alternative operational systems for new applications; (3) identify the technologies required to enable the implementation of advanced operational communication satellites; (4) formulate preliminary plans for developing the required technologies; and (5) support appropriate initiatives in the FCC, IRAC, and ITU for new space communications applications. The approach is to formulate and carry out in-house and contracted studies to meet the objectives. These studies will be of a scoping nature and will address the technical, economic and institution/regulatory feasibility of operational systems.

W85-70469 **643-10-02**
Jet Propulsion Laboratory, Pasadena, Calif.
NEW APPLICATION CONCEPTS AND STUDIES
Y. H. Park 213-354-5170
(650-60-15; 506-58-25; 643-10-01; 643-10-03)

The objectives of this RTOP are to provide for the growth of existing satellite services and new communications satellite applications, and ensure compatibility of NASA's communications flight programs with other space and terrestrial services. Government procedures require all agencies to submit proposed new space system concepts to IRAC and OMB for review four to six years prior to their planned date of initial operation. This is to ensure spectrum availability for telecommunications systems prior to commitment of public funds. The approach will include studies of system concepts with potential applications within the NASA Communications Program. These studies will include conceptual designs, user functional requirements, cost effectiveness, system tradeoffs, and sharing studies required to demonstrate compatibility with existing or planned services. Specific objectives of this RTOP in FY '85 will be to continue and document conceptual designs of the second generation LMSS spacecraft and provice assessment of telecommunication issues and technologies started in FY '84. Also objectives will be to establish a cost model for the overall land mobile satellite system including spacecrafts and all ground systems.

W85-70470 **643-10-03**
Jet Propulsion Laboratory, Pasadena, Calif.
PROPAGATION STUDIES AND MEASUREMENTS
E. K. Smith 213-354-8040
(643-10-01; 643-10-02)

The objectives of the NASA Propagation Studies and Measurements Program are to provide an understanding and analysis of

the basic propagation mechanisms which hinder reliable Earth-space communications, and to develop predictive models for the quantitative evaluation of propagation effects in the bands allocated for space applications. The objectives of the program are accomplished under four major task activities: (1) propagation measurements and experiments; (2) propagation effects modeling and analysis; (3) propagation assessment and evaluation; and (4) advanced propagation studies. The first area includes the traditional area of the program (satellite based and ground based experiments above 10 GHz) which has been de-emphasized in FY-85; and airborne propagation experiments supporting the mobile satellite (MSAT-X) program which has been expanded. The second area supports model development in Earth-space propagation (foliage attenuation, terrain multipath, space diversity, ionospheric and tropospheric scintillation, natural noise, fade rate and fade duration). The third area involves NASA activities in CCIR (International Radio Consultative Committee) in the propagation area; in the updating of the NASA propagation handbook for satellite system design; and propagation effects assessment at UHF for mobile satellite applications. The fourth area includes multiple scattering and coherence bandwidth studies and propagation constraints on digital and wideband systems.

Experiment Coordination and Operations Support

W85-70471 **646-41-01**
Lewis Research Center, Cleveland, Ohio.
EXPERIMENTS COORDINATION AND MISSION SUPPORT
J. W. Bagwell 216-433-6196

The objective of this effort is to provide the technology, skills, and services necessary for the conduct of a meaningful experiment program using advanced communications satellite technology. The approach is to: investigate and evaluate transitional and low cost techniques for providing earth terminal systems for the conduct of experiments using satellites incorporating advanced communications technologies; and to supply equipment updates and operational in-house support of the communications research facilities at LeRC.

W85-70472 **646-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
THIN-ROUTE USER TERMINAL
F. Naderi 213-354-5095
(650-60-15; 646-41-02)

The Communications Division of the Office of Space Science and Applications of the National Aeronautics and Space Administration (NASA) is currently engaged in an activity aimed at accelerating the deployment of the first generation of satellites for land mobile communications and technologically enhancing future generations. While the first satellite will be developed and operated by the private sector, NASA intends to obtain a portion of the satellite capacity in return for free or favorable launch terms. NASA will then use its portion of the capacity to conduct experiments aimed at demonstration of advanced technologies which are likely to be representative of second generation land mobile satellite systems (LMSS). These technologies include network management and multiple-access techniques, mobile radios, and mobile antennas. The activities leading to development of various technologies and the subsequent experiments are, for the most part, undertaken under the umbrella of RTOP 650-60-15. This RTOP which is closely coordinated with RTOP 650-60-15, will outline the mobile terminal development. The mobile terminals will be modular so as to offer flexibility of component upgrade as various technologies evolve and become available. The units will be adaptable modular radios composed of plug-in modular components and a core module which will provide the common support circuits such as control logic, transmitter and receiver RF sections, and frequency synthesizer. The core module provides the common functions of a mobile transceiver while the other modules are plugged in to the core module to provide the functions necessary for a complete transceiver configuration. As technologies evolve and new modulation, coding, vocoding, antenna, or networking are to be tested, these peripheral modules can be evaluated using the core module as a basis. The baseline terminal will be capable of transmitting 2400 bps of speech and data in 5 KHz channel and will be upgraded later to transmit 4800 bps in the same channel spacing. The emphasis will be on spectral and power efficiency at low cost.

Advanced Communications Research

W85-70473 **650-60-20**
Lewis Research Center, Cleveland, Ohio.
SPACE COMMUNICATIONS SYSTEMS ANTENNA TECHNOLOGY
J. W. Bagwell 216-433-6196

The objective is to conduct supporting research and technology development on a multibeam antenna system for advanced geostationary communication satellites and supporting earth terminals. Efforts will be directed at applications of such antennas for multiple spot beams and scanning beams. Previous efforts under this RTOP have resulted in the design, fabrication, and delivery of POC models of both ground and satellite antennas. Current efforts will involve the evaluation of those antennas, their incorporation into laboratory systems, and assessment of requirements for future systems. Future efforts will be directed at using advanced technology in the development of mobile antennas for 30/20 GHz applications and the development of spaceborne antennas for intersatellite links.

W85-70474 **650-60-21**
Lewis Research Center, Cleveland, Ohio.
SATELLITE SWITCHING AND PROCESSING SYSTEMS
J. W. Bagwell 216-433-6196
(650-60-20; 650-60-22; 650-60-23)

The objectives are to develop the switching technology for the routing of signals (message traffic) aboard multibeam, multichannel communications satellites; to develop spectrally efficient, high data rate digital modulation technology; and design and development of the enabling LSI technology for flight system implementation of a baseband processing (i.e., digital routing) for communications satellite applications. Work will consist of multiple contracts in FY-85 to develop advanced modulation technology and burst demodulators for the space and ground segments using bandwidth efficient concepts and cost reducing techniques.

W85-70475 **650-60-22**
Lewis Research Center, Cleveland, Ohio.
RF COMPONENTS FOR SATELLITE COMMUNICATIONS SYSTEMS
J. W. Bagwell 216-433-6196

The objective is to perform supporting research and technology development in the area of space related RF components including power amplifiers (tube and solid state), low noise receivers, and other components. Initial efforts center on those components identified as needed in the 30/20 GHz band in support of the Advanced Communications Technology Satellite (ACTS) experimental program. Future efforts will focus on further improving TWT performance in areas such as diamond support rods, linearization techniques, and tunneladder construction, and on assessing the reliability and improving the performance of solid state devices. By means of principally a contractual program, analysis and synthesis techniques for the above space program components will be developed; the developed techniques will be applied to determine the basic characteristics of components meeting specified requirements; experimental components will be fabricated; and fabricated components will be tested and evaluated.

W85-70476 **650-60-23**
Lewis Research Center, Cleveland, Ohio.
COMMUNICATIONS LABORATORY FOR TRANSPONDER DEVELOPMENT
J. W. Bagwell 216-433-6196
(650-60-12; 650-60-22; 650-60-21)

The objectives are to design and develop a laboratory test facility to be used to test communication system components and subsystems; to provide laboratory simulations of TDMA multibeam satellite communications systems; and to further develop prototype ground terminal systems for use with advanced communication satellites. A 30 GHz uplink, frequency translator and 20 GHz downlink communications system, including transmitting and recycling ground terminals, and satellite segment will be designed, developed, and tested. Continuous bit stream rates of nominally 27.5 MBPS and 220 MBPS will be used to modulate the links. End to end calculations will be made. Software simulation results will be compared with the hardware simulation results. Upon completion, network control methods will be added and bursty data transmissions will be tested and evaluated in both hardware and software. Finally, the baseband processor and IF switch matrix and several simulated stations will be integrated.

W85-70477 **650-60-26**
Lewis Research Center, Cleveland, Ohio.
ADVANCED STUDIES
J. R. Ramler 216-433-4000
(650-60-20; 650-60-21; 650-60-22; 650-60-23; 643-10-02; 643-10-20)

The objectives are to: (1) define the nation's current and future satellite telecommunications needs; (2) define advanced operational satellite system concepts and configurations to meet those needs while improving satellite capacity and frequency/orbit utilization; (3) define enabling technologies for such systems appropriate for advanced development by NASA; and (4) define and develop advocacy for suitable advanced communications technology development programs to be undertaken by NASA. The approach is to conduct in-house and contracted studies to assess needs; determine system requirements; and define future satellite services and systems (both space and ground segments) requiring advanced communications technology. The output from these studies will be used to plan and guide future communications technology development.

Information Systems

W85-70478 **656-42-01**
Marshall Space Flight Center, Huntsville, Ala.
SPACE PHYSICS ANALYSIS NETWORK (SPAN)
J. L. Green 205-453-0028
(442-20-01)

The objective of this research is to develop the Space Physics Analysis Network or SPAN that would link together a large number of NASA space scientists for the purpose of correlative scientific research. SPAN will become a test bed for the design of data systems for the future and will develop techniques necessary for correlative analysis of scientific data using computer networks.

Thematic Mapper Development

W85-70479 **667-60-16**
National Space Technology Labs., Bay Saint Louis, Miss.
CROP MENSURATION AND MAPPING JOINT RESEARCH PROJECT
D. P. Brannon 601-688-2043
(677-60-17)

This RTOP will (1) develop a detailed LANDSAT MSS test base with which TM results can be compared; (2) develop and test data analysis techniques for deriving agricultural information from LANDSAT 4 TM data; and (3) test the developed techniques in an operational setting in cooperation with International Harvester Company. During Phase 1 a multitemporal classification of LANDSAT MSS data (February; July; September 1981 growing season) was produced in Poinsett County, Arkansas. These results were compared with those from the detailed work done over the Powers Slough/Otwell quadrangle test site to determine the effect of differences in areal extent on classification accuracy. Also several variations of unsupervised classifications were performed to determine if areas showing double cropping practices could be discriminated. The pixel-by-pixel analysis proved most effective in identifying double cropped acreage from a multitemporal data set. Phase 2 dealt with reducing the amount of TM data analyzed over an area and still maintain classification and object accuracy. These points were specifically requested by IH in view of any operational plans they might have for analyzing large volumes of data. The third phase requires an operational test of techniques in close cooperation with IH market analysts. Project results will be disseminated to the agricultural business community through a workshop mechanism.

W85-70480 **667-60-18**
National Space Technology Labs., Bay Saint Louis, Miss.
TIMBER RESOURCE INVENTORY AND MONITORING
C. L. Hill 601-688-2047

The objective is to test the ability of the Thematic Mapper to provide information regarding the current condition of the forest land base. This information (provided manually in the past) is used to develop forest management strategy to maximize raw material production, minimize production cost, and increase the present net worth of the forest land base. The approach will be to: (1) determine species composition, density strata, and age strata for each forest stand (an indication of Gross Merchantable Volume); and (2) discriminate various silvicultural activities (i.e., site preparation, planting, thinning, harvest, and prescribed burning). Assessments of silvicultural activities provides an indication of management intention, final product, future harvest trends, and availability of wood fiber.

Earth Resources Technology Satellite-D (Landsat-D)

W85-70481 **668-37-99**
Ames Research Center, Moffett Field, Calif.
LONG TERM APPLICATIONS RESEARCH
E. H. Bauer 415-965-5898
(677-63-00)

The purpose of this research is to determine the technical viability of engineering remote sensors and remote sensing techniques in a range of environmentally and ecologically different regions and to relate research where possible to major earth science issues. The approach is to use previously established test sites, data bases, and/or cooperative relationships so as to focus applied research in areas that benefit both the NASA and the cooperator's interest toward long term applications. NASA's emphasis will be in those areas that complement science objectives in hydrology, terrestrial ecosystems and remote sensing. Specific ecosystems for study include the arctic sub-arctic biomes in Alaska and the Idaho shrub-steppe.

Climate Research

W85-70482 **672-21-99**
Ames Research Center, Moffett Field, Calif.
AEROSOL AND GAS MEASUREMENTS ADDRESSING AEROSOL CLIMATIC EFFECTS
P. Russell 415-965-5404

The objective of this RTOP is to advance understanding of aerosol effects on climate. Focus is especially on the effects of

major volcanic eruptions and major tropospheric hazes such as the Arctic haze. The approach is to collect, analyze, interpret, and publish data on the aerosol particles and precursor bases that constitute or form the hazes of, interest and to use U-2, ER-2, and the CV-990 as platforms to access the subject aerosols.

W85-70483 **672-31-99**
Ames Research Center, Moffett Field, Calif.
AEROSOL FORMATION MODELS
O. B. Toon 415-965-5971
(672-32-99)

The objective is to simulate the ambient stratospheric aerosol layer and the El Chichon volcanic cloud. The simulations will be compared with observations and will be used to create input data sets for climate models. The models will be utilized to test data sets for internal consistency and to better determine the physics and chemistry of the stratosphere. A two dimensional model of stratospheric aerosols has been developed and is reasonably successful in duplicating the observations. The major problem with two dimensional models is obtaining realistic transport. A multi-dimensional model will be used to replace the 2-D model. This will allow both 2-D and 3-D simulations. The 3-D simulations will be done using observed winds and winds from a dynamical model. Extensive data comparison and sensitivity tests will be done with this multidimensional model. The model will be used to simulate larger volcanic eruptions of the past.

W85-70484 **672-32-99**
Ames Research Center, Moffett Field, Calif.
CLIMATE MODELING WITH EMPHASIS ON AEROSOLS AND CLOUDS
J. B. Pollack 415-965-5530
(672-31-99)

A coordinated set of theoretical, laboratory, and field investigations will be conducted to study the chemical and radiative properties of clouds and natural (e.g., volcanic) and man-made atmospheric aerosol particles in order to assess their inpact on regional and global climate. The field investigations are intended to provide information on aerosols complementary to that being obtained from spacecraft platforms (e.g., SAM II and SME) so as to insure a comprehensive set of properties for climatic analyses. The theoretical and laboratory tasks are directed at interpreting and utilizing the aerosol data sets to perform the desired climatic assessments. The centerpiece of the field investigations is a set of coordinated aerosol experiments which are flown together on an appropriate aircraft platform (e.g., NASA U-2 and CV-990). Both theoretical modeling and laboratory studies are used to define the mechanisms of aerosol and cloud formation, to provide hypotheses that can be tested by the field investigations, and to provide ultimately predictive tools. Theoretical investigations involving radiative transfer, dynamics, and formation are utilized for making the climatic assessments.

W85-70485 **672-50-99**
Ames Research Center, Moffett Field, Calif.
ARC MULTI-PROGRAM SUPPORT FOR CLIMATE RESEARCH
A. Margozzi 415-965-5517
(672-21-99; 672-31-99; 672-32-99)

The objective is to consolidate ARC Multi-program Support (IMS) costs for the Ames 672-UPN so that charges need not be made against individual RTOPs in the UPN. The 672-UPN supports the study of atmospheric aerosols through observational and theoretical tasks. These include assessments of the impact of stratospheric aerosols on climate, understanding the role aerosols play in chemistry of the stratosphere, evaluating the aerosol components of pollution, and determining their composition and mode of formation.

Stratospheric Air Quality

W85-70486 **673-41-12**
Jet Propulsion Laboratory, Pasadena, Calif.
STRATOSPHERIC CIRCULATION FROM REMOTELY SENSED TEMPERATURES
L. S. Elson 213-354-4223

The objective of the research is to develop an improved quantitative understanding of the large scale circulation of the lower stratosphere in the 15 to 30 km region. Included in the topics addressed are both free and forced waves along with the zonally averaged component of the circulation. The approach is to examine traditional scaling approximations which have been applied to the stratosphere. Such approximations have been based mainly on tropospheric applications and are not always appropriate for stratospheric problems. When an approximation is found to be inappropriate, an alternative approach is developed. The technique employed maximizes the use of high quality satellite data which provides both global coverage and good vertical resolution. For these applications, limb observations (LIMS, LRIR) have been found to be superior to other data sets. By inferring the circulation from the observations, the results are less dependent on modeling assumptions. The use of data also allows the selection of dominant processes from among competing theoretical models.

W85-70487 **673-41-13**
Jet Propulsion Laboratory, Pasadena, Calif.
SATELLITE DATA INTERPRETATION, N2O AND NO TRANSPORT
S. S. Prasad 818-354-6423

Satellite observations of minor and trace chemical species and of precipitating electrons and protons are being analyzed to elucidate chemistry and transport of nitrous and nitric oxide. Satellite measurements of minor and trace stratospheric species O3, NeO, CH4, NO2, HNO3 are converted into seasonal zonal averages of the mixing ratios. Measurements of key species such as O3, N2O, and CH4 are then inserted in various combinations into theoretical one- and two-dimensional kinetic and transport models. Predicted latitudinal vertical distributions of the remaining species are then compared with observations to determine significant features of stratospheric chemistry and transport with particular emphasis on those of nitrous and nitric oxides.

W85-70488 **673-61-02**
Jet Propulsion Laboratory, Pasadena, Calif.
MESOSPHERIC-STRATOSPHERIC WAVES
R. W. Zurek 818-354-3725

The observed cold summer pole and warm polar night in the upper mesosphere are thought to be due to the adiabatic cooling and heating associated with a cross-equatorial zonally symmetric circulation, which is itself driven by the momentum flux-divergences associated with vertically propagating waves. Recent work has shown that the flux-divergence of zonal momentum due to atmospheric tides may be marginally important compared to the longitudinally averaged zonal momentum balance of the mesosphere. Calculations of the tidal flux divergences indicate that the tidal contribution to the longitudinally averaged meridional momentum balance may be the more significant term, particularly at low latitudes.

W85-70489 **673-61-07**
Goddard Inst. for Space Studies, New York.
CLIMATOLOGICAL STRATOSPHERIC MODELING
David Rind 212-678-5593

The objectives of this RTOP are to understand the impact of potential climate perturbations on the stratosphere, to assess the effect of any alternations in stratospheric dynamics on the impact of anthropogenic release on stratospheric ozone, and to understand the relationship between 1D, 2D and 3D transports. The approach is to employ 3-D studies using a climate/middle atmosphere model and 1D/2D photochemical models in cooperation with McElroy (Harvard University).

W85-70490 **673-61-99**
Ames Research Center, Moffett Field, Calif.
STRATOSPHERIC DYNAMICS
R. E. Young 415-965-5515

The objectives of this research are to increase our understanding of the dynamics, thermodynamics, and composition of the Earth's stratosphere, and to investigate the mechanisms by which trace species are exchanged between troposphere and stratosphere. The approach will involve a combination of theoretical and observational studies. Global and mesoscale circulation models will investigate transport and exchange processes. Satellite data analysis will be used to characterize wave and transport phenomena in the stratosphere. Meteorological and diagnostic analysis will be conducted in support of aircraft measurement programs, such as the Troposphere-Stratosphere Exchange experiment.

Geopotential Research Program

W85-70491 **676-20-01**
Goddard Space Flight Center, Greenbelt, Md.
GEOPOTENTIAL FIELDS (MAGNETIC)
R. A. Langel 301-344-6565

The major objectives of this RTOP are to develop more accurate and reliable models of the Earth's main magnetic field and its temporal variation and to study the physical processes in the core which are responsible for generation of that field. The approach includes both collection of all suitable data types and of the development of new analytic techniques. New observatory and repeat data are continually being added to our data set as they become available. Planned extension of models to epochs prior to those already analyzed (1960) will require acquisition and quality verification of additional data. Marine and aeromagnetic data are not yet extensively used. These are easily acquired but are of uneven, and often unknown quality and so require extensive reduction before utilization. New techniques are under development both for the representation of secular variation and for the main field itself. These include utilization of periodic terms and/or partial fractions for secular variation and of spline functions for both the main field and for secular variation. Methods of making error estimates are under review to attempt more realistic error bounds on both model coefficients and on the computed fields.

W85-70492 **676-30-01**
Goddard Space Flight Center, Greenbelt, Md.
GEODYN PROGRAM
Barbara H. Putney 301-344-6018

The major objectives of this RTOP are: (1) improvement and maintenance of the geodynamics software systems; creation of a state-of-the-art orbit determination and geodetic parameter estimation system; (2) conversion and optimization of Geodyn, Solve, and Erodyn software to the Cyber 205 computer; (3) creation of aids for the user community to make their usage of the software more user-friendly and productive. The development of the software systems to support gravitational field, polar motion, Earth rotation, baseline determination, Earth and ocean tide models, and other geodynamics work will continue, and their efficient conversion to the vector processor will be accomplished. The approach is to support following programs areas: (1) gravitational field determination; (2) development of models of the Earth's interior structure; (3) development of lithospheric models; (4) demonstration of the ocean geoid for oceanography; (5) use of gravity data for resource assessment; and (6) GRM and TOPEX missions.

W85-70493 **676-30-05**
Jet Propulsion Laboratory, Pasadena, Calif.
SEMI DRAG FREE GRADIOMETRY
D. Sonnabend 818-354-7593

The objective of this work is to begin development of a technique for operating sensitive instruments, primarily gravity gradiometers, aboard the vehicle (Shuttle). The technique provides intermittent drag free operation of the payload instrument, with minimum impact on Shuttle systems or operations. The payload instrument would be encased in a conducting shell, and free floated in the Shuttle bay. Contact with any structure would be prevented by eddy current forcing coils. Previous studies under the former RTOP have shown that normal Shuttle disturbances including air drag, rotation, and crew motion can all be accommodated.

W85-70494 **676-59-10**
Goddard Space Flight Center, Greenbelt, Md.
GEOPOTENTIAL RESEARCH MISSION (GRM) STUDIES
T. Keating 301-344-8817
(676-40-01)

The objectives are to: (1) conduct system studies of the Geopotential Research Mission (GRM) and prepare a Phase B proposal; (2) support the science working group; (3) conduct magnetic simulation; and (4) conduct surface momentum accommodation coefficient measurement. System studies will determine the complex relationship of the Doppler tracking, the DISCO, the propulsion, and the on-board computer-controlled, drag-free flight profile. Magnetic simulations will be performed to illustrate mission capability. The science steering group will participate in a GRM science conference to present the results of three years of research. The surface momentum accommodation measurements will be measured in a neutral beam vacuum chamber.

W85-70495 **676-59-33**
Marshall Space Flight Center, Huntsville, Ala.
SUPERCONDUCTING GRAVITY GRADIOMETER
C. R. Baugher 205-453-2701

The objective of this RTOP is to develop a full vector, three-axis superconducting gravity gradiometer for space flight applications. The instrument will be designed to have, as a minimum requirement, a measurement sensitivity of 0.01 ETVOS units in an orbital environment and exhibit a measurement time constant consistent with the current requirements of geodynamics research into the mass distribution of the terrestrial lithosphere. The final functioning sensor unit will be constructed and tested in a manner consistent with a proto-flight approach to a possible scientific shuttle flight.

W85-70496 **676-59-55**
Goddard Space Flight Center, Greenbelt, Md.
GRAVITY GRADIOMETER PROGRAM
W. D. Kahn 301-344-5462

The objective is to conduct studies of a spaceborne gravity gradiometer system for Earth and planetary mapping of the gravity field. These studies will furthermore be used to prepare the foundation for an advanced Geopotential Resources Mission-B Mission for the latter part of the next decade. Studies will be performed to assess the capability of a gravity gradiometer to recover gravity and geoid anomalies as a function of horizontal resolution. Computations will be performed for typical land and sea surface areas and for each combination of assumed values for the instrument and system noise levels at orbit altitude. Orbit requirements and data reduction techniques for a gravity gradiometer will be developed for the gradiometer to map the fine structure of the Earth's gravity field.

W85-70497 **676-59-75**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED MAGNETOMETER
E. J. Smith 818-354-2248

The objective of this RTOP is to evaluate the helium magnetometer in various modes of operation, specifically the scalar field mode, and determine its suitability for use on future missions. The evaluation is to be directed to near term flight opportunities such as the Geopotential Research Mission, the Mars Geoscience Climatology Orbiter, the tethered satellite, possible programs on future shuttle flights (including those that involve high inclination orbits) and such other opportunities as arise. A magnetometer which can be operated in either the scalar or vector mode, possibly by cycling between the two modes will be developed. A H3(3) nuclear free precession magnetometer will be tested and devel-

oped. A design and evaluation team has been formed consisting of scientists and engineers from the Magnetic Fields Group assisted by two consultants: an expert on helium magnetometers and an expert on alkali magnetometers. Other Laboratory personnel will be involved as needed, e.g., to assist in thermal and mechanical design, analysis and test.

Resource Observation Applied Research and Data Analysis

W85-70498 **677-25-99**
Ames Research Center, Moffett Field, Calif.
TERRESTRIAL ECOSYSTEMS/BIOGEOCHEMICAL CYCLING
David L. Peterson 415-965-5232
(199-30-32)

The objectives are to understand the scene radiance variation of broad band satellites attributable to forest species/structural properties such as leaf area index; relate these properties to functional variables; primary productivity and biogenic emission of nitrogenous compounds; explain the variation in organic chemistry of forest canopies, within and between ecosystems; to derive total canopy nitrogen, phosphorus and lignin content through high spectral resolution spectroscopy; and simulate the biogeochemical cycling dynamics of forested ecosystems through canopy-driven mechanistic modeling and data synthesis. Partial correlation analysis of TM and AVHRR data against ground-based allometric data for controlled experiments in temperate coniferous forests will be conducted. Near-infrared spectroscopy using high spectral resolution instruments in the lab, field and remotely, concurrent with wet chemical analysis will be conducted to determine the organic chemistry and estimate total nitrogen, phosphorus, and lignin content of canopies. Extant biological and environmental data for a canopy-driven model simulating water and nutrient controls of carbon photosynthesis with environment driving forces will be synthesized.

W85-70499 **677-26-01**
National Space Technology Labs., Bay Saint Louis, Miss.
SOIL DELINEATION
Ramona Pelletier 601-688-3830

The objective of this research is to develop remote sensing techniques capable of delineating soils and soil properties in a manner that would serve to expedite the preparation of soil surveys. This will be accomplished by: (1) conducting laboratory spectroradiometer measurements of selected benchmark soils representing a broad cross section of U.S. soils from test sites around the country exhibiting a variety of soil and climatic conditions; (2) conducting field spectroradiometer measurements or selected soils from above and comparing with the laboratory data; and (3) acquiring remotely sensed aircraft or spacecraft data for the soils as above and comparing with the field radiometric measurements. Soil parameters and site characteristics of importance in soil map unit delineation which can be correlated with intrinsic soil spectral properties will be identified. Those field dependent factors such as surface roughness, crusting, moisture, plant residue, and partial vegetative cover will be studied as to the degree in which they alter the innate spectral response of surface soils. Homogeneous spectral classes resulting from processing various combinations of visible reflective IR and emissive IR bands will be compared with digitized soil map data.

W85-70500 **677-26-02**
National Space Technology Labs., Bay Saint Louis, Miss.
SHORTGRASS STEPPE - LONG-TERM ECOLOGICAL RESEARCH
H. B. Musick 601-688-3830

The objective of this investigation is to determine the patterns of temporal and spatial variation in ecosystem attributes in Long-Term Ecological Research (LTER) sites in arid and semiarid vegetation. Special attention will be given to the influence of site characteristics on spatial variation in surface temperature. Study sites are the Jornada LTER site in south-central New Mexico and the Central Plains LTER site in north-central Colorado. Patterns of seasonal and yearly variation in albedo and green vegetation indexes will be determined for the Jornada site by analysis of co-registered retrospective MSS data. Patterns of spatial variation in vegetation type, soil type, and other ecosystem attributes will be determined for the Jornada site by multispectral classification of TMS or TM data, followed by field observations to determine the ecosystem attributes for each spectral class. Patterns of spatial variation in surface temperature will be analyzed for their relationship to field-measured vegetation and soil parameters (Jornada site) or to remotely sensed reflectance data (Central Plains site).

W85-70501 **677-27-01**
National Space Technology Labs., Bay Saint Louis, Miss.
ECOLOGICALLY-ORIENTED STRATIFICATION SCHEME
S. A. Sader 601-688-3830
(677-27-02; 677-27-03; 677-27-04)

The objective of this task is to develop ecologically-oriented methods of stratifying forest landscapes which will form the basis for the design of a tropical forest inventory and monitoring system utilizing remotely sensed data in a geographic data base. The four subtasks to be addressed are as follows: (1) determine the relationship between forest change and ecological factors; (2) revise a forest cover classification scheme within an ecological framework; (3) determine if ecological units could serve as strata for forest (biomass and carbon) inventory; and (4) determine the extent to which remotely sensed data can be used to delineate ecological zones. Relationships between ecological zones, biophysical data (soils and topography) and vegetation composition and structure will be analyzed using the Costa Rica and Puerto Rico data sets. The research in Puerto Rico will be coordinated with the U.S. Forest Service, Mississippi State University, University of Puerto Rico, and the Commonwealth Department of Natural Resources. In Costa Rica, the institutional affiliations are the Organization for Tropical Studies, Tropical Science Center, and the National Mapping Institute.

W85-70502 **677-27-02**
National Space Technology Labs., Bay Saint Louis, Miss.
MULTISTAGE INVENTORY/SAMPLING DESIGN
S. A. Sader 601-688-3830
(677-27-01; 677-27-03; 677-27-04)

The objective of this task is to develop a forest inventory and monitoring system utilizing multistage remotely sensed data. The approach will include the use of a digital data base. A sampling frame will be developed from ecological forest strata. Sample selection will be based upon probability proportional to prediction or variable probability, thus providing a quantifiable inventory approach for regional or global estimation of deforestation rates, biomass, carbon flux, and other ecological processes. Synthetic Aperture Radar (SAR) and Laser profiler data will be analyzed to determine if these two types of data can be associated with forest structure parameters (canopy height, form, and density). The feasibility of including AVHRR, MSS, TM, SAR, and/or Laser Profiler data as stages (information levels) in a multistage design, will be investigated. The design of an inventory approach will be coordinated with the U.S. Forest Service, Southern Forest Experiment Station (Inventory Unit - Starkville, MS and the Institute of Tropical Forestry, Puerto Rico). Study sites are located in Mississippi, Louisiana, Puerto Rico, and Costa Rica.

W85-70503 **677-27-03**
National Space Technology Labs., Bay Saint Louis, Miss.
FIELD WORK - TROPICAL FOREST DYNAMICS
Steven A. Sader 601-688-3830
(677-27-01; 677-27-02; 677-27-04)

The field work to be supported by this RTOP will be necessary to verify and link remotely sensed estimates with ground truth measurements acquired by conventional ground inventory/sampling methods. The two main research areas to be supported by field work are (1) to develop forest stratification methodology based

on an ecologically oriented classification scheme, and (2) to design a tropical forest inventory and monitoring system utilizing remotely sensed data. The approach will include field work conducted in the Costa Rica and Puerto Rico study areas. Specific tasks to be supported by field verification and sampling include: detailed life zone mapping (Costa Rica only); collection of remote sensing ground truth; forest canopy height/profile measurements; development of non-destructive forest biomass estimation techniques; evaluation of forest clearing detection techniques; verification of ecological relationships; and the study of tree dendrometry in context of biomass sampling and forest canopy porosity.

W85-70504 **677-27-04**
National Space Technology Labs., Bay Saint Louis, Miss.
AIRCRAFT SUPPORT - TROPICAL FOREST DYNAMICS
Steven A. Sader 601-688-3830
(677-27-01; 677-27-02; 677-27-03)

The objective of this task is to acquire aircraft SAR and Laser profiler data over domestic and tropical study areas to determine if these two types of data can be correlated with forest structure parameters (canopy height, form, density) that cannot be collectively discerned from sensors that operate in other spectral wavelengths. Correlation of microwave data with forest parameters would be valuable especially in perpetually cloud-shrouded tropical regions that can rarely be imaged, if at all, with other sensors. The approach will utilize laser profiler data that has been demonstrated to accurately measure ground and canopy profile, and which provides information about tree or canopy height that is a key measurement in the estimation of biomass or timber volume. Correlations of SAR and Laser data with forest structure parameters and biomass will be investigated as possible components of a tropical forest inventory design. Study sites are located in Mississippi, Louisiana, Puerto Rico, and Costa Rica.

W85-70505 **677-27-20**
National Space Technology Labs., Bay Saint Louis, Miss.
STUDY OF THE DENSITY, COMPOSITION, AND STRUCTURE OF FOREST CANOPIES USING C-BAND SCATTEROMETER
S. T. Wu 601-688-3833

As a part of the coordinated, four-year plan of research for integrated optical and microwave vegetation studies, the objective is to conduct field research, utilizing a mobile C-band radar scatterometer and a Barnes 12-1000 radiometer, to investigate optical reflectance and microwave backscatter characteristics associated with forest biophysical parameters and different levels of above ground biomass. This RTOP addresses the following basic research issues: (1) can the increased vegetation canopy penetration expected from C-band radar scatterometer data be of value in assessing biophysical parameters such as leaf area index and phytomass for a wide range of net productivity values; (2) can the sensitivity of C-band, dual polarized radar scatterometer data to vegetation canopy structure aid in separation of similar canopy types e.g., deciduous and coniferous forests); (3) will increased canopy penetration result in confusion due to variations in understory litter-ground surface; and (4) how can multidate radar data be used with multidate optical data to form the basis for extraction of growth-related features useful for robust vegetation identification and canopy condition assessment.

W85-70506 **677-41-03**
Jet Propulsion Laboratory, Pasadena, Calif.
TIMS DATA ANALYSIS
A. B. Kahle 213-354-7265

The objectives of the RTOP are: (1) to evaluate the geologic utility of multispectral thermal infrared surveys employing the recently upgraded thermal infrared multispectral scanner (TIMS); (2) to determine the suite of rock types that can be effectively discriminated on the basis of TIMS measurements alone or in combination with other types of remotely sensed data; and (3) to determine the physical basis for rock type discrimination capabilities achieved by the TIMS based on spectral emissivity, thermal inertia, surface conditions, and insolation history. We will acquire TIMS data over a variety of geologic terrains containing diverse assemblages of volcanic, metamorphic, and sedimentary rock units. We will compare spectral boundaries identified in TIMS imagery with stratigraphic/lithologic boundaries displayed on conventional geological maps, and relate observed similarities and differences to the physical and chemical properties of in situ surface materials, and to the provenance and weathering history of surficial geological deposits. We will conduct laboratory and field studies on the emission properties of natural geological materials to support the analysis and interpretation of TIMS data, and compile a collection of laboratory and field emission spectra and associated documentation concerning sample characteristics in a form that is readily accessible to other investigators. We will solicit the participation of academic investigators in the analysis of TIMS imagery, and we will organize a workshop on the results of recent TIMS data analysis activities to be held at NSTL during the 2nd quarter of FY-1985. We will document the measurement capabilities and operating characteristics of the TIMS and the PFES.

W85-70507 **677-41-07**
Jet Propulsion Laboratory, Pasadena, Calif.
ROCK WEATHERING IN ARID ENVIRONMENTS
A. R. Gillespie 213-354-6927
(677-41-03; 677-41-25; 677-41-09; 677-41-27; 677-46-02)

The objective of this program is to determine the different rates of chemical and mechanical processes that contribute to the weathering of rocks in arid environments. Remote sensing methods appropriate to the measurement of weathering products are being evaluated as new techniques to aid in relative dating and age ranking of geologic deposits and in geologic mapping of lavas and weathered deposits commonly found in arid regions. These methods utilize image data spanning the spectrum from 0.4 micron to, 25 cm, in the visible-reflective infrared, thermal infrared, and radar regions. We are applying these methods to a wide variety of arid test sites to determine whether the chemical alteration of rock surfaces and the mechanical breakdown of rock particles proceeds in a consistent fashion in areas of similar lithology and climate. The work proposed in this RTOP involves collaboration of researchers from JPL and the University of Washington. In our approach we are studying lava flows and coarse clastic deposits such as alluvial fans, glacial moraines, and river terraces, all of which are typical for arid regions of the western United States. Specific topics include: (1) development of soils and caliche; (2) changes in surface roughness characteristics and clast size distributions; (3) development of surface stains and coatings of Fe and Mn oxides, clays, and silica gels; and (4) destruction of glassy rinds on pahoehoe and the development of duricrusts on granitic rocks and sandstone. Vegetation changes accompanying weathering are being studied under related RTOP 677-41-09. A major effort is to improve chronologic data, in order to better identify weathering rates. Chemical and mechanical changes accompanying weathering which are detectable remotely are being studied by conventional geochemical and petrographic means. Relative ages of studied geologic units are being determined by conventional and innovative methods. Study areas have been established in California, Nevada, Idaho, Oregon, and Hawaii.

W85-70508 **677-41-13**
National Space Technology Labs., Bay Saint Louis, Miss.
GEOLOGICAL REMOTE SENSING IN MOUNTAINOUS TERRAIN
D. L. Rickman 601-688-3833

The objective of this work is to determine the utility of integrated Thematic Mapper Simulator (TMS) and Thermal Infrared Multispectral Scanner (TIMS) data to quantitatively discriminate and map several basic geologic phenomena, including the estimation of silica content, and the identification and distribution of igneous lithologic units. Certain epigenetic changes in mineralogy will be examined as needed to resolve and avoid confusion in the work on the prime objectives. A complicating factor will be to accomplish the analysis for data from a mountainous area. The general approach was to acquire TMS and TIMS data over the Pyramid Mtns. south of Lordsburg, N.M. The data have been geometrically corrected

to a common base, and integrated with digital elevation data. FY-84 field work includes sampling the rock soil, and estimating land cover variables, i.e., vegetation by species, density, percent live and dead, and the percent of soil. Field samples will be analyzed for 10 elements by X-Ray spectroscopy in a cooperative effort with the Univ. of Missouri/Rolla. In FY-85, field spectrometer data will be acquired in the visible and near infrared with a GER spectrometer and in the mid-IR with a Beckman spectrophotometer, model 4210. Thin sections of the rocks will also be made to estimate the percentages of the major minerals and glass. Together with the remote sensing imagery, these data will be used to test the ability of the TIMS data to estimate the SiO2 content of silicate rocks. A second task will be the analysis of the enhanced TMS/TIMS integrated imagery to qualitatively discriminate the lithologic units and areas of epigenetic change. Emphasis will be on techniques, specifically on canonical analysis, that produce images for interpretative analysis.

W85-70509 **677-41-24**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTISPECTRAL ANALYSIS OF SEDIMENTARY BASINS
H. R. Lang 213-354-3440

The primary objectives are to evaluate the combined utility of remote sensing surveys conducted at visible, infrared, and microwave wavelengths for mapping subtle chemical and physical variations in strata; to define the stratigraphic sequence and modeling facies; to delineate geologic structures and infer tectonic regimes at both local and regional scales in the Wind River/Bighorn Basin area; to compare the types of lithologic and structural information that can be extracted from remotely sensed data with that obtained with conventional field mapping, borehole, and geophysical techniques; and to develop strategy for integration of geological, remote sensing, geophysical, and borehole data for basin modeling. The general approach is to perform the following as a three year collaborative effort by participants from Geology, Radar Remote Sensing, and Cartographic Application Groups at JPL and the University of Hawaii: (1) select a sedimentary basin for study; (2) acquire, compile, and coregister remote sensing surveys conducted by orbital and airborne systems; (3) determine extended spectral signatures of sedimentary rock units at visible, infrared, and microwave wavelengths; and (4) correlate these signatures with physical and compositional attributes of individual strata in their natural state of exposure and in their unweathered state. Laboratory and field studies will be performed in support of the analyses. In FY-85, a workshop will be organized to include individuals with expertise in basin analysis and modeling, and individuals with detailed knowledge of the stratigraphy and structure of the study area. The workshop will provide an opportunity to identify critical gaps in current understanding of basin evolution and topical geological problems in the study area and assess utility of geological information derived from remote sensing for addressing these problems Workshop results will refine the experimental plan for subsequent fiscal years.

W85-70510 **677-41-29**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTISPECTRAL ANALYSIS OF ULTRAMAFIC TERRANES
M. J. Abrams 213-354-6927
(677-41-03; 677-41-25)

The objective of this study is to evaluate the utility of visible, near-infrared and thermal infrared images and field measurements for lithologic discrimination and geologic mapping of ultramafic rocks. A central goal is to determine the potential contribution of multispectral remote sensing techniques to the study of ophiolites on a global basis. Ophiolites are characteristic assemblages of mafic and ultramafic rocks that are generally interpreted to be ancient sections of the Earth's oceanic crust that are exposed at the margins of continental areas as the result of tectonic processes. An important contribution would be the ability to reliably distinguish between ophiolites and other bodies of ultramafic rocks, such as alpine-type periodotites, that have different geologic significance. We will also study the association of vegetation species/ communities with rock type, to determine what geologic information may be revealed. Test areas are in the Josephine Ophiolite (N. California), Bay of Islands Ophiolite (Newfoundland), Trinity Peridotite (N. California) and the Sierra Nevada (California). In each of these areas, image data has been acquired or will have been acquired by Sept.-84, under existing RTOPs. During FY-85 this project will consist of the following tasks: (1) completion of the geobotanical mapping project now being conducted by Univ. of Washington researchers; (2) preliminary evaluation of the utility of multispectral images for mapping ultramafic rocks; and (3) organization of a scientific workshop to identify ways in which remote sensing can be used to address major research issues involving ophiolites. The results of tasks 2 and 3 could form the basis of a broader research project in subsequent fiscal years. This may be the subject of a JPL proposal for FY-86.

W85-70511 **677-42-04**
National Space Technology Labs., Bay Saint Louis, Miss.
GEOBOTANICAL MAPPING IN METAMORPHIC TERRAIN
W. G. Cibula 601-688-3833

The purpose of this RTOP is to develop and evaluate practical techniques for using the Thematic Mapper (Initially through simulation) for geobotanical mapping. The emphasis is on ore bearing terrains in area which are moderately to heavily vegetated. The approach will include using geobotanical methods involving the use of surface vegetation to help identify the nature and properties of the substrate. The two aspects that are believed to be identified by remote sensing means are: differences in plant community structure, and the effects of mineral stress in the plant community. Data processing will include the development of spectral pattern recognition outputs, since pattern recognition is effective in emphasizing minute detail in spectral data and therefore is capable of finding subtle geobotanical relationships. Field verification of results is central to the project. Concurrently, geological data from other sources, e.g., geologic quad sheets which are available for the site, will be obtained and compared to the spectral data map products. Additionally, quadrants of floristically uniform forest associations will be chosen within each major geologic unit. These sites will be used as study areas to arrive at a better understanding of the relationship between differing geological units and differing structural and floristic compositions of the forests which occur on these units.

W85-70512 **677-42-09**
Jet Propulsion Laboratory, Pasadena, Calif.
ARID LANDS GEOBOTANY
B. N. Rock 818-354-6229
(677-42-08; 677-41-25)

The primary objective of this study is to evaluate the use of remote sensing measurements obtained at visible, infrared (both reflective and emissive), and microwave wavelengths to determine the multitemporal, multispectral contribution of arid land vegetation. This is to be done so that a more accurate assessment of the multispectral characteristics of exposed edaphic/geologic materials may be made by removing the spectral contribution of vegetation. During FY-85 the emphasis will be on measuring, characterizing, and modeling the vegetation contribution of representative species/species associations of arid land vegetation. The general approach will be to perform the following in conjunction with selected universities and other government agencies: (1) continue study of in situ botanical and geological conditions for test sites previously selected as representative of both Mojavean and Great Basin desert vegetation communities; (2) determine the botanical and geological conditions for new test sites representative of the Sonoran and Chihuahuan desert vegetation communities; (3) acquire and co-register visible infrared, and microwave remote sensing data from these areas, (4) conduct in situ field and laboratory spectral measurements of both typical vegetation types and edaphic/geologic background materials at visible, infrared, and microwave wavelengths; (5) conduct theoretical studies of the reflectance, emissive and backscatter properties of vegetated and unvegetated surfaces in support of mathematical model development for inferring both spectral characteristics and areal density of arid land vegetation types; and (6) assess the value of the

methods and models developed for estimating the vegetation contribution to an arid land mixed pixel.

W85-70513 **677-46-02**
Jet Propulsion Laboratory, Pasadena, Calif.
NEW TECHNIQUES FOR QUANTITATIVE ANALYSIS OF SAR IMAGES
D. L. Evans 213-354-2418
(677-41-24; 677-41-07; 677-47-08)

The availability of multiple incidence angle radar data from Shuttle Imaging Radar (SIR-B) and multiple polarization data from the JPL airborne Synthetic Aperature Radar (SAR) will result in a significant increase in the amount and type of information derivable from SAR images. Surface roughness and slope variations can be mapped with images acquired with the like-polarized, multi-incidence angle SAR images that will be acquired by SIR-B. With multiple polarization data, there will be an increased ability to characterize surficial units from the detailed surface scattering and dielectric constant information derivable from the multipolarized images. In addition, it may be possible to penetrate vegetation canopies with suitable polarization combinations in order to maximize surface returns under the canopy, or conversely, returns from the vegetation canopy itself. The objectives of this RTOP are to develop techniques to extract the maximum amount of geologic information from multi-parameter radar images, and to determine the optimum radar configurations for geologic mapping and analysis. This will involve analysis of both radar image texture and tone with supporting measurements from the JPL airborne scatterometer and field instruments. This proposal covers the continuation of a basic research effort at JPL involving the development and implementation of new techniques for analyzing SAR images. It represents the efforts of two researchers in the Imaging Radar Geology Group, one researcher in the Radar Systems Science and Engineering Group at JPL, and one graduate student at CalTech. The RTOP will be broken down into four specific studies involving: (1) radar backscatter modelling for derivation of surface characteristics; (2) quantitative analysis of radar image, tone, and texture for integration into multisensor image analysis; (3) modelling of radar penetration through vegetation canopies; and (4) measurements of polarization properties in calibrated images.

W85-70514 **677-47-03**
Jet Propulsion Laboratory, Pasadena, Calif.
AIRBORNE RADAR RESEARCH
W. E. Brown 213-354-2110
(677-47-07; 691-05-03)

The objective of this RTOP is to develop the NASA-JPL aircraft radar facility to meet the specific needs of the NASA remote sensing program. This RTOP covers a three-year upgrade program for the facility which incorporates a C-Band Synthetic Aperture Radar (SAR) and additional on-board digital data handling capability to make the facility compatible with research and development needs in preparation for shuttle reflights such as the proposed Shuttle Imaging Radar-C program and for data utilization from free-flyers such as the ERS-1 satellite, both of which contain C-Band SAR imagers. The C-Band radar (5275 MHz) incorporates the L-band exciter used to generate the chirp function, the basic logic for generating the pulse repetition frequency, and the various logic functions for sampling and storing the digital data. All procurements were completed in FY-84 and the fabrication will be nearly completed. In FY-85 the laboratory tests, the antenna patterns and the initial flight engineering tests will be completed. Other work completed in FY-84 includes the digital signal level monitor, the procurement and installation of a single dual polarized antenna, and modifications to the receiver to reduce the Tactical Air Navigation System interference level in the 1215 to 1235 MHz band. In FY-85, other work to be accomplished includes the development and test of an 8-bit analog to Digital Converter and improve the performance of the digital tape recorder.

W85-70515 **677-47-07**
Jet Propulsion Laboratory, Pasadena, Calif.
AIRCRAFT RADAR MAINTENANCE AND OPERATIONS
T. W. Thompson 213-354-2654
(677-47-03)

For this RTOP, JPL will maintain and operate the NASA/JPL L-band airborne synthetic aperture radar, the NASA/JPL L- and C-band airborne scatterometers, and the NASA/JPL 2 to 18 GHz truck spectrometer. These sensor systems will be used to collect experimental radar data for a number of ongoing NASA/OSSA research and development activities and the shuttle imaging radar program. A plan for use of these radar systems to satisfy requirements of investigators in the NASA/OSSA Geology, Land Processes, and Ocean Processes Programs will be formulated by JPL. Each airborne radar will be operated in three separate missions; each mission would have eight flights. These missions would be similar to the winter 1984 Synthetic Aperture Radar (SAR) Expedition when NASA/Ames and JPL supported seven CV-990 flights for six different NASA (Goddard, Johnson, and JPL) investigators. A joint airborne SAR/Scatterometer Expedition in August, September, and October 1984 will be conducted by NASA/Ames to support shuttle imaging radar (SIR-B) underflights and to supply airborne radar data for ten NASA/OSSA investigators. In FY-85, JPL envisions conducting a number of expeditions to satisfy a number of NASA investigators who want to observe a number of biomass targets throughout the seasons. Also, JPL in FY-85 will operate the 2 to 18 GHz truck spectrometer in one field experiment. This RTOP will also support the upgrading of the aircraft scatterometer by acquiring new antennas.

W85-70516 **677-50-52**
Lyndon B. Johnson Space Center, Houston, Tex.
MATHEMATICAL PATTERN RECOGNITION AND IMAGE ANALYSIS
R. P. Heydorn 713-483-4017

The purpose of the mathematical pattern recognition and image analysis (MPRIA) project will be to conduct fundamental research in three basic areas: preprocessing, digital image representation, and object scene inference. The MPRIA project was begun in July 1982 as part of the Fundamental Research Program in remote sensing. The project was started in response to an AN call and contains approximately ten university investigations at three NASA centers. This project has now been placed within the RTOP program and therefore this proposal will be for a continuation of MPRIA under this RTOP. Preprocessing is concerned with the rectification of an image to a map and the registration of one image to another image. Digital image representation research includes texture, shape, mixture models, approximation by splines, computer graphics, and density estimation. This research is also concerned with developing a representation of digital image data that uses the properties of the image needed to make a given inference. Object scene inference involves estimating a scene property, making an inventory, or developing a map. Research topics are being proposed in classification, expert systems, empirical Bayes and regression.

W85-70517 **677-53-01**
National Space Technology Labs., Bay Saint Louis, Miss.
THERMAL IR REMOTE SENSING DATA ANALYSIS FOR LAND COVER TYPES
J. E. Anderson 601-688-3833

Recent technology advancements permitted the construction of fairly narrowband (approximately 0.5 microns) scanning radiometers which are capable of resolving pixel to pixel variations in temperatures in the vicinity of 0.2 to 0.3 C, (for the 8 to 12 micron region of the electromagnetic spectrum). Research work conducted in the past has been restricted primarily to the use of single broadband radiometers, and thus results of such research were compromised to a degree. Using narrowband, multichannel sensor technology, this study will conduct an investigation into the basic factors associated with generalized land covers that influence IR emissivity and temperature, so that a fundamental understanding of the potential use of such data can be achieved. A physical

model has been designed to estimate the absolute radiometric temperatures of vegetated targets, without the need for ground truth. This model (presently in advanced testing) takes advantage of the grey body nature of vegetation in the thermal IR, and is based on the use of data collected by the ERL Thermal IR Multispectral Scanner. After compensation has been made for atmospheric perturbations using LOWTRAN-6 (an atmospheric model developed by the USAF Geophysics Laboratory), the TIMS channel ratioing technique is used with iterative convergent analysis to estimate the absolute temperatures of green vegetation.

W85-70518 **677-60-17**
National Space Technology Labs., Bay Saint Louis, Miss.
CROP CONDITION ASSESSMENT AND MONITORING JOINT RESEARCH PROJECT
Gary J. Irish 601-688-1907
(677-60-16)

The primary objective is to examine the capability of LANDSAT Thematic Mapper data to produce agricultural information of specific interest to the agricultural chemicals industry. Monsanto Agricultural Products Company has been selected as the industrial representative for the project. Meetings between Monsanto and NSTL/ERL produced the following objectives: (1) Examine the capability of Thematic Mapper Data to identify cropping patterns which can be used in a multi-year data base in conjunction with digitized soils data. (2) Examine the capability of Thematic Mapper Data to delineate crop and field conditions of interest to the agricultural chemicals industry. Specific objectives are to: examine the effects of weed infestation on the TM sensor response values from crops and develop techniques to detect weed infestations; and to examine the effects of crop residue on harvest/post-harvest fields and develop techniques to predict residue cover levels. This joint research project will be conducted in three phases. Phase 1 will be a technique development phase in which the objectives are addressed by ERL staff members. Phase 2 will be cooperative Monsanto/ERL operational test of the results and techniques developed in Phase 1. During Phase 3 the project results will be disseminated to the agricultural chemicals industry and related members of the agri-business community through a workshop mechanism.

W85-70519 **677-62-02**
Lyndon B. Johnson Space Center, Houston, Tex.
GLOBAL INVENTORY TECHNOLOGY - SAMPLING AND MEASUREMENT CONSIDERATIONS
M. C. Trichel 713-483-4017

The objective is to investigate the trade-offs among selected multi-resource remote sensing approaches for mapping and inventorying global vegetation in order to support directly the attainment of vegetation information needs as identified in Land-Related Global Habitability Issues (NASA TM 85841), Global Biology Plan (NASA TM 85629), Global Change, Impacts on Habitability (JPL D-95), and Global Change, A Biogeochemical Perspective (JPL 83-51). A critical issue in vegetation mapping/inventory is the degree to which a synoptic low-cost sensor such as AVHRR can satisfy Earth science information needs and the degree to which sampling higher resolution/higher cost data is required. Four basic mapping/inventory strategies will be investigated: (1) complete coverage of the target area with a single sensor; (2) sampled coverage of the target area with a single sensor; (3) complete target coverage with one sensor and sampled coverage with a second sensor; and (4) complete coverage with one sensor and sampled coverage with two additional sensors. For each selected strategy, a map/inventory will be produced for site of limited size (two or three LANDSAT full-frames) for several sets of operating conditions (i.e., amount of cloud cover, accuracy of target class delineations). This procedure will provide replications which depict the variation in performance to be expected from the strategy in larger scale analyses and which will form the basis of a formal statistical analysis of selected mapping/inventory summary parameters. The study will result in an assessment of the accuracy of remote sensing based estimates of vegetation areal extent and location for several typical strategies, and provide a basis of support to related proposals for global vegetation mapping/inventory.

W85-70520 **677-63-99**
Ames Research Center, Moffett Field, Calif.
LONG TERM APPLICATIONS JOINT RESEARCH IN REMOTE SENSING
E. H. Bauer 415-965-5898
(668-37-10; 668-37-11)

The overall objectives are to identify and map land features which impact on the site selection of utility transmission line corridors and waste disposal facilities. Techniques developed will emphasize use of unique TM dynamic range, spectral, radiometric, and spatial characteristics. These tasks are cooperative with private industry (Pacific Gas and Electric and Woodware and Clyde Consultants, respectively). The transmission line corridor analysis and siting task centers upon development of a field segmentation and classification algorithm. The algorithm will optimize mapping of land use and intrastructure features affecting corridor siting. The waste disposal site selection task involves use of optimum wave band combination, regression, classification, and edge pattern recognition techniques to separate water, semi-arid land, and geologic features. Both TM and TM simulator (TMS) data will be used in both tasks.

W85-70521 **677-64-01**
National Space Technology Labs., Bay Saint Louis, Miss.
WETLANDS PRODUCTIVE CAPACITY MODELING
D. D. Dow 601-688-3833

As part of the ongoing joint research between NASA/National Space Technology Laboratories/Earth Resources Laboratory and NOAA-National Marine Fisheries Service/Southeast Fisheries Center, the NASA objective of the Wetlands Productive Capacity Modeling Project is to further develop remote sensing tools, utilizing the Thematic Mapper (TM), to estimate annual marsh vegetation production and to quantify the spatial and hydrologic factors responsible for the export of marsh materials to the estuarine food chain. The P.C. model will generate detrital export measurements as input toward the Estuarine Ecosystem Model being developed by NMFS. The coupling of the two models establishes a technique for estimating the economic value of wetlands with respect to estuarine dependent fish and shellfish production. This RTOP addresses the following research activities for FY-85: (1) TM analysis--marsh biomass investigation to examine the feasibility of using ground-based biometer techniques and their extrapolation to space sensors; (2) TM analysis--exercise mensuration algorithms including interface, interface density, distance-to-water, and water body type results and compare their accuracy with the MSS results; and (3) investigation of marsh grass primary production and its decomposition to determine the effect of the distance-to-water variable on marsh growth and the export of detritus.

W85-70522 **677-80-22**
Jet Propulsion Laboratory, Pasadena, Calif.
IMAGE PROCESSING CAPABILITY UPGRADE
S. D. Schultz 213-354-8241

The objective of this work is to establish an interactive image processing capability within building 183 to satisfy the image analysis needs of the geology group. Two color-image-display work stations and additional disk storage will be procured and installed on the group's computer. Software that is available from existing sources will be procured to carry out the image processing and analysis. Additional software will be written as required to route data sets to IPL digital film recorders and to perform specialized image processing functions.

W85-70523 **677-80-27**
Goddard Space Flight Center, Greenbelt, Md.
CHARACTERISTICS, GENESIS AND EVOLUTION OF TERRESTRIAL LANDFORMS
N. M. Short 301-344-7870

The objective of this research is to determine the role that

space technology, especially Earth observation systems utilizing remote sensing devices, should play in defining, quantifying, and applying techniques for analysis of landforms at regional (small) scales. A longer term objective is to evaluate the potential of geomorphic analysis and geomorphic units mapping as a major input to and framework for characterizing land surface units of interest in prospective global habitability programs. Current effort is being directed toward completion of Regional Landforms from Space, a book-length document that will summarize knowledge of regional landform analyses of space-acquired images. This publication is being prepared by select experts in various subfields of geomorphology. The same group comprises the organizing committee for a workshop on Regional Geomorphology being planned for the first quarter CY-85. That workshop will (1) review past and current work in regional geomorphology, (2) specify approaches to geomorphic analysis using space technology, and (3) identify and plan new areas of research into the field. A proceedings from this workshop will be developed during the remainder of FY-85; this will include recommendation for future programs.

Crustal Dynamics

W85-70524 **692-05-05**
Goddard Space Flight Center, Greenbelt, Md.
RESIDENT RESEARCH ASSOCIATE (CRUSTAL MOTIONS)
David E. Smith 301-344-8555

The objective of this research is to combine the very long base interferometry (VLBI) and laser ranging results and other geophysical and geological data in a general study of the tectonic activity in a variety of geological areas. Initial attention will be given to data in the western United States, Mexico and Canada and the relationship of this activity to deformations in southern California. This RTOP will provide the support for a Resident Research Associate in the earth dynamics discipline area.

W85-70525 **692-59-01**
Goddard Space Flight Center, Greenbelt, Md.
CRUSTAL MOTION SYSTEM STUDIES
B. F. Chao 301-344-6120

The objective of this research is to conduct preliminary studies of the measurements, systems and sensors that may be required in the middle of the next decade for geophysical and geodetic studies in the Earth, Moon and planets. Conceptual studies will be undertaken to determine new measuring techniques for sensing the dynamical motions, such as, tides, polar motion, crustal movement, and gravity field of the Earth and the planets to accuracy levels an order of magnitude greater than presently possible.

W85-70526 **692-59-45**
Jet Propulsion Laboratory, Pasadena, Calif.
GPS POSITIONING OF A MARINE BOUY FOR PLATE DYNAMICS STUDIES
T. H. Dixon 213-354-7535

This RTOP is intended to perform a system analysis of the use of GPS (Global Positoning System) receiver technology for determining the location of an ocean surface platform with respect to the GPS reference frame. The development of a system for measuring the location of benchmarks on the ocean floor with respect to an acoustic transmitter on the surface is being performed under another Geodynamics Program RTOP, by F. N. Spiess of Scripps Institution of Oceanography. The combined objective of these two RTOPs is to precisely tie ocean floor benchmarks to an Earth centered reference frame. GPS-based systems have been developed for high precision, cost effective geodetic measurements under the NASA Geodynamics Program. Current proof-of-concept receivers have demonstrated baseline measurements with a precision of several cm. The next generation system is being developed for use in determining the orbit of the TOPEX satellite. Further improvements are expected to increase precision to the one cm level. If this level of performance can be maintained in a system used at sea, it will be adequate for obtaining an absolute position for the surface element(s) of an acoustic sea floor benchmark system. Certain developments in system design are required in order to use this technology for sea surface positioning. These include antenna design, determining instantaneous positions of a wave-tossed platform, and determining the orientation of that platform. Preliminary sea trials with the SERIES GPS receiver indicate that signal tracking from a slowly moving buoy such as FLIP is readily accomplished.

W85-70527 **692-61-01**
Goddard Space Flight Center, Greenbelt, Md.
REGIONAL CRUST DEFORMATION
S. C. Cohen 301-344-8826

The overall objective of this RTOP is to improve the understanding of regional scale crustal deformations at tectonic plate boundaries and plate interiors. Specific objectives include: (1) interpreting and modeling crustal movements in California in terms of fundamental geotectonic processes in order to explain spatial and temporal behavior of observed movements, (2) the development of numerical models of continental collisions taking into account tectonic plate motions and crustal, lithosphere, asthenosphere structure and rheology; and (3) modeling crustal stresses in Western Europe. Theoretical and numerical model development and data analysis efforts are continuing in modeling plate boundary interactions and stresses in plate interiors. For interpreting tectonic processes in California, space geodetic measurements are being compared to ground based surveys and geological investigations. Spatial and temporal patterns of crustal movement are being matched to models of the Earth structure and dynamic processes. For understanding continental collision processes, finite element models of deformation in a nonlinear viscous medium are being developed. These models will be used to understand horizontal and vertical deformation processes in India, China, and the Arabian Plate. For modeling crustal stresses in Western Europe, spherical shell theory will be combined with models of subcrustal stress to generate surface stress patterns.

W85-70528 **692-61-02**
Jet Propulsion Laboratory, Pasadena, Calif.
REGIONAL CRUSTAL DYNAMICS
G. A. Lyzenga 213-354-6920

The objective of this research is to obtain understanding of the physical processes which influence deformation and displacement of the Earth's crust in tectonically active regions. Past and continuing work in this area encompasses theoretical modeling of deformation processes, and synthesis of observational constraints from selected geophysical data sets. In particular, the approach proposed here consists of: (1) finite element modeling of deformation; (2) analytic parameter studies of crustal processes; (3) seismological studies of tectonics in the active Caribbean region; and (4) geophysical studies of the more studied and accessible southern California region. The anticipated results of this research include: (1) an understanding of the relationship between plate driving forces and crustal stress; (2) insight into the longer term evolution of tectonic stress regimes; (3) new direct evidence for the sense and rate of Caribbean plate motion; and (4) a synthesis of classical geologic studies with space-derived data. Each of these will be the subject of scientific publications.

W85-70529 **692-61-03**
Goddard Space Flight Center, Greenbelt, Md.
CRUSTAL DEFORMATION INVESTIGATIONS PROGRAM SUPPORT
Jean E. Welker 301-344-0459
(676-01-01)

The objective of this RTOP is to provide technical management support to AN's (university grants and private contracts) in the crustal deformations discipline area. The programs approach is to initiate, monitor, and report on research activities, conducted for sponsorship of the Crustal Deformation Applications Notice.

Laser Network Operations

W85-70530 **693-05-05**
Goddard Space Flight Center, Greenbelt, Md.
RESIDENT RESEARCH ASSOCIATE (EARTH DYNAMICS)
D. E. Smith 301-344-8555

The objective of the RTOP was to study the interaction of the solid Earth, oceans and atmosphere to better understand the observed coupling of the atmospheric winds with the changes in the length of the day, and the extent of the role of ocean circulation in this process. This RTOP will provide the support for a Resident Research Associate in the earth dynamics discipline area.

W85-70531 **693-61-02**
Jet Propulsion Laboratory, Pasadena, Calif.
LITHOSPHERIC STRUCTURE AND MECHANICS
C. F. Yoder 213-354-2444

The objective of this research is to provide constraints on lithospheric structure and upper and lower mantle rheological structure. A study of large plate boundary earthquakes will be made using a three-dimensional finite element numerical model. The mass displacements arising from large earthquakes provide a mechanism for exciting Chandler wobble which may be sensitive to the local rheological properties (i.e., Newtonian versus non-Newtonian viscosity). Earthquakes also change Earth's polar moment of inertia and Earth's external gravity field which may cause detectable changes in Earth rotation and perturb the orbits of artificial Earth satellites such as Lageos. This study will provide important layered Earth model with Newtonian viscosity. The influence of different internal boundary conditions, radial viscosity structure, and ice sheet melting history will be examined. A simple model for lateral variations in viscosity will be developed to serve as a bridge to finite element modeling of this phenomena.

W85-70532 **693-61-03**
Goddard Space Flight Center, Greenbelt, Md.
LITHOSPHERIC INVESTIGATIONS PROGRAM SUPPORT
Jean E. Welker 301-344-0459
(676-01-01)

The objective of this RTOP is to provide technical and financial management support to AN's (university grants and private contracts) in the lithospheric discipline area. The approach is to initiate, monitor, and report on research activities, conducted for sponsorship of the lithospheric applications notice. An appropriate and timely funding for AN Support plus compilation and reporting on the results of this research is expected.

Sounding Rockets

W85-70533 **879-11-41**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS (ASTRONOMY)
Andrew M. Smith 301-344-8648

The astronomical sounding rocket program provides a unique capability to conduct a broad range of scientific investigations. The program flexibility and short lead time make it possible to observe unusual physical phenomena for which satellite instrumentation is not available. The program flexibility makes it possible to expeditiously follow up discoveries as well as to provide tests and calibrations of satellite instrumentation. This unique capability is exploited by obtaining one of a kind observations of those types of astronomical phenomena that do not need large amounts of repetitive data to delineate their physical processes. New types of observations are possible because of recent technical advances in such essential areas as aberration control diffraction gratings and two dimensional multipixel photon detectors. These observations can contribute significantly to the understanding of the i.s. medium, stars, nebulae, and peculiar galaxies. The present objectives are to develop payloads which take advantage of opportunities to obtain spatial images of faint extended ultraviolet sources. Over the next few years, the present payload will be upgraded by employing improved detectors; a new payload will be designed to obtain very narrow band (< 1mm) imagery. The latter instrument is intended to obtain information about line emission in external galaxies as well as galactic sources. All instrument development will be done in such a manner that the instruments can be used on spacelab or on spartan (shuttle pointed autonomous research tool for astronomy).

W85-70534 **879-11-46**
Goddard Space Flight Center, Greenbelt, Md.
SOUNDING ROCKET EXPERIMENTS (HIGH ENERGY ASTROPHYSICS)
E. A. Boldt 301-344-5853

High energy astrophysics (especially X-ray astronomy) is a rapidly evolving field of research, both scientifically and technically. Our exploitation of the capabilities of short lead time, planning flexibility, accurate pointing and extremely high telemetry rates afforded by rocketborne experiments are major factors in our success to date; a vigorous elaboration of this activity with spartan is now necessary for continuing to make timely and important contributions that complement data from our satellite missions and for the effective planning of advanced future missions (e.g., BBXRT, AXAF). This involves experiments with systems incorporating newly developed spectrometers and X-ray concentrators.

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

Advanced Systems

W85-70535 **310-10-23**
Goddard Space Flight Center, Greenbelt, Md.
SOFTWARE ENGINEERING TECHNOLOGY
Frank E. McGarry 301-344-6846
(506-54-56; 310-40-49; 310-10-26; 310-40-45)

The objective of this RTOP is to identify, evaluate, and refine software engineering technology as applied to the software development process for the NASA environment. The technology to be studied includes software development methodologies (such as structured implementation techniques, various testing techniques, structured analysis approaches to design), software development tools (such as code auditors and analyzers, configuration management aids and PDL processors), software measures and models (such as cost and reliability estimation models), and techniques for increasing reusability of software. The identified methodologies are intended to significantly reduce the overall life cycle costs of the software within the Mission and Data Operations area. The approach to attain the stated objectives include the utilization of an experimentation laboratory wherein proposed tools, methodologies and models may be acquired, developed, applied and studied in an actual software production environment. This laboratory (called the Software Engineering Laboratory (SEL)) first of all identifies technologies of potential benefit to the NASA software development process, then identifies appropriate measures for assessing the impact of the technology and coordinates the detailed experimentation of applying and tuning the technology within selected software development projects supporting various requirements of Mission and Data Operations. Each of the projects is then carefully studied to determine the impact within the NASA software development environment and to further identify refinements or additional technologies (tools, models, methodologies, language characteristics, etc.), that could positively impact NASA software and would be directed at addressing specific NASA software shortcomings.

W85-70536 **310-10-26**
Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE/ORBIT TECHNOLOGY
Charles R. Newman 301-344-5666

The objectives are to develop, evaluate, and demonstrate new technology for attitude and orbit determination/prediction/analysis

for both ground-based and onboard application, including algorithms, techniques, software, and hardware. The technology developed under this RTOP support the Office of Space Tracking and Data Systems in the areas of mission computing and analysis, TRDSS operations, and data processing. For TDAS support, alternate user tracking techniques will be identified and evaluated for accuracy of the orbit determination and the impacts on the ground and space systems of TDAS. Techniques that allow onboard navigation and that simplify ground based orbit determination will be examined. In the area of attitude/orbit algorithm development, various techniques, algorithms, and filters will be developed and evaluated for their applicability to automted and improved orbit and attitude determination and control configurations. The configurations may be onboard or ground-based. Various ground control point (GCP) processing algorithms wll be analyzed and automated techniques will be developed for GCP registration.

W85-70537 **310-10-42**
Goddard Space Flight Center, Greenbelt, Md.
PRECISION TIME AND FREQUENCY SOURCES
John W. Coffmann 301-344-7652
(644-03-05; 676-59-35)

The objectives of the RTOP are to research and develop additional and/or improved time and frequency standards and associated time and frequency distribution, transfer and measurement systems for VLBI, near Earth and deep space tracking, tracking data relay system (TDRS) and other NASA programs requiring precision time and frequency devices. Improvements in the NR maser design will continue to be developed. In addition to improvements for increased reliability and serviceability, laboratory studies are planned for improved performance in hydrogen masers. These include the continued evaluations of the quartz cavity liner, continued evaluation of the integral cavity, and further investigations of designs of the variable volume maser. Research and development of innovative frequency standards will continue. The superconducting cavity stabilized oscillator (SCSO) development and fabrication will be continued for future integration into hydrogen maser; and, if funding allows, initial investigations into the trapped mercury ion device will begin. Research and development of new processing and fabrication technology for the manufacture of electrodeless quartz supported resonators will begin (again if funding allows). New techniques for evaluating ensemble of interacting masers for improved frequency and timekeeping and dissemination will continue to be investigated.

W85-70538 **310-10-60**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO METRIC TECHNOLOGY DEVELOPMENT
Robert N. Treuhaft 818-354-6216
(310-10-62; 310-10-63; 310-10-61)

The broad objective of RTOP 60 is to design and demonstrate improved techniques of radiometric data acquisition and analysis as used by the DSN to support navigation and radio science. The principal specific objective is to improve methods of accurate angular spacecraft navigation. Experimental work is based largely on the technique of very long baseline interferometry (VLBI). With VLBI, spacecraft angular positions are measured relative to the planets by locating both spacecraft and planets in an inertial reference frame defined by extra-galactic radio sources (EGRS). RTOP 60 is concerned with errors in establishing the EGRS positions and station locations in the inertial reference frame, locating the spacecraft relative to the EGRS, and locating the planets in the EGRS frame. Error analysis for radio science experiments which use VLBI/radio metric observables is also performed. Work is being done to develop hardware and software which will increase the efficiency of DSN tracking and data acquisition. An effort is underway to incorporate the key elements of a VLBI correlator in a few very large scale integration (VLSI) chips, thereby opening the possibility of a portable correlator capability. Research into high speed computing techniques will yield processors for the DSN which may increase the throughput of data analysts by a factor of at least two. Other investigations include the possibility of using antenna arraying concepts inherent in VLBI in order to receive the weak signals of Voyager at Uranus and Neptune.

W85-70539 **310-10-61**
Jet Propulsion Laboratory, Pasadena, Calif.
EARTH ORBITER TRACKING SYSTEM DEVELOPMENT
T. P. Yunck 818-354-3369
(310-10-60; 310-10-63)

The objective of this RTOP is to develop the conceptual design for an integrated system to track Earth satellites--including low Earth orbiters (LEO's), highly elliptical orbiters (HEO's), and eventually geosynchronous Earth orbiters (GEO's)--and to demonstrate the feasibility of this conceptual system. The design goals are to improve on current tracking accuracy by an order of magnitude in a system that is inexpensive to deploy and operate. Nominally, the system should provide satellite position accuracies of a meter or better at altitudes below 600 km (typical shuttle altitudes), a few decimeters at altitudes between 600 km and about 5000 km (common for scientific Earth observation missions), scaling up to 1 to 5 meters at geosynchronous altitude. It should require no more than ten ground terminals and those should be transportable, operate unattended, accumulate data at phone line compatible data rates, and cost less than $1 million apiece. Finally, the system should be able to determine non-DSN station locations to a decimeter, provide continuous coverage for an unlimited number of satellites, and operate in a purely passive or receive-only mode. The approach is to apply the global positioning system (GPS) of 18 navigation satellites being developed by the Department of Defense. The proposed technique employs differential GPS observables--range, range change, range rate--constructed from observations made concurrently with receivers on the ground and on low orbiters. Higher orbiters, above about 10,000 km, would carry a beacon rather than a GPS receiver. This delta GPS technique is derived from the delta VLBI techniques demonstrated on various deep space missions and, currently, on a GEO under this RTOP. Other work under RTOP 61 includes system performance analysis and design, system software design, ground receiver prototype development, and actual flight demonstrations of the tracking techniques. Related work is being done under RTOPs 60 and 63, and under RTOPs funded by the Oceanic Processes and Geodynamic Branches of OSSA.

W85-70540 **310-10-62**
Jet Propulsion Laboratory, Pasadena, Calif.
FREQUENCY AND TIMING RESEARCH
R. L. Sydnor 818-354-2763
(310-10-60; 310-10-61; 310-10-64; 310-10-68)

The thrust of this RTOP is the development of frequency and time standards and distribution systems and equipment for the effective utilization of these technologies in the Deep Space Network (DSN) of the next decade. Accurate and stable frequency and time are the basis for outer space navigation, particularly that which use interferometric or differential techniques between DSN stations. The reliability of current systems must be improved in order to decrease M and O costs and to increase the H-maser availability to 99%. The goal is to improve the mean time between failures from 25 months to 5 years and the mean time for repair from 3 months to 3 weeks. In addition, the present frequency and timing performance of the DSN of 10 to the minus 14th power and 100 nsec must be improved by the mid-1980s to 10 to the minus 16th power and 10 nsec. The goal for the early 1990s is 10 to the minus 17th power and 1 nsec. New technology, such as trapped ion, superconducting cavities, or cooled quartz oscillators must be developed to meet these goals. The high spectral purity required at K-band will be achieved by these frequency standards. Redundant frequency standards are planned to achieve the high system reliability, so a means must be provided in the form of a frequency standard selection and control system (FSSCS) to achieve switching to alternate standards upon failure of the prime standard with a minimum change of frequency and phase. The goal is 0.01 degrees of phase and 10 to the minus 15th power change in frequency. Effective utilization of the high stabilities achieved by the frequency standards requires precision

frequency and time distribution. Fiber optic systems will be developed to disseminate these references over distance from 10 meters to 30 kilometers. The goal of the fiber optic system is 10 to the minus 18th power frequency stability and 0.1 nsec time stability. The capability of a DSS to perform at stability levels commensurate with the frequency standards must be validated for X-band Uplink and future missions.

W85-70541 **310-10-63**
Jet Propulsion Laboratory, Pasadena, Calif.
SPACE SYSTEMS AND NAVIGATION TECHNOLOGY
C. S. Christensen 213-354-7408

The objective of this RTOP is to establish the anticipated navigation requirements for Deep Space Network (DSN) supported missions planned for the 1985 to 2000 era and to assess their implications on the DSN radiometric and navigation systems. To meet the future navigation needs the RTOP focuses on three primary areas. The first area, navigation technology, identifies and evaluates data strategies for improving deep space navigation accuracies and enhancing mission capabilities. Radiometric data requirements for new navigation functions, such as Asteroid and Comet orbiters, are established. Navigation concepts and data strategies, consistent with low cost mission support, are formulated and demonstrated using data from current missions. The second area focuses on reducing mission operations costs and increasing reliability by the automation of radiometric data processing. A navigation development system has been implemented using a VAX 11/780 computer. This system will serve as the foundation for the long range goals which are to develop high speed computer graphics capabilities, investigate navigation use of concurrent processor technology, and initiate automated event-driven operations and diagnostic procedures. The third area establishes system level requirements for QUASAT, an Earth-orbiting antenna to be used to acquire very long base interferometry. The QUASAT will provide enormous radio science payoff but impose unique tracking system requirements. An early investigation of a few key technology issues will have significant impact on both the mission design and the tracking system support. Initial objectives are to demonstrate, using the Tracking and Data Relay Satellite System (TDRSS), the feasibility of transferring ground based stable frequency standards to an Earth orbiter and to obtain interferometric fringes using the TDRSS single access antenna and a DSN station.

W85-70542 **310-20-33**
Goddard Space Flight Center, Greenbelt, Md.
NETWORK SYSTEMS TECHNOLOGY DEVELOPMENT
J. J. Schwartz 301-344-7313

The objective of this RTOP is to investigate the applicability of new technology in the Tracking and Data Relay Satellite System (TDRSS) era. Selected technology will be investigated by means of feasibility studies, prototype development and demonstration, and by cost and reliability impact studies. A major goal is to investigate the effect of non-Gaussian channel characteristics on TDRSS link performance and develop coding and signal designs which optimize link performance. Associated with this goal is the objectives of validating the analytical predictions by means of limited hardware simulations extention of CLASS to provide a flight performance prediction and evaluation function, and to modify the CLASS to provide a network design and evaluation tools.

W85-70543 **310-20-38**
Goddard Space Flight Center, Greenbelt, Md.
SATELLITE COMMUNICATIONS TECHNOLOGY
D. D. Wilson 301-344-5257

The objective of this RTOP is to introduce an efficient high-rate digital telecommunication transport system to support NASA programs. The work focuses on two major tasks with objectives to define and demonstrate an efficient multinode satellite-based digital telecommunications system which can provide to geographically dispersed users multiple-access on a common link; and to define and demonstrate advanced signal processing and coding techniques which could provide an improvement in data transmission speed and performance through 36-MHz C-Band domestic transponders. The approach for each task is as follows: Define the system requirements and resultant network architecture. Then, develop and demonstrate the system elements including low-cost implementation of time division multiple-access (TDMA) terminals, maintenance and control terminal, TDMA control center, transportable satellite Earth station, integrated voice and data switching terminal and digital speech interpolation terminal. Evaluate the feasibility of combining the best performance of signal processing and coding elements using modeling and computer simulation techniques to provide 85 MBS transmission through a C-band transponder at .0000001 bit error rate and 99.5% error free seconds with specified satellite system characteristics.

W85-70544 **310-20-39**
Goddard Space Flight Center, Greenbelt, Md.
VERY LONG BASELINE INTERFEROMETRY (VLBI) TRACKING OF THE TRACKING AND DATA RELAY SATELLITE (TDRS)
Philip Liebrecht 301-344-7782

The objectives of this RTOP are to utilize very long base interferometry tracking of the Tracking and Data Relay Satellites (TDRS) as an independent measure with which to validate the Tracking and Data Relay Satellite System tracking capability, to demonstrate the application of passive interferometric techniques to improve TDRS trajectory determination, and to determine the detailed requirements and specifications for an operational, dedicated TDRS interferometric tracking system. A three-phase approach will be used. During the first phase, experiments will be conducted to demonstrate the feasibility of the technique, and provide data for the evaluation of different design alternatives and for comparison with the bilateration ranging transponder derived orbits. The second phase will involve formulating overall functional requirements and system analysis for a dedicated operational system, leading toward the final phase which will develop complete detail system specifications for such a system.

W85-70545 **310-20-46**
Goddard Space Flight Center, Greenbelt, Md.
ADVANCED SPACE SYSTEMS FOR USERS OF NASA NETWORKS
R. P. Hockensmith 310-344-9067
(506-61-26)

The objective of the work under this RTOP is to achieve technological advances in radio frequency (RF) and optical systems, antenna subsystems and associated control technology, on-board data storage systems, and in telecommunications coding. These developments will satisfy future requirements of users of NASA networks (spacecraft and Space Transportation System payloads) that require near-global coverage through data relay satellite systems (Tracking and Data Relay Satellite System (TDRSS); Tracking and Data Acquisition System (TDAS)) and other networks as appropriate for the support of the missions. The approaches for accomplishing the objective are: (1) to identify the basic operational space flight requirements; (2) to investigate active and passive components and antenna systems that are feasible, but may be a technical risk, to attain the required performance; (3) to investigate methods of reducing and controlling torque noise induced into space platforms due to electro-mechanical steering of large, high-gain antennas; (4) to investigate methods of high density and high rate recording and storage; (5) to investigate improvements in telecommunication coding schemes for spacecraft generated data; (6) to develop system designs incorporating these optimum subsystems to permit user projects to specify proven, reliable hardware with a high confidence level in the performance capability, cost, and required procurement cycle; and (7) to exploit necessary improvements in testing techniques that properly characterize these critical systems.

W85-70546 **310-20-64**
Jet Propulsion Laboratory, Pasadena, Calif.
ADVANCED TRANSMITTER SYSTEMS DEVELOPMENT
Rob Hartop 818-354-3433
(310-20-65; 310-30-68; 310-30-70)

The object of this RTOP is the development of advanced

transmitter systems applicable to future DSN missions that also provide the capability to perform radar astronomy on planets, satellites, asteroids, comets and other targets within the solar system. Recently completed at DSS-13 are a 20 KW CW X-band transmitter and a receiver/exciter subsystem that are currently being used to demonstrate a complete ground station frequency stability of 5 parts in 10 to the 15th power when averaged over 1000 seconds. The subsystems are also being used in conjunction with S-band transmitter and receiver subsystems to investigate simultaneous S and X-band uplink/downlink operations. These tests will first determine the extent of increased system noise temperatures and generation of intermodulation products, and will be followed by progressive system improvements to demonstrate the technology for simultaneous uplinks at widely spaced frequencies for future DSN use. Already demonstrated are the need for increased harmonic filtering of the S-band transmitter, and stationary antenna operation of both transmitters without significantly increased noise temperatures. The detailed design of a Ka-band gyroklystron will lead to hardware development beginning in FY-86. Concurrently with this contractor effort is the in house design of a state of the art transmitter system from the exciter input at 44 to 100 MHz to the feedhorn output at 34 GHz. This transmitter system will feature advanced technology in several areas including superpower (400 KW CW) higher mode generation, control and filtering, very high phase stability, high reliability, and complete microprocessor monitoring and control. When mounted on the upgraded 70 M antenna at Goldstone, this transmitter will provide an effective radiated power of some 100 trillion watts, enabling the scientific observation of many new targets within the solar system.

W85-70547 **310-20-65**
Jet Propulsion Laboratory, Pasadena, Calif.
ANTENNA SYSTEMS DEVELOPMENT
D. Bathker 818-354-3436

The objectives of this RTOP are to identify and develop transferable technology to enhance the capabilities of the NASA/JPL Deep Space Network by improving the performance of large Earth-based antennas. This is accomplished through work in both the electromagnetic and structural (mechanical) areas that design, analyze, and demonstrate (where appropriate) the feasibility of selected antenna development options. The objectives include the accurate evaluation of performance factors and the cost estimation needed to select the improvements with the largest payoff in performance per unit cost. The approach includes the application of software and computation intensive synthesis and analysis of very large (30 to 70 meter diameter) reflector antenna systems. Designs are optimized for a combination of maximum antenna gain and minimum system noise temperature. Development work concentrates on improved surface accuracy through antenna structure upgrades, precision surface panel development, improved and easier to use panel alignment techniques, and feed technology that enables wideband multifrequency operation with high power transmission (400 kW CW) and simultaneous ultralow noise (less than 20 K) receiving system performance. Precise measurement techniques for performance evaluation are developed and utilized for technology demonstrations and for new or modified operational antenna testing. Measurement and diagnostics tools being developed include optical measurement and microwave holographic techniques. A major effort for the future is the design and development of key technology for a new Ka band, development antenna at DSS 13.

W85-70548 **310-20-66**
Jet Propulsion Laboratory, Pasadena, Calif.
RADIO SYSTEMS DEVELOPMENT
J. A. McNeil 818-354-3268

The objectives of this RTOP are to improve the Earth based receiving elements of the spacecraft to Earth communications link to meet the future navigation, telemetry and science needs of the DSN; to lower the cost of implementation and modification; and to increase the reliability and decrease the cost of maintenance of receiving equipment and cryogenic systems. Six work units are directed to various aspects of this RTOP: (1) develop a multifrequency, ultralow noise amplifier system to cover S, X, and Ka-bands with broad bandwidths and high gain and phase stability. To this end, both a Ka-band maser with upconverters and solid state amplifiers utilizing high electron mobility transistors (HEMT) are being developed, as well as the analytical tools and measurement systems needed for designing and characterizing slow wave structures, HEMT devices, and microwave low noise amplifiers; (2) develop a magnetic refrigeration stage for operation between 15 and 4 kelvin as an alternative to the Joule-Thomson stage currently in use. Utilizing the cooling effect of adiabatic demagnetization, this process has the potential for increased reliability, lower operating temperatures, and lower total energy requirements; (3) to improve the reliability and performance of the current cryogenic cooling equipment by tripling the MTBF and increasing cooling efficiency; (4) develop our present low noise amplifier technology in support of interagency arraying for unique opportunities like Voyager-Neptune encounter; (5) develop microwave cryogenic devices, such as fixed and tunable filters and slow wave structures; and (6) calibrate and model the propagation medium and establish a statistical database of the microwave temperature and attenuation at Ka-band, and determine system performance degradation caused by rain and other atmospheric effects on antenna and feed system components.

W85-70549 **310-20-67**
Jet Propulsion Laboratory, Pasadena, Calif.
OPTICAL COMMUNICATIONS TECHNOLOGY DEVELOPMENT
J. R. Lesh 818-354-2766

The objective of this RTOP is to develop and demonstrate the technology needed for efficient and reliable optical communications for DSN supported missions in the 1990's and beyond. To accomplish this objective, and to focus the RTOP, a near term goal of developing the technology and engineering models for a flight demonstration of optical communication principles by the late 1980's has been established. The actual building and integrating of the flight hardware, as well as the performing of the demonstration are assumed to be funded outside this RTOP. However, this RTOP will provide the resources to define, analyze, and perform critical developments needed for the demonstration. This RTOP will establish requirements for an optical receiving station for Earth vicinity reception of interplanetary optical signals, and perform critical systems designs and technology developments to meet those requirements. Additionally, in order to assess the impact of optical communications on deep space vehicles, the above activities will also be performed for the deep space terminal. In support of the longer term objective, this RTOP will develop and demonstrate laser source and laser detection technology for both noisy (high background light) environments typical of missions near brightly lighted planets, as well as the more benign (darker) environments characteristic of planetary encounters far from the Sun. This technology is expected to utilize heterodyne reception techniques for the former and direct detection techniques for the latter.

W85-70550 **310-20-68**
Jet Propulsion Laboratory, Pasadena, Calif.
DSN MONITOR AND CONTROL TECHNOLOGY
C. F. Foster 818-354-5070
(310-20-64; 310-20-65; 310-20-66)

The objectives of this RTOP are the development and demonstration of technology for unattended tracking station operations. The approach used is the development of a test bed remote controlled unattended station at DSS 13. This test bed includes automated control of an unattended 26m antenna, high-power transmitter, receiver-exciter, and data processing subsystems (subcarrier demodulator). Control of the equipment is from JPL. This test bed has evolved over several years to include an increasingly comprehensive set of subsystems, and improved operator interfaces. Fully unattended receive capability was demonstrated for six months in FY-78 and 79 to provide controlled life cycle cost data. Unattended operation of the high-power transmitter was demonstrated for two months in FY-80/FY-81. An

unattended uplink demonstration of tracking and commanding the Pioneer 8 spacecraft began in FY-83 and extended into FY-84. Emphasis in FY-85 will be: to complete Pioneer 8 Unattended Tracking and Command Demonstration; to evaluate the performance record of this demonstration; and to initiate a study of the monitor and control system needed for a new Ka-band antenna at DSS 13.

W85-70551 **310-20-71**
Jet Propulsion Laboratory, Pasadena, Calif.
COMMUNICATION SYSTEMS RESEARCH
J. H. Yuen 818-354-7058
(310-20-67)

The objective of this RTOP is to develop digital communication systems technology required to meet the needs of DSN supported missions for the late 1980's and 1990's. To meet the foreseen needs for efficient and low cost NASA space communications the RTOP will focus on improving or expanding space communication capability. End-to-end telemetry system performance will be improved by providing analysis, modeling, and computer simulation of subsystems to estimate individual subsystem impact on the quality of delivered data. Coding/decoding and modulation/demodulation techniques which are consistent with the present day constraints on complexity will be investigated in order to achieve an additional 2.0 dB reduction in required signal to noise ratio. Techniques to assure robust communications under non-ideal channel environments will be developed. Communication efficiency will be improved by developing information processing and data handling methods which can maintain information content but reduce required data volume and rate. Integrated source encoding, buffering, multiplexing, and packetization strategies will be investigated. The needed improvement by the DSN to provide efficient support of high elliptical earth orbiters will be identified and investigated.

W85-70552 **310-30-70**
Jet Propulsion Laboratory, Pasadena, Calif.
DIGITAL SIGNAL PROCESSING
W. J. Hurd 818-354-2748
(310-30-60; 310-30-66; 310-30-67; 310-30-69)

The purpose of this RTOP is to investigate, develop, test and demonstrate advanced signal processing techniques and equipment which enable the DSN to plan and achieve its performance requirements at reduced risk and cost to implementation and operations. There are two major thrusts. First is the development of advanced receiver signal processing, and symbol stream combining which will enhance the DSN antenna arraying capability at Voyager, Uranus and Neptune encounters. Second is development of VLSI circuits with applications to coded communications and DSN signal processing. The current engineering objectives are: (1) to design, develop and demonstrate high performance, miniaturized and cost effective digital signal processing for the telemetry signal processing portions of an advanced receiver for the DSN; (2) to develop a symbol stream combining system for low signal-to-noise ratio antenna arraying, and to demonstrate the performance and cost effectiveness of this technique on Voyager signals at Uranus encounter; (3) to develop and demonstrate custom high speed very large scale integrated circuits (VLSI) to meet DSN peculiar needs including reduced size and cost in high performance coders and decoders, and advanced receiver telemetry signal processing; and (4) to provide engineering support for the RFI surveillance system. During FY-85 the tasks are: demonstrate low SNR telemetry processing, third order and sideband aided carrier tracking, and symbol stream combining on Voyager signals; complete the telemetry signal processing breadboard by inclusion of direct carrier modulation types; complete testing of VLSI 4-bit Reed-Solomon decoder, complete design and fabrication of 8-bit R-S decoder, and begin design of Viterbi decoder; design VLSI accumulate and dump chip and a FFT commutator-delay chip for telemetry signal processing and spectrum analysis; and continue engineering support of the RFI surveillance system.

W85-70553 **310-40-26**
Goddard Space Flight Center, Greenbelt, Md.
OPERATIONS SUPPORT COMPUTING TECHNOLOGY
D. T. Ketterer 301-344-8460

This RTOP is aimed at improving the accuracy, timeliness, cost effectiveness, and operational aspects of ground based orbit computations and products in the TDRSS era. It addresses the evolution of the Operations Support Computing (OSC) technology; the objective is to research, analyze, and develop advanced operational concepts, and computer system designs for operations. System studies in FY-85 will concentrate on developing concepts and techniques for an intelligent terminal based system to improve the OSC functions. The Research and Technology Support Facility (RTSF) employing intelligent terminals will be used to develop and demonstrate recommended operations concepts. A major effort is directed towards developing a graphics support system on intelligent terminals to define graphics displays that will increase an operator's/analyst's ability to make informed, accurate, and timely decisions to fast changing events through the visualization of mission characteristics.

W85-70554 **310-40-37**
Goddard Space Flight Center, Greenbelt, Md.
HUMAN-TO-MACHINE INTERFACE TECHNOLOGY
W. F. Truszkowski 301-344-9261
(310-40-44)

The objectives of this RTOP are to: develop and apply natural man/machine interfaces for space payload and ground control systems including data base management systems, and develop methodologies, models, and guidelines which emphasize the human factors issues associated with man/machine interfaces and interactions. The intention is to apply recent advances in human factors analysis, data base management, and artificial intelligence to man/machine interface and interaction problems. The approach to be taken is: (1) to identify and apply state of the art data base management technology to mission and data operations systems; (2) to apply human factors and advanced knowledge engineering techniques and methodologies in the development and application of user interfaces to various data/information systems actively used in the mission and data operations environment; and (3) to formulate and execute a plan for a human factors testbed to support near term application directed man/machine interface development and analysis. The RTOP is a system level RTOP supporting TDRSS operations, mission operations, mission support computing, and general systems engineering activities.

W85-70555 **310-40-45**
Goddard Space Flight Center, Greenbelt, Md.
MISSION OPERATIONS TECHNOLOGY
P. J. Ondrus 301-344-8001

The main objective of this Research and Technology Objectives and Plans (RTOP) is to develop techniques and validate concepts that will improve operations efficiency, reliability, and reduce mission cost. The task objectives of the RTOP are: (1) the development and application of automation techniques to a command and control environment, (2) provide the technology for distributed command and control systems, and (3) the assessment and development of software development tools for real time command and control software programs. These three objectives represent the major technical challenges facing real time command and control systems for the late 1980s. The RTOP approach consists of supporting three separate, but interrelated tasks. The first task, the Control Center Automation Task, seeks to study, analyze, and prototype activities leading to the automation of control center functions. Major problems addressed in this approach are remote initialization of systems and the testing of automated systems. The second task, Remote User Interface, seeks to define and develop a standard remote user interface for attached payload operations.

W85-70556 **310-40-46**
Goddard Space Flight Center, Greenbelt, Md.
DATA PROCESSING TECHNOLOGY
Frederick W. McCaleb 301-344-6386

This RTOP supports the development and utilization of new technology to improve the performance of high data volume data processing systems. Currently there are two major objectives: (1) utilization of optical disk digital data storage technology in data processing systems; and (2) development of guidelines for automatic quality assessment in high volume data processing systems. These objectives are being pursued as two independent tasks. Task one consists of two elements, namely, implementation of a digital optical disk test bed system and development of data management strategies for large data bases stored on optical disk. Task two assesses various error management and quality control techniques to determine an economically viable level of automatic error management in high data volume data processing systems.

W85-70557 **310-40-49**
Goddard Space Flight Center, Greenbelt, Md.
SYSTEMS ENGINEERING AND MANAGEMENT TECHNOLOGY
R. W. Nelson 301-344-7809

The objective of this RTOP is to develop and evaluate systems level concepts and technologies which will be utilized to optimize the management, operation, and evolution of the Space Tracking and Data Systems (STDS). Major subobjectives are: (1) the development of a systems engineering and management support system for the introduction and consistent use of systems engineering principles and management practices in all phases of the system life cycle; (2) the definition, designing, and implementation of a cost/allocation/prediction model for STDS subsystems; and (3) the specification, design, and development of an automation supported software management/development environment based around the concepts of software factory and reuseable software. The RTOP approach is to develop associated tools and techniques, apply the techniques to representative problems, and evaluate both the techniques and the results prior to full utilization in STDS. This is a system level RTOP supporting mission operations, mission support computing, spacecraft data acquisition, data processing, and tracking and data relay satellite system (TDRSS) operations.

W85-70558 **310-40-72**
Jet Propulsion Laboratory, Pasadena, Calif.
NETWORK HARDWARE AND SOFTWARE DEVELOPMENT TOOLS
W. M. Whitney 213-354-4410
(310-30-70)

The overall objective is to produce computer tools that significantly assist DSN engineers in organizing, conducting, and managing the design and implementation of digital system hardware and software. Effective use of these tools will enable the DSN to take advantage of the benefits of very-large-scale integrated circuits (VLSI) and other semiconductor technologies in implementing digital systems. The system of tools being assembled for digital design will accommodate all essential steps in design, verification, and testing. Design can be conducted at the levels of logic, electrical circuitry, or layout; lower-level tools will handle the details of design implementation. Tools at different levels will be integrated by means of standard formats for representing circuit connectivity, topology, and geometry, and by programs that convert from one format to another. The system will eventually support all common implementation methodologies, including integrated circuits, gate arrays, standard cells, custom VLSI, and the principal VLSI fabrication technologies. The tools are resident on a VAX-11/780 computer with the VMS operating system. A VAX 11/750 workstation under UNIX permits importing, using, and evaluating UNIX-based tools written outside of JPL. Algorithms are being designed for special DSN function. Research is being done on methods of planning, conducting, and managing software development, and documenting and evaluating the software development process and its products. A specific task is focused on how to organize the software engineering and hardware design tools and integrate them and the resources of host computers into coherent systems, and also present users with a stable and congenial software environment.

OFFICE OF SPACE TRANSPORTATION SYSTEMS

Advanced Programs

W85-70559 **906-54-40**
Marshall Space Flight Center, Huntsville, Ala.
THE HUMAN ROLE IN SPACE (THURIS)
S. B. Hall 205-453-4196

Objective of this task is to further develop a human functions verification program based upon findings from THURIS studies. The approach is to assess the effectiveness of humans in the generic activities identified by prior THURIS work. Man/machine task allocation models and human role performance enhancement techniques will be analyzed. These analyses will refine previous data and upgraded the THURIS data base with input from recent manned missions. Over guideline funds will be used to begin selected verification tests of man/machine task allocation models and enhancement techniques for generic activities.

W85-70560 **906-54-61**
Lyndon B. Johnson Space Center, Houston, Tex.
RENDEZVOUS/PROXIMITY OPERATIONS GN&C SYSTEM DESIGN AND ANALYSIS
P. C. Kramer 713-483-3254

The objective is to develop a rendezvous/proximity operations guidance, navigation, and control (GN&C) system design compatible with all interacting elements of the space fleet (e.g., Orbiter, OTV, OMV, and free flyers). An automated system will be developed to support routine operations of the space fleet. Operational requirements will be defined and incorporated into the conceptual GN&C system design. Simulation tools will be developed and/or enhanced to support the design and evaluation processes. Performance and trade studies will be conducted to evaluate various GN&C system options and to establish an evolutionary system design. Significant technology drivers associated with the GN&C system development will be identified. Four main tasks are included: (1) automated rendezvous/prox ops system analysis; (2) proximity operations requirements definition; (3) navigation system development (operational requirements definition); and (4) laser sensor model development (operational requirements definition).

W85-70561 **906-54-62**
Lyndon B. Johnson Space Center, Houston, Tex.
ECLSS TECHNOLOGY FOR ADVANCED PROGRAMS
F. H. Samonski 713-483-4823

The potential future missions under consideration have diverse environments and unique requirements that differ from those of the Space Station. Advanced missions have longer resupply periods, necessitating the use of more expendable-free approaches. The objectives of this RTOP is to examine potential synergisms between life support systems of the Space Station and future missions/vehicles as part of a comprehensive study to support the subsequent development of life support system components which can perform over the wide range of potential requirements. It is anticipated that the study will identify the unique mission drivers and identify the corresponding environmental control and life support subsystem ECLSS technology needs and voids.

W85-70562 **906-55-10**
Marshall Space Flight Center, Huntsville, Ala.
STRUCTURAL ASSEMBLY DEMONSTRATION EXPERIMENT (SADE)
J. K. Harrison 205-453-2795

The Structural Assembly Demonstration Experiment SADE objectives are to demonstrate that the Shuttle has the capability to serve as a base for building a large structure in space, to

measure the extent to which the MSFC Neutral Buoyancy Simulator (NBS) can accurately simulate space assembly, and to determine the performance of the truss in terms of deployment and assembly. A single flight is planned in 1987. The 100 foot long truss will be constructed over a period of several hours using astronaut EVA assistance and other Shuttle resources. The construction procedure is being tested in the NBS, and will be repeated on-orbit. The truss will be constructed in a vertical direction from the Shuttle bay and remain attached. Several days later disassembly will occur and the disassembled truss will be returned to Earth.

W85-70563 **906-55-61**
Marshall Space Flight Center, Huntsville, Ala.
PHASED ARRAY LENS FLIGHT EXPERIMENT
W. E. Thompson 205-872-2792

The objective will be to continue capability development of reliable deployment and delivery of large aperture sensors by the Orbiter or upper stages. The FY-85 task will provide NASA support on cooperative NASA/USAF/DARPA test program currently proposed as a joint-funded activity. This tests program is for structural deployment/retraction of radiating membrane which supports DOD capabilities for space surveillance systems and NASA/civil capabilities for advanced communications systems. This task will utilize requirements and definition data from related program/studies such as DARPA/USAF membrane development/ demonstration, Low-Altitude Radar Missions, and the NASA definition on Large Antenna Flight Test and Experimental Communications Platform. The planned approach is to fabricate a test article for initial ground tests and subsequent flight test on the Orbiter. The test article will be integrated with flight support hardware previously developed and flown by NASA.

W85-70564 **906-63-03**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL TRANSFER VEHICLE (OTV)
D. R. Saxton 205-453-0162
(506-63-59; 506-63-29)

The objectives of this effort are to conduct conceptual definition and technology studies of Orbital Transfer Vehicle OTV concepts, subsystems, evolutionary approaches, and implementation of an Aeroassisted Flight Demonstration Experiment. Particular emphasis will be placed on: (1) investigation of alternative launch modes, basin options, and missions; (2) establishing feasibility and providing definition/optimization of OTV concepts; (3) assessing and planning for development and verification of technology; (4) investigating the feasibility of propellant scavenging; (5) initiating definition of a large scale cryogenic storage flight experiment; (6) conducting breadboard testing; and (7) preliminary design/development of a flight experiment to demonstrate critical aspects of an Aeroassisted OTV atmospheric mission phase. Phase A in house and contracted studies have resulted in several selected groundbased Shuttle Orbiter compatible OTV concepts, both aeroassisted and all propulsive. The FY-84/85 activity will investigate concepts compatible with alternative launch and basing modes. The cryogenic breadboard is operational, and testing has been initiated. It is expected that OAST will assume funding of the Aeroassist Concept Analysis task continuation. A flight experiment demonstration of the Aeroassist OTV is included to provide for design and development of a jointly funded (OAST/OSF) Aeroassist Flight Experiment.

W85-70565 **906-63-06**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED SPACE TRANSPORTATION SYSTEMS - LUNAR BASE AND MANNED GEO OBJECTIVES
Barney B. Roberts 715-483-3278

Now that the Space Shuttle has become operational, and NASA is in the early stage of conceptual definition of the next logical steps in the Space Transportation System, it is time to once again assess the long range objectives of the civilian space agency in order to provide the necessary guidance for a logical, rational and integrated phases development of the Space Station and other transportation system elements. To focus the effort requested in this RTOP, the scope of the study will be bounded by activities between, and inclusive of, geosynchronous orbit and the surface of Earth's moon (including Earth-Moon libration points). Transportation system elements required to support these activities are, of course, not subject to geosynchronous orbit as a lower bound, but will extend back to LEO (i.e., Space Station, OTV). The products of the effort described in the RTOP will be reports detailing rationale for, functions of, and the opportunities provided by an advanced transportation system, the mapping of the rationale and functions into system element requirements, and conceptual definition of several competing options that will satisfy these requirements. As a post-script to the analysis, the report will include a brief assessment of the capability of the proposed transportation system elements to support other solar system mission objectives such as asteroid rendezvous, Mars sample return, and manned solar system exploration. The tasks, their relationships, and the proposed output is shown in the attached flow charts.

W85-70566 **906-63-30**
Lyndon B. Johnson Space Center, Houston, Tex.
OTV GN&C SYSTEM TECHNOLOGY REQUIREMENTS
G. G. McSwain 713-483-4476

The objective of this RTOP is to develop a conceptual design for the OTV GN&C Guidance and Navigation Computer system and to identify the associated technology drivers both in context of the Shuttle Transportation System/Space Station environments and expendable upper stage experience. The plan for FY-85 is to develop mission requirements, refine the conceptual GN&C system design, and perform an evaluation of this design. This effort will provide a broader base of technology and mission requirements to support: (1) aerobraking for both lifting brake and drag modulation techniques, (2) orbital navigation techniques utilizing Global Positioning System GPS, and (3) development of rendezvous and docking requirements for low Earth rendezvous with the Orbiter and Space Station. Integration requirements leading to commonality across project/program lines will be identified to reduce overall system costs. Implicit in the overall task will be the future development and application of the tools, models, and analysis techniques necessary to support the effort.

W85-70567 **906-63-33**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE TRANSPORTATION SYSTEM (STS) PROPELLANT SCAVENGING STUDY
Gene R. Grush 713-483-5395

The objectives of this study are to: (1) finalize test plan and design requirements for ground and/or flight experiment of the STS propellant scavenging system; (2) provide parametric cost data for a propellant resupply system consisting of a propellant scavenging system; and (3) determine manifesting impacts of propellant resupply system using a propellant scavenging system. Based on the results of earlier studies, a more comprehensive evaluation of this potential resource of fluids is warranted. This study will focus on the experimental requirements, manifesting impacts, on-orbit propellant requirements, vehicle's center of gravity window, new technological requirements and analytical analysis with respect to the proposed STS propellant scavenging system concept.

W85-70568 **906-63-37**
Lyndon B. Johnson Space Center, Houston, Tex.
HIGH ALTITUDE ATMOSPHERE DENSITY MODEL FOR AOTV APPLICATION
J. D. Gamble 713-483-5071

The objective of this RTOP is to provide High Altitude Atmospheric Density Data Base for Aeroassisted Orbital Transfer Vehicle (AOTV). Continuation of Space Shuttle Orbiter effort will be terminated at the end of the Orbiter Flight Test Program (Flight 19). Orbiter accelerations derived from IMU and Aerodynamic Coefficient Identification Package (ACIP) will be utilized to derive atmospheric density. Orbiter derived density will be compared against National Weather Service provided density profiles and profiles predicted by existing global atmosphere models. A statistical model for atmospheric density including density shears

such as were observed on STS-4 and STS-9 will be provided. Recommendations for modifications to current global atmosphere models will be provided.

W85-70569 **906-63-39**
John F. Kennedy Space Center, Cocoa Beach, Fla.
ORBITAL TRANSFER VEHICLE LAUNCH OPERATIONS STUDY
John M. Twigg 305-867-4670

The objects are to consider expanding the capability of STS to the Orbital Transfer Vehicle (OTV) concepts. These concepts include the OTV/ACC, a ground based OTV, and a space based OTV. Vehicles under study include reusable and expendable stages, cryogenic and hypergolic propulsion systems, and manned and unmanned configurations. For all OTV confiigurations being considered by NASA this study will address the requirements for ground and space launch operations. This will include the identification of all new and/or modified launch site facilities and equipment required for prelaunch activities, i.e., handling, build up, test, checkout, integration and launch, all post launch activities to turnaround a reusable OTV and the manpower and cost associated with these activities. The study will pay particular attention to the need for evaluating the current launch operation philosophy associated with similar vehicles and the need to be able to conduct rapid turnaround with minimal personnel for this series of vehicles.

W85-70570 **906-64-23**
John F. Kennedy Space Center, Cocoa Beach, Fla.
WEATHER FORECASTING EXPERT SYSTEM
Tom Davis 305-867-3494

The objective of this RTOP is to determine the dependency of the Shuttle and Advanced Launch Vehicle launch and landing windows upon adequate forecasting of weather conditions for very finite and specific time periods. The endemic climatological conditions at Kennedy Space Center are very unique due to the geographic location and frontal inter-actions. Forecasting specific conditions for the area with respect to a unique launch or landing window requires an expertise built up over a long period of time through experiencing actual conditions over the various seasonal fluctuations. Such expertise is constantly jeopardized through personnel changes within the weather forecasting organization. This project will capture the weather forecasting domain expertise of forecasters who have considerable experience in the KSC local area. This expertise will be captured by incorporating the knowledge in an expert system set of software. The extensive climatological data gathering system that is currently in place at KSC can also be assimilated by the expert system to provide the data base upon which the expert system inference engine can make forecast decisions. The prototype expert system will be exercised in real-time by the weather forecasters to assist in forecasting and will be modified based on actual weather conditions vs forecasted conditions.

W85-70571 **906-64-24**
John F. Kennedy Space Center, Cocoa Beach, Fla.
ROBOTICS HAZARDOUS FLUIDS LOADING/UNLOADING SYSTEM
R. M. Ferguson 305-867-3402

The objective of this RTOP is to study the loading and unloading of hazardous fluids such as hydrazine in connection with the Shuttle, future launch vehicles, and spacecraft ground processing operations (and in the future on-orbit operations). These operations are tedious, time consuming, require trained SCAPE specialists, and involve considerable risks to personnel as well as to the launch vehicles and/or spacecraft in the event of spills or leaks. This project would develop leak-proof connectors, holding plates, robotic manipulation hardware, and control systems for accomplishing these hazardous operations with a completely automated robotics system without requiring the intervention of any human personnel.

W85-70572 **906-65-04**
Marshall Space Flight Center, Huntsville, Ala.
SDV/ADVANCED VEHICLES
J. E. Hughes 205-453-0162

The objectives of this effort are: to refine vehicle concepts and supporting facilities/equipment definition for Shuttle Derived Vehicles (SDV); to establish and incorporate mission requirements into the basic vehicles definition; to establish methods of transporting propellant to an orbiting space station and/or propellant holding tanks; and to determine costs, benefits, and schedules required for implementation. Contracted studies are currently in progress to define several SDV concepts that could augment the basic STS in several different ways. These concepts utilized current state of the art technologies, and the configurations were established by trade analysis. SDV concepts that are currently investigated include: Shuttle Derived Cargo Vehicles (side mount and in line) and reusable liquid rocket boosters. Potential mission applications and benefits will be examined in more depth for selected vehicle concepts or classes in FY-85, along with further definition of the vehicle concept(s), its capabilities, requirements for on orbit propellant transportation, and requirements for implementation. Cost and schedule estimates will be made for configuration trades and selection. Phase B studies and advanced development efforts in FY-85 and FY-86 will identify the desired vehicle configuration(s) and complete system and subsystem trade studies in preparation for future procurement.

W85-70573 **906-65-33**
Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF FLEXIBLE PAYLOAD AND MISSION CAPTURE ANALYSIS METHODOLOGIES AND SUPPORTING DATA
T. C. French 203-453-3467

The objective is to develop a computer aided, interactive capability to conduct comparative evaluations of advanced launch vehicles, orbital transfer vehicles, space station configurations, operational modes, fleet sizes, ground facilities, and other facets of potential future NASA programs requiring various trade studies and analyses to identify the high payoff options from both user accommodations and overall system cost effectiveness prospectives. The comparative evaluations involve capture/cost analyses which are general phases that apply to the various analyses that can be conducted at different levels of detail. The approach has been to develop the methodologies required to conduct capture/cost analyses, procure and develop necessary computer hardware and software to implement the computer aided interactive system and to establish the data requirements necessary to support the overall activity. Presently the system is in a state of development. Some of the system elements are further along in the development phase than others, and the interfaces between elements are in the process of being established. Hence, the establishment of the particular data required, the associated data formats and the computer data files will be developed in the follow up activity.

W85-70574 **906-70-00**
Marshall Space Flight Center, Huntsville, Ala.
TETHER APPLICATIONS IN SPACE
G. F. VonTiesenhausen 205-453-2789

The objectives are to investigate the established five categories of tether applications in space; transportation, constellation, electrodynamic interactions, gravity utilization, and technology and test; to perform theoretical and engineering design feasibility investigations of tether applications in space; to establish requirements and the cost effective potential of concepts; to perform preliminary design and concept verification validity leading to proof of concept testing. Numerous tether applications are being evaluated by several companies and academic groups (Martin-Denver, MIT, SAO) to decide which warrant continued study. Those selected will be more thoroughly examined, and an engineering design and cost benefit analysis will be performed.

C-2

W85-70575 **906-70-16**
Langley Research Center, Hampton, Va.
SHUTTLE TETHERED AEROTHERMODYNAMIC RESEARCH FACILITY (STARFAC)
P. M. Siemers 804-865-3984
(506-63-37; 506-63-43; 506-51-13)

The conclusions from studies relative to the use of vehicle aerodynamic forces generated during an atmospheric pass to achieve orbital plane changes have been that although there are no technology show stoppers, there are many aerodynamics related technology challenges which must be solved. The objective of the proposed research is to define the feasibility of accomplishing aerothermodynamic research in the rarefied upper atmosphere (90 to 200 km) using in-situ measurements obtained from a tethered shuttle subsatellite of a tethered wind tunnel. The proposed in-situ atmospheric data will support upper atmospheric aerothermodynamic technology programs as well as atmospheric science. The feasibility of a tethered subsatellite has been demonstrated in the literature. The proposed research will concentrate on the definition of the subsatellite and its instrumentation, guidance and control, and mission profile. The proposed system will maximize data acquisition while minimizing the impact on orbiter operational constraints. To accomplish atmospheric definition the instrumentation will include accelerometers and a tether tensiometer.

W85-70576 **906-70-23**
Lyndon B. Johnson Space Center, Houston, Tex.
APPLICATION OF TETHER TECHNOLOGY TO FLUID AND PROPELLANT TRANSFER
Ken Kroll 713-483-5495

The objective of this effort is to examine the feasibility, design requirements, operational limitations, cost and benefits of the tethered orbital refueling concept. The approach is to use a contracted effort that studies specific areas of concern while developing a preliminary design. The areas of concern that are to be examined are fluid transfer methods, fluid sloshing, hazard clearance, fluid/tether interaction, and operation of a propellant depot on the Space Station. These results for the preliminary design will then be compared to an alternate technique to determine relative cost and benefits.

W85-70577 **906-70-29**
Lyndon B. Johnson Space Center, Houston, Tex.
ELECTRODYNAMIC TETHER: POWER/THRUST GENERATION
J. E. McCoy 713-483-5171

The objectives are to: (1) calculate operating efficiency of plasma-electric motor/generator systems, using experimental data on characteristics of large high-voltage structures immersed in plasma, (2) calculate dynamic stability of long flexible conductors in Earth orbit, (3) measure coupling efficiency of prototype hollow cathode plasma brushes, (4) define and breadboard a flight experiment needed to define calculated efficiencies and stabilities, (5) adapt dynamic stability simulations for real-time and accelerated time mission simulation, training, and on-orbit stability augmentation control, and (6) assess cost/benefits of representative electrodynamic tether concepts. Existing knowledge of plasma current coupling between conducting structures in low Earth orbit and the surrounding ionospheric plasma and geomagntic field will be applied to calculate the performance and efficiency to be expected from application of the resulting motor/generator effect to station keeping and attitude control of large orbital systems. Ground based and orbital flight tests necessary to verify the predicted performance values will be defined. Stability of the tether wire against perturbations will be analyzed, with emphasis on excitation and damping of standing wave modes in realistic engineering models. Efforts will be coordinated with existing scientific programs and with JSC engineering and flight operational elements.

W85-70578 **906-70-30**
Lewis Research Center, Cleveland, Ohio.
ELECTRODYNAMIC TETHER MATERIALS AND DEVICE DEVELOPMENT
Robert Bercaw 216-433-6143
(506-55-72)

The objective of this effort is to develop and characterize electronic materials and devices needed to enhance currently planned electrodynamic tether experiments. This includes characterization of plasma-pinhole interactions in insulated tethers, the development of coatings for oxidation protection of tether insulation, the development of high voltage components, and the development of electron emission devices as requested in support of JSC.

W85-70579 **906-75-00**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL MANEUVERING VEHICLE
W. G. Huber 205-453-5311

The objective of this effort is to provide the program definition (Phase B) of the Orbital Maneuvering Vehicle (OMV) and the development of planning and cost data to support the subsequent hardware design and fabrication contract. In addition, this effort will include supporting development activities in the rendezvous, docking, remote control and servicing system/manipulator areas. Extensive in-house and contracted (Phase A) studies have built a sound base of potential applications for this system and have defined competing concepts for satisfying the requirements. Through the day-to-day management of the definition phase (Phase B), all segments of potential user interest/requirements will be factored into a set of firm requirements supported by cost and schedule data for initiation of the follow-on hardware phase.

W85-70580 **906-75-06**
Jet Propulsion Laboratory, Pasadena, Calif.
TMS DEXTERITY ENHANCEMENT BY SMART HAND
A. K. Bejczy 213-354-4568
(506-54-65; 506-57-25)

The general objective of this work is the development, testing and evaluation of a smart hand system integrated with the PFMA at MSFC to enhance the operational dexterity of the TMS in performing manipulative tasks on a target body before and after docking with the target. The smart hand system includes: (1) proximity, tactile and force sensing with associated electronics integrated with a suitable end effector mechanism; (2) man-machine interface devices and techniques required for an efficient smart hand operation; and (3) computer-aided controls for automation of some smart hand tasks. The development is planned in three phases. Phase 1 covers the hand mechanism and control, force-torque sensor with graphics display and microcomputer system for control and data handling. Phase 2 will add proximity and grasp force sensing and control capability to the smart hand. Phase 3 will add computer-based automation components to the smart hand in an interactive automatic/manual control mode. The specific FY-85 objectives are: complete Phase 1 smart hand development at JPL; integrate and test Phase 1 smart hand at MSFC; and start Phase 2 smart hand design and development at JPL. The design of TMS smart hand components will evolve from the sensor, control, display and man-machine interface designs developed or under development at JPL within the base technology program for advanced teleoperator (telepresence) research. The total effort is planned as a three-phase development. The control experiments will be defined and done jointly with MSFC personnel. Existing hardware and facility equipment at MSFC will be utilized to the greatest extent possible. The JPL and MSFC parts of the joint effort will be defined in each separate test case. The scheduling will accommodate the general work schedule on the TMS at MSFC.

W85-70581 **906-75-22**
Lyndon B. Johnson Space Center, Houston, Tex.
ORBITAL DEBRIS
A. E. Potter 713-483-5039

The objective of this work is to define the current debris population using existing sources of data and to forecast as

accurately as possible its future growth in order to permit timely adjustments to spacecraft design and operations. The objective is approached by obtaining and compiling all existing data souces (e.g., NORAD, ground-based optical, IRAS data, window pitting), modelling the data in order to predict the current environment, and applying the model to spacecraft engineering and operations. A key problem is the lack of data on debris that is less than 1 cm debris population at operational altitudes (200 to 500 km). This work will define and constrain the problem through modelling; a related, but separate flight project has been proposed to provide data by in situ measurements.

W85-70582 **906-75-23**
Lyndon B. Johnson Space Center, Houston, Tex.
ADVANCED RENDEZVOUS AND DOCKING SENSOR
H. O. Erwin 713-483-3660

The objective of this task is to develop, test, and evaluate a small, lightweight, accurate laser based rendezvous and docking sensor to satisfy the needs of a variety of spacecraft and missions. The RTOP scope will emphasize docking capability in the initial development work. The docking sensor will measure the relative attitude, position, and velocity of the target vehicle with respect to the chase vehicle. Only an array of three small optical reflectors is required on the target vehicle. Greater range capability for rendezvous can be added later. A modular design concept is envisioned to provide flexibility in satisfying the rendezvous, stationkeeping and docking requirements of different types of spacecraft and missions. Under this task, a laboratory model of the sensor system will be fabricated and tested, providing the basis for the development of a spaceflight demonstration system. The spaceflight demonstration system will be developed and tested in the FY-86-88 time frame for the Ice Breaker Program.

W85-70583 **906-75-41**
Lyndon B. Johnson Space Center, Houston, Tex.
TELEPRESENCE WORK STATION
Lyle M. Jenkins 713-483-4407

The objective is to develop a preliminary design of the Telepresence Work Station (TWS) with options for evaluation and utilization of technology development items. The TWS is a system composed of base supporting one or more dexterous manipulators controlled by an operator in the Orbiter cabin. The TWS includes lighting, TV, and other sensors to develop telepresence capability for the operator. A contracted study will develop the preliminary design. Inhouse testing and simulation as well as intercenter contact will be used to incorporate technology developments and components in the preliminary design.

W85-70584 **906-75-50**
Lyndon B. Johnson Space Center, Houston, Tex.
SATELLITE SERVICING PROGRAM PLAN
Gordon Rysavy 713-483-4407

The objective of this RTOP is to develop a program plan for the orderly development of STS and Space Station based satellite servicing equipment and associated servicing interfaces, considering need, cost, cost benefits, technological readiness, and other prioritizing factors which may be identified.

W85-70585 **906-75-52**
Lyndon B. Johnson Space Center, Houston, Tex.
OPERATIONAL ASSESSMENT OF PROPELLANT SCAVENGING AND CRYO STORAGE
Tim Cleghorn 713-483-3278

The objectives of this RTOP are to accomplish the following tasks. (1) define the characteristics of cryogenic transfer from an operational and utilization approach; (2) perform a flight design assessment of the ET propellant scavenging concept and identify incompatibilities and/or trade offs between requirements and operations; (3) develop a working model of cryogen behavior under long term zero g storage conditions. The approach to the first task will be parametric in nature. Low g transfer will be studied to examine a correlation between thrust level, transfer rate, and timeline. Fluid properties will be assessed before, during and after transfer. The second task will be accomplished through the completion of the following analyses: ET disposal, ascent performance analysis, attitude analysis, mission capability, and flight software assessment. The third task will involve a detailed study of the thermal and density stratification, which occurs in a low g environment, and how this impacts quantity gauging and pressure cycling.

W85-70586 **906-75-59**
Lyndon B. Johnson Space Center, Houston, Tex.
INTERACTIVE GRAPHICS ADVANCED DEVELOPMENT AND APPLICATIONS
Robert H. Brown 713-483-3458

Significant technical advances have been achieved in the computer graphics and computer generated imagery fields in the recent past which have tremendously improved the hardware capabilities. Systems are now available which will allow real time visibility into the analysis process. It is now feasible to expand existing computational analysis capabilities through use of computer generated devices to allow real time evaluation of time critical and man in the loop activities. Systems generating thousands of 3 dimensional vectors with perspective and distance dimming in real time (30 Hertz) are being made available on the graphics system market. Modification of Firmware (micro-code) allows implementation of special high speed processing and analysis of data bases (objects) and functions. An example of such would be preliminary technique assessment in the on orbit rendezvous and proximity operations phases as well as the RMS payload handling phase. Applications will be timelining, trajectory design, launch window analysis, consummables planning, systems and software design, flight safety issues, and real time mission support, as well as analysis and evaluation of the Tele Maneuvering System (TMS), Satellite Servicing, Tether Operations, Cargo Bay Crew Activities, and Space Station Activities.

W85-70587 **906-80-11**
Lyndon B. Johnson Space Center, Houston, Tex.
DATA AND SOFTWARE COMMONALITY ON ORBITAL PROJECTS
H. E. Smith 713-483-4281

The objective of this effort is to explore and establish an approach toward commonality and standardization across NASA orbital flight projects which reduces the development risks and costs of ownership of software and data systems. The effort involves the creation of a generic avionics design and a set of standards and policies covering software and system implementation. The effort is applicable to all advanced programs, especially those directly related to the Space Operations Systems. There are elements of the effort directly applicable to Space Station which are already sponsored under the end-to-end information systems effort. This particular effort will focus on non-Space Station Systems and the integration of the products across all flight systems efforts.

W85-70588 **906-80-13**
Lyndon B. Johnson Space Center, Houston, Tex.
AUTOMATED SOFTWARE (ANALYSIS/EXPERT SYSTEMS) DEVELOPMENT WORK STATION
Robert H. Brown 713-483-4676

Two stated goals of NASA are: (1) Establish NASA as a leader in the development and applications of advanced technology that contribute to significant increase in agency and national productivity and (2) demonstrate the appliction of Automation in terms of AI/Expert Systems application in manned spaceflight. Software development with today's technology will continue to be an ever increasing percentage of the total program cost and will become the single most critical schedule driver. There are two types of software that are required in future programs (1) analyses programs, primarily mathematical and (2) decision making software in terms of expert systems. Present technique for development of analysis programs are inadequate for future programs and productivity must be increased by two orders of magnitude. The expertise for developing Expert Systems resides primarily with the academic

community and the cost per system development is unacceptable. Significant reductions must be made and an inhouse expertise developed. Finally, the two types of software must be made to play together. The objective of the efforts is to demonstrate a 10 fold increase in the production of software and to demonstrate the capability of one year.

W85-70589 **906-80-14**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACECRAFT APPLICATIONS OF ADVANCED GLOBAL POSITIONING SYSTEM TECHNOLOGY
J. F. Pawlowski 713-483-4647

The Global Positioning System (GPS) is capable of highly accurate spacecraft navigation and is baselined in this role in future spacecraft designs. A class of GPS techniques can be defined separate from those used in the classical navigation function. The GPS can be further applied to address issues in the design of future spacecraft, other than simple navigational requirements. Research is proposed which investigates the potential of the GPS to function as an input sensor to spacecraft systems required to provide the following services: (1) attitude control and pointing; (2) timebase; (3) structure control; (4) traffic control. Initial investigations into these techniques are performed during Orbiter GPS requirements definition efforts. Although these areas appear to have potential application to future spacecraft, no further work is planned in support of the Space Shuttle Program. The general approach of this RTOP will be to extend these concepts toward system descriptions by feasibility study, requirements/performance analysis, and spacecraft implementation proposal.

W85-70590 **906-90-03**
Marshall Space Flight Center, Huntsville, Ala.
GEOSTATIONARY PLATFORMS
R. H. Durrett 205-453-2792

The purpose of this RTOP is for the office of space flight (OSF) portion of a joint OSF/OSSA program primarily to enable effective aggregation of space communication payloads to enhance the arc/spectrum resource and, secondarily, to pursue alternative ways to enhance STS operations at geosynchronous orbit. The guiding overall NASA objectives of this program will be to ensure continued preeminence of the U.S. in space technology and to fully exploit the STS. A four phase program is to be pursued, with the OSF responsibility being in the bus/transportation and related space operations areas. The first phase will: establish validity of payload aggregation; identify critical technologies and support capabilities; and identify and scope U.S. industry/NASA's role in enabling the required technology and provision of platform operational support. The second phase will define industry/NASA roles, NASA's program content, and program resources required to establish enabling technology. Critical technology development will be initiated. The third phase will be to design required experimental mission(s) and flight system(s) concepts necessary to establish enabling technologies. Proof of concept technology development will be complete. Finally, the fourth phase will be to develop experimental systems as required and to conduct experiment mission operations.

W85-70591 **906-90-22**
Marshall Space Flight Center, Huntsville, Ala.
MAJOR REPAIR OF STRUCTURES IN AN ORBITAL ENVIRONMENT
J. K. Harrison 205-453-2795

The objective of this research is to develop the capability to perform major structural repair work on damaged space systems. To define the requirements for tools, techniques, logistics, and special equipment needed for such operations as welding, grinding, shaping, forming, cutting, riveting, and bonding in an orbital environment. To identify candidate methods for accomplishing the various tasks on orbit. To develop, through analysis, design, and testing, the prototype hardware and techniques for these maintenance and repair activities. The classes of repair work, i.e., welding, drilling, grinding, etc., will be defined, the likely repair jobs or requirements will be developed, and the tools and techniques needed will be studied and classified. After this, solutions in the form of new tools and techniques will be developed and ground tested. Those that prove feasible will be proposed for flight development and for application to the Space Station as well as the other space systems.

SPACE STATION PROGRAM OFFICE

Space Station Focused Technology

W85-70592 **482-50-22**
Lewis Research Center, Cleveland, Ohio.
RESISTOJET TECHNOLOGY
R. E. Jones 216-433-6233
(506-55-22; 481-25-22)

The overall objective is to define and provide resistojet thruster system technology for Space Station. Selection of propellants for the thruster will be based on Space Station System studies. Candidate propellants include hydrogen, hydrazine, and environmental control system fluids such as methane, water, nitrogen, and carbon dioxide. Laboratory model thrusters will be used to determine performance, lifetime, and effluent characteristics. A subsequent effort will be directed at developing the technology for an advanced system capable of improved performance.

W85-70593 **482-52-21**
Ames Research Center, Moffett Field, Calif.
HUMAN BEHAVIOR AND PERFORMANCE
Joseph C. Sharp 415-965-5100
(199-22-62; 505-35-11; 506-57-21)

To insure high levels of crew productivity over extended tours onboard the space station, an integrated approach to the determination of work station and habitability needs for effective human behavior and performance, and the prescription of guidelines to satisfy those needs is required. Previous work in aviation human factors shows that work station performance, particularly performance that is heavily dependent on information transfer, is strongly subject to the influence of non-work-station parameters, such as those associated with habitability and intracrew interactions. Using mockups of selected work station and other habitable space station volumes, research will be conducted to evaluate the interacting effects of display/control designs and habitability parameters on work station tasks and non-work-station behavior. Concepts for work station design and operation based on perception and cognition research, particularly associated with proximity operations, will be tested in a mission context involving coordination with other activities, such as EVA servicing, and leisure and meal oriented activities. The effects of variations in habitability parameters, such as volume and window design, on performance and behavior will be evaluated.

W85-70594 **482-52-25**
Jet Propulsion Laboratory, Pasadena, Calif.
MULTIFUNCTIONAL SMART END EFFECTOR
A. K. Bejczy 818-354-4568
(506-57-22; 506-57-25; 481-57-25)

The general objective of this work is to establish the technology readiness in the 1987 to 1988 time frame for an advanced teleoperator flight experiment in support of space station operations and involving the use of an integrated multifunctional end effector, tool, sensor, control and display system. A key element of this general objective is the development of an efficient human operator interface to the system including automation aids, as expressed in the major thrusts of the space human factors development plan. The FY-85 objectives are: (1) overall task analysis and requirements development taking into account space station operations in the initial configuration and in relation to the space shuttle; (2) development and evaluation of system design alternatives; (3) development of system mechanization concept design including automation aids and human operator interface. This

focused technology and advanced development effort will build on previous R & D work and results in this area at JPL and will be coordinated with ongoing efforts at other NASA centers, in particular at JSC and at MSFC. The development effort will lead to the demonstration of a prototype ground system and to the engineering specifications of a flight experiment system to be carried on the space shuttle. The prototype system will be built for a one arm teleoperator but in a way that it can be extended or reconfigured for a two arm teleoperator system carried on the shuttle, on the OMV or on the space station itself.

W85-70595 **482-52-29**
Marshall Space Flight Center, Huntsville, Ala.
ORBITAL EQUIPMENT TRANSFER AND ADVANCED ORBITAL SERVICING TECHNOLOGY
A. Quinn 205-453-0080

Requirements for servicing and other operations external to the space station, including experiments which are free flying or attached, will be defined. Techniques for manual transfer of equipment to and from the space station will be developed. Tools and crew aids for EVA tasks will be defined and demonstrated via simulation techniques. Approaches for servicing OMV common modules, MSFC-responsible laboratory modules and logistics modules will be evaluated and tools and procedures will be defined. Ground and in-flight experiments will be conducted to verify techniques and equipment selections.

W85-70596 **482-53-22**
Lewis Research Center, Cleveland, Ohio.
LUBRICANT COATINGS
W. R. Loomis 216-433-3147

The objectives of this RTOP are to select, optimize and evaluate coatings required for use in components for efficient transfer of mechanical power in space station applications and long-life coatings for latch-down mechanisms, bearings, cams, etc. The lubricant formulations must be optimized, coatings developed to afford surface protection, and lubricants identified to provide low friction, low wear, and low volatility in space.

W85-70597 **482-53-23**
Langley Research Center, Hampton, Va.
LONG TERM SPACE EXPOSURE
C. P. Blankenship 804-865-2042
(506-53-23)

The objective of this research is to develop long-life thermal control coatings for composite structures that are resistant to atomic oxygen, solar UV, and thermal cycling in the space station orbital environment. Emphasis is placed on coatings that will have low solar absorptance and emittance and can be applied to composite tubes. These coatings will also serve to protect the substrate composite materials from degradation due to atomic oxygen. Coating concepts to be evaluated include sputter deposited metallic/oxide layered coatings, coated teflon films to be applied during composite fabrication, and anodized aluminum foils that would be placed on composite tubes during fabrication or adhesively bonded to finish tubes. Coatings will be applied to composite tubes and subjected to a series of qualification tests to evaluate performance and durability. The most promising concept will be scaled up to demonstrate feasibility of coatings structures expected to be used on the space station.

W85-70598 **482-53-25**
Jet Propulsion Laboratory, Pasadena, Calif.
OXYGEN ATOM RESISTANT COATINGS FOR GRAPHITE-EPOXY TUBES FOR STRUCTURAL APPLICATIONS
R. H. Liang 818-354-6314
(481-53-25)

The principal objective is to evaluate the effects of energetic oxygen atoms on candidate thermal control coatings and coated surfaces in order to assess their durability in a low Earth orbit environment for application in the space station. A further objective is to develop selection criteria for thermal control coatings based on a model of long term degradation of these coating materials. A two-fold experimental and modeling approach will be established. This approach will combine flight exposure experiments with ground based experiments on the same materials. Flight exposure aboard shuttle will be preceded and followed by specific spectroscopic analyses of the erosion production at the surface and in the bulk. The ground based experiment will be carried out by using continuous wave and pulsed oxygen atom beam of similar flux and energy to those observed in the low Earth orbit. Fast optical and electron paramagnetic resonance detecting assemblies will be used for sensitive monitoring of key primary transients and intermediate degradation products.

W85-70599 **482-53-27**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE ENVIRONMENTAL EFFECTS ON MATERIALS AND DURABLE SPACE MATERIALS
Lubert J. Leger 713-483-2059

The objectives of these studies center around improving durability of currently available space materials and to develop material concepts which will be durable to atomic oxygen, Space material durability studies will concentrate in three areas: (1) chemical conversion coatings; (2) silver Teflon concepts; and (3) graphite epoxy structural tube tape layup. For the chemical conversion process, the range of application of surface treatments (anodizing and alodining) needs to be expanded and developed to result in desired optical properties. Silver Teflon application techniques and processes have to be developed to improve the system integrity and durability. Promising techniques include vacuum deposition of silver directly onto a substrate and overcoating Teflon in a fluidized bed process to a suitable thickness. Another promising technique is co-curing a thermal control and atomic oxygen protective coating during fabrication and tape layup of the graphite epoxy structural tubes for the space station. Also, substrates for solar arrays will be developed which are durable to atomic oxygen. Flight experiments to define the mechanisms involved and obtain oxidative rate data will be proposed.

W85-70600 **482-53-29**
Marshall Space Flight Center, Huntsville, Ala.
SPACE DURABLE MATERIALS
J. W. Massey 205-453-1290

Develop the materials technology required to support the conception and development of the Space Station. The plan will demonstrate technology readiness by CY-87 for space durable materials. The work defined by this plan will be performed as follows: development and characterization of durable coatings with consideration of the effects of atomic oxygen environment; exposure of active and passive experiment modules in a flight experiment for confirmation of technology readiness; development of Space Station contamination control criteria and methods of evaluation including the characterizing and modeling of flow phenomena; definition of lubrication requirements and documentation of lubrications/systems evaluation; development and evaluation of on-orbit joining, bonding, sealing techniques for Space Station elements; and development of on-orbit repair materials and techniques for module and structural elements. The goal of this program is to develop, demonstrate, and document the required materials technology for use in the development, design, fabrication, and operation of the Space Station.

W85-70601 **482-53-43**
Langley Research Center, Hampton, Va.
ERECTABLE SPACE STRUCTURES
C. P. Blankenship 804-865-2042

The objective is develop erectable truss structure construction procedures to a point where a rational assessment of their application to space station can be made. Candidate graphite/epoxy tube designs will be evaluated to determine their suitability for use as space station primary structure and to build a multi-bay component for use in testing a mobile remote manipulator system.

W85-70602 **482-53-47**
Lyndon B. Johnson Space Center, Houston, Tex.
DEPLOYABLE TRUSS STRUCTURE
W. C. Schneider 713-483-3076

The principal objective of this RTOP is to develop a large, stiff, planar area truss structure that can be folded and packaged for transport in the Shuttle payload bay and automatically deployed to its full planar area with a minimum astronaut assistance. The principal concept to be developed is that of large tetrahedral planar truss containing structural members with foldable joints and energy storage mechanisms, and can be preloaded after deployment to eliminate joint tolerance and to stiffen the structure. The principal tasks are to: develop the specially designed foldable joints and energy mechanisms; construct kinematic models to verify the strength and dynamic characteristics of the truss; develop practical deployment and packaging designs compatible with use of the Orbiter as a transportation vehicle and deployment platform; determine the optimum design parameters as a function of size and stiffness requirements; evaluate manufacturing and material options for joints and truss members; demonstrate by ground testing the practicality and performance of the system; and propose appropriate flight experiments and demonstrations.

W85-70603 **482-53-49**
Marshall Space Flight Center, Huntsville, Ala.
DEPLOYABLE TRUSSES FOR SPACE STATION
E. E. Engler 205-453-3950

Develop the structures and materials technology required to support the conception and development of the Space Station. The plan will demonstrate technology readiness by CY-87 in the following areas: assembly in space, environmental protection, damage assessment and repair. The work defined by this plan will be performed as follows: development, demonstration; and test of space assembly methods and associated hardware for assembly of Space Station modules; development and test of integral wall designs and penetration damage studies. The goal of this program is to develop, demonstrate, and document the required technology for use in the development, design, fabrication, and operation of the Space Station.

W85-70604 **482-53-53**
Langley Research Center, Hampton, Va.
ANALYSIS AND SYNTHESIS/SCALE MODEL STUDY
C. P. Blankenship 804-865-2042

New analytical methods applicable to deployment and robotic manipulation will be investigated. Specifically, a computer program for flexible-body deployment and robotic arm manipulation will be developed. A scaled structural dynamics model of a space station will be developed and constructed and the feasibility and limitations of testing such a model will be established. A feasibility study to establish limitations and benefits of the pathfinder model will be the first task.

W85-70605 **482-53-57**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION/ORBITER DOCKING/BERTHING EVALUATION
J. K. Hinson 713-483-2561
(506-64-27)

The overall objective of the effort described in this RTOP is to define, through rigorous analyses and simulations, the mechanism design requirements and proximity operations procedures for docking or berthing the orbiter to the Space Station. The docking and berthing processes will be evaluated using the Payload Deployment and Retrieval Systems Simulation (PORSS), the Shuttle Engineering Simulator (SES), and other existing simulations as required. Simulations will include dynamic modeling of the Remote Manipulator System (RMS)and the Space Station Reference Configuration, plume impingement effects, and orbiter systems. The final approach of the orbiter to contact of docking interfaces or RMS grapple and maneuvering to contact of berthing interfaces will be simulated. The output will be boundary conditions (contact velocities and misalignments) for design of the docking/berthing mechanism. The effects of subsystem failures will also be evaluated. An additional objective is to develop a math model which accurately reflects the contact forces produced by the RMS while performing berthing, assembly, or servicing tasks. This closed load path/constrained motion model is required to accurately represent the mechanical interface dynamics of a berthing device while under RMS control.

W85-70606 **482-55-42**
Lewis Research Center, Cleveland, Ohio.
SPACE STATION PHOTOVOLTAIC ENERGY CONVERSION
C. R. Baraona 216-433-5358

The objective is to demonstrate pilot production of 8x8 cm infrared transparent silicon solar cells which will lower array operating temperature and increase power output in orbit. The approach will be to have a contractor optimize the gridded back contact cell and the production process to obtain cell performance, throughout, and yield to satisfy space station requirements.

W85-70607 **482-55-49**
Marshall Space Flight Center, Huntsville, Ala.
SILICON ARRAY DEVELOPMENT AND PROTECTIVE COATINGS
M. R. Carruth, Jr. 205-453-4275

The objective of this RTOP is to provide the focused technology development necessary to provide state-of-the-art photovoltaics for the space station. Because the low risk fall back position for the space station will be utilization of a planar solar array, development of an advanced planar array to increase efficiency and lower cost will be performed. Several areas of development will be pursued. They are back grid contact cells and superstrate array blanket design and development of protective coatings for solar array materials. Solar cell modules will be designed and fabricated for various performance testing. A solar array modular wing design will be produced and full size panels fabricated and tested to evaluate design. Protective coatings will be evaluated and a data base generated through ground testing.

W85-70608 **482-55-52**
Lewis Research Center, Cleveland, Ohio.
SPACE STATION CHEMICAL ENERGY CONVERSION AND STORAGE
C. R. Baraona 216-433-5358

The objective is to demonstrate the technology readiness of the alkaline EMS and to extend the life endurance testing and performance data base. The approach is to design, build, and test a prototype alkaline regenerative fuel cell with 10 kW nominal power level that is 55% efficient and has a lifetime of more than 20,000 hours.

W85-70609 **482-55-62**
Lewis Research Center, Cleveland, Ohio.
SPACE STATION THERMAL-TO-ELECTRIC CONVERSION
A. F. Forestieri 216-433-6786

The objective is to develop analytic codes and model the performance of solar dynamic power systems, to solve the critical technology issues of concentrators, and to evaluate heat storage materials and receiver designs. Analytic codes will be provided and validated with actual solar dynamic performance data. Several 12 to 18 meter diameter concentrators will be developed and elements will be fabricated and tested. Heat receiver test capsule data will be determined and two heat receivers will be designed, fabricated, and tested.

W85-70610 **482-55-72**
Lewis Research Center, Cleveland, Ohio.
AUTOMATED POWER SYSTEM CONTROL
M. E. Valgora 216-433-6983

The objective is to develop a methodology, control laws, and models for automated operation of a large complex space station power system. The approach will be to develop automated power control and sensing techniques to minimize intervention by ground-based personnel of space station crew. Concepts to enable

automated control, such as state estimation, will be developed so as to be applicable to high voltage ac as well as dc systems.

W85-70611 **482-55-75**
Jet Propulsion Laboratory, Pasadena, Calif.
POWER SYSTEM CONTROL AND MODELLING
P. C. Theisinger 818-354-6094

The objective is to develop the LeRC Space Station power system. Two tasks are proposed. These are: (1) Automated Power System Control (LeRC UPN No. 481-20-05-03), and (2) Power system Modeling (LeRC UPN no. 481-20-42-02) Automated Power System Control: The general objective for this area is to develop candidate power system autonomy implementations, including processes, sensors and controls. Power System Modeling: The general objective for this area is to develop an integrated modeling and simulation tool which incorporates candidate Space Station power system technologies and is capable of performing conceptual and preliminary design modeling and simulation. The approaches are as follows: Automated Power System Control; the approach in this area is to review existing autonomy technology, to develop top level power system autonomy requirements, to design candidate autonomy implementations based upon the requirements, to identify critical enabling or enhancing technologies required by the implementations, and to develop the technologies equipped based upon the existing technology assessment. Power System Modeling; the approach in this area is to review existing models and simulation software, to define the required modeling and simulation function and the architecture that imposes, to identify areas of required upgrade or missing technology, and to develop and integrate the required models and simulation software.

W85-70612 **482-55-77**
Lyndon B. Johnson Space Center, Houston, Tex.
REGENERATIVE FUEL CELL (RFC) COMPONENT DEVELOPMENT ORBITAL ENERGY STORAGE AND POWER SYSTEMS
J. Dale Denais 713-483-2783
(506-55-57)

The objective of this research and development effort is to advance the fuel cell and electrolysis components to a 40,000-hour plus life. Components refers to the accessory section (pumps, valves, regulators, etc.) and not the electrochemical cells which make up the fuel cell and electrolysis stacks. The approach is to develop the acid and the alkaline RFC concepts for usage as the energy storage system in Space Station. Both of these concepts require research, design development and/or testing to demonstrate reliability and long life.

W85-70613 **482-55-79**
Marshall Space Flight Center, Huntsville, Ala.
AUTOMATED POWER MANAGEMENT
D. J. Weeks 205-453-4952

The objective of this RTOP is to provide the focused technology development necessary to provide automation of the distribution, management, and control of the common module electrical power system for Space Station. Automation evaluations shall be conducted to determine areas and extent appropriate for applications. Expert rule systems shall be developed and appropriate automated power management hardware and software shall result as products of this effort.

W85-70614 **482-56-86**
Goddard Space Flight Center, Greenbelt, Md.
SPACE ENERGY CONVERSION - TWO PHASE HEAT ACQUISITION AND TRANSPORT FOR SPACE STATION USERS
Stanford Ollendorf 301-344-5228

The objectives are to develop and test two-phase radiators, heat transport systems, controls and devices which transfer heat across boundaries and are unique to space station users. The approach is as follows: (1) to build and test heat exchangers, radiators, and flexible heat pipes at the breadboard level; (2) to develop algorithm for maintenance and control of two-phase heat transport system; and (3) to verify overall performance operation of a capillary pumped, two-phase acquisition system.

W85-70615 **482-56-87**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL MANAGEMENT FOCUSED TECHNOLOGY FOR SPACE STATION
J. G. Rankin 713-483-4941

The objective of this RTOP effort is to develop thermal control technology required to specifically support manned Space Station applications. Effort will be directed toward developing technology that satisfies the unique Space Station thermal management requirements of evolutionary growth, long life heat rejection, and user friendly thermal acquisition and transport. In the area of heat rejection, concepts will be developed for: (1) constructing radiators in space; (2) high capacity heat pipe designs for radiator or other thermal control applications; and (3) gimbaled or minimum environment seeking radiator systems to minimize radiator size and reduce sensitivity to thermal coating degradation from prolonged solar exposure. In the area of thermal acquisition and transport, a thermal bus will be developed to demonstrate the merits and limitations of this user friendly heat transport design. Also, design techniques will be developed for efficient coupling and decoupling of heat loads from the bus, and transferring heat into and out of the bus.

W85-70616 **482-56-89**
Marshall Space Flight Center, Huntsville, Ala.
MANNED MODULE THERMAL MANAGEMENT SYSTEMS
J. W. Owen 205-453-5503

The objective of this RTOP is to develop the technology for high capacity thermal storage, low power consuming refrigeration and freezers, and integral structural radiator systems for Space Station over a three-year period. Technology demonstration will be accomplished in a test bed environment. The effectiveness of body mounted radiators will be imperically derived. Control concepts for these radiators will be developed and scale demonstrations made. Thermal storage/heat transport system studies will be made to optimize location of storage devices. Requirements for Space Station refrigeration system will be developed and potential application of current cryogenic sytems will be evaluated.

W85-70617 **482-57-13**
Langley Research Center, Hampton, Va.
SPACE STATION CONTROL AND GUIDANCE/INTEGRATED CONTROL SYSTEMS ANALYSIS
L. W. Taylor 804-865-4591

The objective is to develop the control and display design techniques for integrated multi-disciplinary analysis to enable trades to be performed more efficiently. The space station configuration of loosely coupled modules will result in a highly flexible vehicle having several structural modes within the bandwidth of the control system. Therefore, the interaction of the control system and structure requires close examination to identify design shortcomings and to rectify them either through design or vehicle configuration changes to insure mission success. The approach will involve using high speed data networking systems to develop integrated capability between configuration, structures and control analyses, and synthesis software. Design studies will be conducted and optimal space station configurations will be developed. These tools will also facilitate the support of other space station studies. Control approaches to satisfy the control requirements associated with a large, highly flexible manned space station will be designed and evaluated with special attention to attitude maneuvering and highly flexible multi-module spacecraft with a large variety of mission requirements.

W85-70618 **482-57-39**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED CONTROLS AND GUIDANCE CONCEPTS
H. Buchanan 205-453-4582
(506-57-39)

The objective of this RTOP is to develop specific technology which will support the Space Station: adaptive rigid body control for an evolving station; non-contracting slip rings; and state electro-optical sensors. The techniques and devices developed

will become part of an integrated technology demonstration program. For controlling the time-varying system, an adaptive scheme relying on filters and gain coefficients determined as a function of measured system geometry will be examined. Simulation and stability analysis techniques will be used to determine performance. For non-contacting slip-ring application, a state-of-the-art optical data link providing two-way signal transfer at high rates will be designed and built. The development of a solid state electro-optical device will proceed from recent advances in charge injection devices technology and will include a focal plane device adaptable to a number of Space Station related applications.

W85-70619 **482-58-11**
Ames Research Center, Moffett Field, Calif.
EXTENDED NETWORK ANALYSIS
H. Lum 415-965-6544
(506-58-11)

The objective is to extend RTOP 506-58-11, Advanced Technology for Spaceborne Information Systems, both in the level-of-effort and in scope to support evaluation of detailed data network designs and development. The simulation is extended from the lower four layers of the International Standards Organization (ISO) reference model to provide models from the top application layer on down for local area networks.

W85-70620 **482-58-13**
Langley Research Center, Hampton, Va.
SPACE DATA TECHNOLOGY
Harry F. Benz 804-865-3535
(505-34-13; 506-58-13; 505-37-13; 505-37-23)

The objective of this focused technology effort is to exploit electronics related technologies for enhanced data management capabilities on space station. Specific areas of technology to be investigated include fiber optics transceiver modules, control/display interfaces, software fault tolerance and Ada software applications to distributed systems. Incorporation of Very High Speed Integrated circuits VHSIC and hardware fault tolerance technology will be carried out as appropriate. Theoretical and experimental research activities will be conducted both in house and under contract to develop concepts and technologies to a point of practical space application. Synergism with on going research and technology base data management activities will be maintained in order to promote maximum incorporation of promising concepts in those areas. Focused technology activities will be aimed at meeting FY-1987 readiness dates for space station utilization.

W85-70621 **482-58-16**
Goddard Space Flight Center, Greenbelt, Md.
SPACE STATION CUSTOMER DATA SYSTEM FOCUSED TECHNOLOGY
H. Plotkin 301-344-6218

The objective of this Space Station Focused Technology RTOP is to develop technology and perform system evaluations for an end-to-end system which satisfies unique customer requirements. The system must accommodate high data rates from a large variable set of spaceborne sources and interfaces. It must permit real time interactive display and control from a distributed network of terminals, both on the ground and in space and it must generate and provide access to data bases, archives and ancillary data. The tasks associated with Spaceborne Data Systems Elements are directed toward achieving the required performance in fiber optic networks, payload interfaces and protocols, bus interface units and gateways, network operating systems and user interface languages. Several tasks in the area of Ground Network Data System Elements will develop, evaluate and demonstrate new concepts in distributed data operations, data storage, archiving and retrieval, software tools and methodologies, user interface technology and high speed telemetry processing. Laboratories will be assembled in which breadboards of advanced technology elements may be tested and evaluated in a system environment. They will also be used for verifying compatibility of selected customer hardware, software and procedures. Hardware and software products from this Goddard RTOP will be tested in an integrated manner using the Data System Test Bed being developed at the Johnson Space Center under the Space Station Advanced Development Program. Testing will be conducted by physical transportation of components or by setting up remote communication links.

W85-70622 **482-58-17**
Lyndon B. Johnson Space Center, Houston, Tex.
DATA SYSTEMS INFORMATION TECHNOLOGY
Edgar Dalke 713-483-2851

The objectives of Task 1 are to provide analysis, definition, and development of a modularly structured end-to-end information and data network HW/SW system which supports automated and interactive operations. The space vehicle's HW/SW data system approach should support the needs imposed by remote and local multi-discipline users. The data system approach shall allow technology evolution and support in-space integration and verification. The development methodology builds upon the international Standards Organization/Open Systems interconnect (ISO/OSI) reference model and distributed relational data base management technology. Its emphasis will be to structure and specify controlled software interface levels for network and executive operating systems, and to establish standards and policies which would insure cost-effective integration of user/vehicle requirements. Another objective of this effort is cooperating with the DoD in their request for NASA participation in their field test efforts with Ada, and, in support of NASA Headquarters to produce a plan for agency transition to the Ada technologies in future NASA projects. The objective of task 2 is to test and evaluate the software technology products being produced by the DoD (Department of Defense) under the name Ada. These products will be evaluated for their suitability for use in the development and maintenance of software applicable to the end-to-end information and data network system described in task 1. Technology products associated with both of these tasks will be developed and examined for proof-of-concept in the data management system testbed.

W85-70623 **482-58-18**
John F. Kennedy Space Center, Cocoa Beach, Fla.
SPACE STATION OPERATIONS LANGUAGE
Jan Heuser 305-867-4074

The Space Station Operations Language (SSOL) is an English-Like user interface via which crew members as well as engineers and scientists may communicate with the Space Station or Payload system. It will be used for procedures or real-time commanding and for supporting integration test and operations on the ground or on-board. The approach encompasses the definition and refinement of user, functional, and interface requirements for the SSOL and its associated software environment. This task has been approved as a Space Station Program Budget Line Item (Ref. SSOL DEF UPN 481-10, KSC #PT-031).

W85-70624 **482-59-23**
Langley Research Center, Hampton, Va.
SPACE COMMUNICATIONS TECHNOLOGY/ANTENNA VOLUMETRIC ANALYSIS
W. D. Mace 804-865-3631

The objective is to develop the analytical techniques required to accurately predict the performance of the space station communications and tracking systems antennas, including the effects of the complex space station structures, operating from UHF into the millimeter frequency range. Three-dimensional analytical models of complex space station structures will be developed, deficiencies in SOA antenna performance prediction techniques for space station applications will be identified and extensions will be made to these techniques to satisfy space station prediction requirements. Antenna pattern coverage must be accurately known for all communications and tracking services required between the space station and other space vehicles.

W85-70625 **482-59-27**
Lyndon B. Johnson Space Center, Houston, Tex.
SPACE STATION COMMUNICATION AND TRACKING TECHNOLOGY
Kumar Krishen 713-483-5518

The objective is to develop microwave and optical communications and tracking systems technology for the space station aimed at: (1) reducing space station operational constraints and the risk/cost of operations; (2) providing lower cost alternatives to present technology; and (3) developing technology needed for cost-effective modular growth of the space station. The program is focused on advanced antenna, multi-access system, infrared (IR) and laser communications, laser and millimeter wave ranging/tracking systems, and advanced television technology. The approach is to establish requirements, perform analytical studies/computer simulations, develop conceptual designs, and breadboard the most feasible designs. A tradeoff of the technology implementations is then performed to yield the most cost-effective subsystem. Designs for multi-use antenna, IR intravehicular communications, and laser docking system were developed in FY-84. Partial breadboarding was also accomplished for the IR communication and laser docking systems. The plan for FY-85 is to initiate breadboard development in the antenna area, continue laser system development, initiate breadboard development for advanced TV, and develop design for the multi-access system.

W85-70626 **482-60-22**
Lewis Research Center, Cleveland, Ohio.
ADVANCED H/O TECHNOLOGY
Robert E. Jones 216-433-4000

The objective of this effort is to provide advanced hydrogen/oxygen thrustor technology for onboard propulsion applications including: space station, space platforms, spacecraft and vehicle auxiliary propulsion. The accomplishment of this objective will provide the Agency with auxiliary propulsion components and/or systems that meet both performance and life goals. Successful accomplishments will also minimize propulsion system propellant requirements and provide for minimum contamination of the spacecraft and associated scientific instruments.

W85-70627 **482-60-29**
Marshall Space Flight Center, Huntsville, Ala.
ADVANCED AUXILIARY PROPULSION
L. W. Jones 205-453-0709

The overall objective of the work described herein is to advance the technology based for low chamber pressure, gaseous oxygen/gaseous hydrogen propulsion systems applicable to the Space Station. The specific activity addressed in this RTOP is the definition of concepts for extracting and utilizing the waste heat rejected by the Space Station thermal control system to condition the propellants. This work will be accomplished by a combination of analytical studies and experimental investigations as appropriate.

W85-70628 **482-61-41**
Ames Research Center, Moffett Field, Calif.
SPACE STATION FOCUSED TECHNOLOGY EVA SYSTEMS/ADVANCED EVA OPERATING SYSTEMS
Joseph C. Sharp 415-965-5100
(506-64-31; 481-33-21)

The objective of this program is to advance the technology base for advanced extravehicular systems required to support long term space missions. The program objective includes technology to support initial space station EVA operations and future space station growth. Advanced extravehicular systems must provide for efficient and routine EVA capability. The program emphasis will be placed on technology areas that provide: no prebreathing requirement; improved hardware performance; increased hardware and system life; hazard protection; reduced manufacturing, maintenance and operations costs. The specific technology areas in this RTOP include: improved multiple bearing joint systems, hazard protection, including thermal, debris, ionization radiation, static charge buildup and sharp corners; manufacturing and materials technology. These technologies will be demonstrated and tested in fully functional space suit configurations.

W85-70629 **482-61-47**
Lyndon B. Johnson Space Center, Houston, Tex.
EVA SUIT TECHNOLOGY DEVELOPMENT
R. E. Mayo 713-483-4931

This RTOP is in direct support of the space station development program and reflects the recommendations made by the Crew and Life Support Working Group to the OAST Space Station Technology Steering Committee. The objectives are to develop the focused technology base for extravehicular space suit and life support system in support of a 1991 space station initial operational capability. These objectives are directed to provide higher operating pressure Extravehicular Mobility Unit configuration concepts that incorporate regenerable subsystems, on-orbit astronaut space suit resizing, and extended operating life to reduce EVA timeline, simplify crewmember procedures, and increase productivity.

W85-70630 **482-64-30**
Lyndon B. Johnson Space Center, Houston, Tex.
EVA PORTABLE LIFE SUPPORT SYSTEM TECHNOLOGY)
R. E. Mayo 713-483-4931

This RTOP is in direct support of the Space Station development program and reflects the recommendations made by the Crew and Life Support Working Group to the OAST Space Station Technology Steering Committee. The objectives are to develop the focused technology base for extravehicular space suit and life support system in support of a 1991 Space Station Initial Operational Capability. These objectives are directed to provide higher operating pressure extravehicular mobility unit (EMA) configuration concepts that incorporate regenerable subsystems, on orbit astronaut space suit resizing, and extended operating life to reduce EVA timeline, simplify crewmember procedures, and increase productivity.

W85-70631 **482-64-31**
Ames Research Center, Moffett Field, Calif.
PLATFORM SYSTEMS/LIFE SUPPORT TECHNOLOGY
J. C. Sharp 415-965-5100
(506-64-31)

The objective of this program is to develop critical crew and life support technology for the initial operating capability (IOC) and growth space station. This technology includes: air revitalization system integration; Bosch carbon dioxide reduction; chemical and biological contaminant control; nitrogen supply subsystem; and supercritical water waste oxidation.

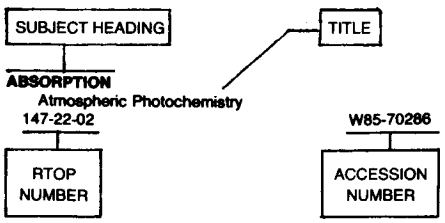
W85-70632 **482-64-37**
Lyndon B. Johnson Space Center, Houston, Tex.
FOCUSED TECHNOLOGY FOR SPACE STATION LIFE SUPPORT SYSTEMS
F. H. Samonski 713-483-4823

This RTOP is in direct support of the Space Station development program. It reflects the recommendations made by the Crew and Life Support Working Group to the OAST Space Station Technology Steering Committee and is consistent with the Space Station POP 84-2 submissions. The objectives are to secure a mature regenerative life support technology base for an early 1990's Space Station Initial Operational capability and to provide backup technology readiness in regenerative life support. The activities pursued under this RTOP are to be directed at process developments for the functions of atmosphere revitalization and water reclamation/waste management, and the development of the control and monitor instrumentation related to these processes.

RTOP SUMMARY

FISCAL YEAR 1985

Typical Subject Index Listing



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A

B

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F

G

H

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RTOP SUMMARY

FISCAL YEAR 1985

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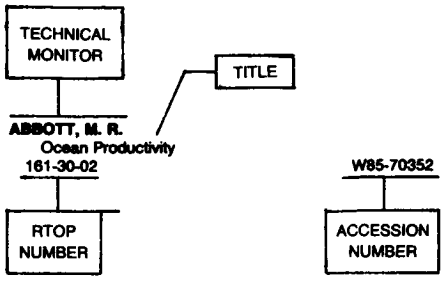

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A

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C

D

E

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N

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P

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V

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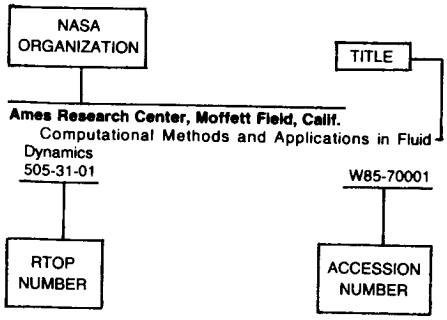
RESPONSIBLE NASA ORGANIZATION INDEX

RTOP SUMMARY

FISCAL YEAR 1985

Typical Responsible NASA Organization Index Listing



Listings in this index are arranged alphabetically by Responsible NASA Organization. The title of the RTOP provides the user with a brief description of the subject matter. The accession number denotes the number by which the citation and the technical summary can be located within the Summary Section. The titles are arranged under each Responsible NASA Organization in ascending accession number order.

A

Hugh L. Dryden Flight Research Center, Edwards, Calif.

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Lyndon B. Johnson Space Center, Houston, Tex.

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A Very High Speed Integrated Circuit (VHSIC) Technology General Purpose Computer (GPC) for Space Station
506-58-12 W85-70198
Data Systems Research and Technology - Onboard Data Processing
506-58-13 W85-70199
Multiple Beam Antenna Technology Development Program for Large Aperture Deployable Reflectors
506-58-23 W85-70206
Advanced Spacecraft Systems Analysis and Conceptual Design
506-62-23 W85-70217
Space Technology Experiments-Development of the Hoop/Column Deployable Antenna
506-62-43 W85-70221
Technology Requirements for Advanced Space Transportation Systems
506-63-23 W85-70223
Entry Research Vehicle Flight Experiment Definition
506-63-24 W85-70224
Shuttle Entry Air Data System (SEADS)
506-63-32 W85-70227
Shuttle Infrared Leeside Temperature Sensing (SILTS)
506-63-34 W85-70228
Shuttle Upper Atmosphere Mass Spectrometer (SUMS)
506-63-37 W85-70230
High Resolution Accelerometer Package (HiRAP) Experiment Development
506-63-43 W85-70233
Technology System Analysis Across Disciplines for Manned Orbiting Space Stations
506-64-13 W85-70236
Technology System Analysis Across Disciplines for Manned Orbiting Space Stations
506-64-14 W85-70237
On-Orbit Operations Modeling and Analysis
506-64-23 W85-70241
FILE/OSTA-3 Mission Support and Data Reduction
542-03-14 W85-70254
Space Flight Experiments (Structures Flight Experiment)
542-03-43 W85-70255
Space Flight Experiments (Step Development)
542-03-44 W85-70256
In-Space Solid State Lidar Technology Experiment
542-03-51 W85-70257
Long Duration Exposure Facility
542-04-13 W85-70260
Non-Destructive Evaluation Measurement Assurance Program
323-51-66 W85-70264
Development of the NASA Metrology Subsystem of the NASA Equipment Management System
323-52-60 W85-70266
PACE Flight Experiments
179-00-00 W85-70366
Crystal Growth Research
179-80-70 W85-70383
Biosphere-Atmosphere Interactions in Wetland Ecosystems
199-30-26 W85-70420
Terrestrial Biology
199-30-36 W85-70423
Early Atmosphere: Geochemistry and Photochemistry
199-50-16 W85-70431
Shuttle Tethered Aerothermodynamic Research Facility (STARFAC)
906-70-16 W85-70575
Long Term Space Exposure
482-53-23 W85-70597
Erectable Space Structures
482-53-43 W85-70601
Analysis and Synthesis/Scale Model Study
482-53-53 W85-70604
Space Station Control and Guidance?Integrated Control Systms Analysis
482-57-13 W85-70617
Space Data Technology
482-58-13 W85-70620
Space Communications Technology/Antenna Volumetric Analysis
482-59-23 W85-70624

Lewis Research Center, Cleveland, Ohio.

Internal Computational Fluid Mechanics
505-31-04 W85-70003
Propulsion Materials Technology
505-33-62 W85-70025
Propulsion Structural Analysis Technology
505-33-72 W85-70026
Graduate Program in Aeronautics
505-36-22 W85-70043
Joint Institute for Aerospace Propulsion and Power Base Support
505-36-42 W85-70046
Technology for Advanced Propulsion Instrumentation
505-40-14 W85-70055
High Thrust/Weight Technology
505-40-64 W85-70056
Intermittent Combustion Engine Technology
505-40-68 W85-70057
Aeronautics Propulsion Facilities Support
505-40-74 W85-70058
Advanced Propulsion Systems Analysis
505-40-84 W85-70059
Rotorcraft Propulsion Technology (Convertible Engine)
505-42-92 W85-70067
Helicopter Transmission Technology
505-42-94 W85-70068
Rotorcraft Icing Technology
505-42-98 W85-70069
Propulsion Technology for Hig-Performance Aircraft
505-43-52 W85-70078
Icing Technology
505-45-54 W85-70097
Advanced Turboprop Technology (SRT)
505-45-58 W85-70098
Aeronautics Independent Research
505-90-28 W85-70104
Turbine Engine Hot Section Technology (HOST) Project
533-04-12 W85-70121
Structural Ceramics for Advanced Turbine Engines
533-05-12 W85-70122
Advanced Turboprop Technology
535-03-12 W85-70125
Materials Science-NDE and Tribology
506-53-12 W85-70134
Submillimeter Wave Backward Wave Oscillators
506-54-22 W85-70155
Electric Propulsion Technology
506-55-22 W85-70167
Photovoltaic Energy Conversion
506-55-42 W85-70169
Electrochemical Energy Conversion and Storage
506-55-52 W85-70172
SP-100 and Solar Dynamic Power Systems
506-55-62 W85-70174
Power Systems Management and Distribution
506-55-72 W85-70176
Thermal Management
506-55-82 W85-70182
Satellite Communications Research and Technology
506-58-22 W85-70205
Earth-to-Orbit Propulsion Life and Performance Technology
506-60-12 W85-70210
Onboard Propulsion
506-60-22 W85-70212
Variable Thrust Orbital Transfer Propulsion
506-60-42 W85-70213
Communication Satellite Spacecraft Bus Technology
506-62-22 W85-70216
Spacecraft Technology Experiments (CFMF)
506-62-42 W85-70220
Systems Analysis-Space Station Propulsion Requirements
506-64-12 W85-70235
High-Pressure Oxygen-Hydrogen ETD Rocket Engine Technology
525-02-12 W85-70249
Flight Test of an Ion Auxiliary Propulsion System (IAPS)
542-05-12 W85-70261
Materials Science in Space (MSiS)
179-10-10 W85-70367
Microgravity Science Definition for Space Station
179-20-62 W85-70373
Microgravity Materials Science Laboratory
179-48-00 W85-70377
Reduced Gravity Combustion Science
179-80-51 W85-70380
Spectrum and Orbit Utilization Studies
643-10-01 W85-70466
New Space Application Concept Studies and Statutory Filings
643-10-02 W85-70468
Experiments Coordination and Mission Support
646-41-01 W85-70471
Space Communications Systems Antenna Technology
650-60-20 W85-70473
Satellite Switching and Processing Systems
650-60-21 W85-70474
RF Components for Satellite Communications Systems
650-60-22 W85-70475
Communications Laboratory for Transponder Development
650-60-23 W85-70476
Advanced Studies
650-60-26 W85-70477
Electrodynamic Tether Materials and Device Development
906-70-30 W85-70578
Resistojet Technology
482-50-22 W85-70592
Lubricant Coatings
482-53-22 W85-70596
Space Station Photovoltaic Energy Conversion
482-55-42 W85-70606
Space Station Chemical Energy Conversion and Storage
482-55-52 W85-70608
Space Station Thermal-To-Electric Conversion
482-55-62 W85-70609
Automated Power System Control
482-55-72 W85-70610
Advanced H/O Technology
482-60-22 W85-70626

M

Marshall Space Flight Center, Huntsville, Ala.

Program Support Communications Network
505-37-49 W85-70054
Aviation Safety - Atmospheric Processes/B-57
505-45-19 W85-70090
Advanced Space Structures Platform Structural Concept Development
506-53-49 W85-70145
Space Vehicle Structural Dynamic Analysis and Synthesis Methods
506-53-59 W85-70150
Multi-kW Solar Arrays
506-55-49 W85-70171
Multi-100 kW Low Cost Earth Orbital Systems
506-55-79 W85-70180
High Capacitance Thermal Transport System
506-55-89 W85-70185
Large Scale Systems Technology Control and Guidance
506-57-19 W85-70188
Teleoperator Human Factors
506-57-29 W85-70195
Data Systems Technology Program (DSTP) Data Base Management System and Mass Memory Assembly (DBMS/MMA)
506-58-19 W85-70204
Reusable High-Pressure Main Engine Technology
506-60-19 W85-70211
Advanced Orbital Transfer Propulsion
506-60-49 W85-70214
Conceptual Characterization and Technology Assessment
506-63-29 W85-70225
Space Systems Analysis
506-64-19 W85-70240
Teleoperator and Cryogenic Fluid Management
506-64-29 W85-70245
Advanced Space Shuttle Main Engine (SSME) Technology
525-02-19 W85-70250
Computerized Materials and Processes Data Base
323-51-05 W85-70263
Advanced X-Ray Astrophysics Facility (AXAF)
159-46-01 W85-70349
Ground Experiment Operations
179-33-00 W85-70374
MPS AR & DA Support
179-40-62 W85-70375
Containerless Processing
179-80-30 W85-70378
Bioseparation Processes
179-80-40 W85-70379
Solidification Processes
179-80-60 W85-70381
Crystal Growth Process
179-80-70 W85-70382
Ground-Based Observations of the Sun
188-38-52 W85-70385
Laboratory and Theory
188-38-53 W85-70387
Gamma Ray Astronomy and Related Research
188-46-57 W85-70397
X-Ray Astronomy
188-46-59 W85-70398
Advanced Mission Study - Solar X-Ray Pinhole Occulter Facility
188-78-38 W85-70400
Advanced Solar Physics Concepts - Advanced Solar Observatory
188-78-38 W85-70401
Gravity Probe-B
188-78-41 W85-70402
Coronal Data Analysis
385-38-01 W85-70450

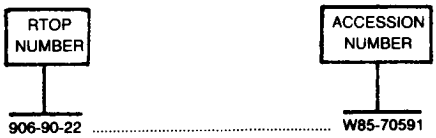
N

W

RTOP NUMBER INDEX

RTOP Summary

Typical RTOP Number Index Listing



This section may be used to identify the RTOP accession number of reports covered in this journal. Thus this section of this index may be used to locate the bibliographic citations and technical summaries in the Summary Section. The RTOP numbers are listed in ascending number order.

RTOP NUMBER INDEX

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-87394		

4. Title and Subtitle	5. Report Date
Research and Technology Objectives and Plans Summary Fiscal Year 1985	April 1985
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
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12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

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16. Abstract

This publication represents the NASA research and technology program for FY 1985. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objectives and 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. The first section containing citations and abstracts of the RTOPs is followed by four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number.

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