

Research **and** **T**echnology

Objectives

and **P**lans



SUMMARY

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FISCAL YEAR 1978

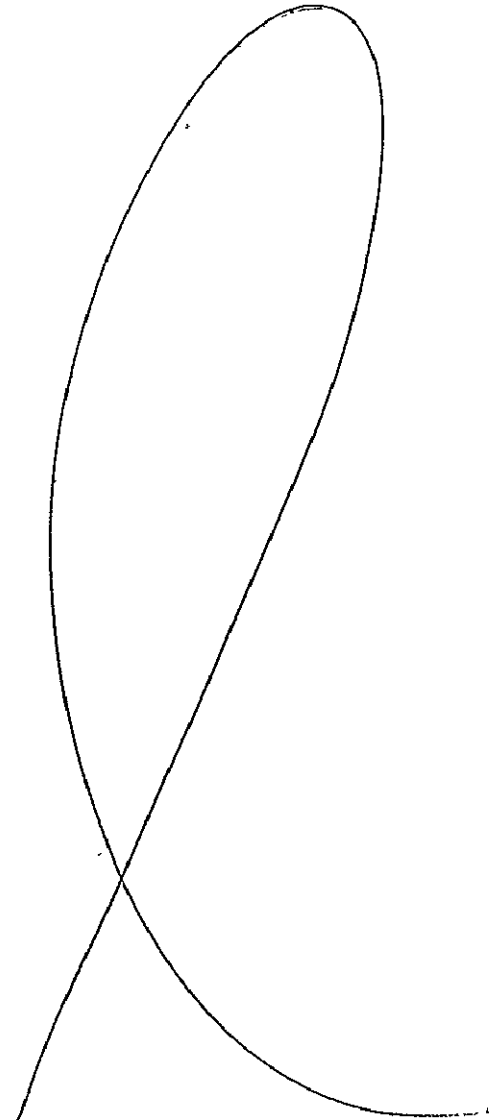
RESEARCH AND

TECHNOLOGY PROGRAM

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INTRODUCTION

This publication represents the NASA Research and Technology program for FY 1978. 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: Edna F. Templeton
Resources and Management Systems Division (RMP)

A handwritten signature in black ink, reading "James J. Kramer". The signature is fluid and cursive, with the first and last names being more prominent.

James J. Kramer
Acting Associate Administrator for
Aeronautics and Space Technology

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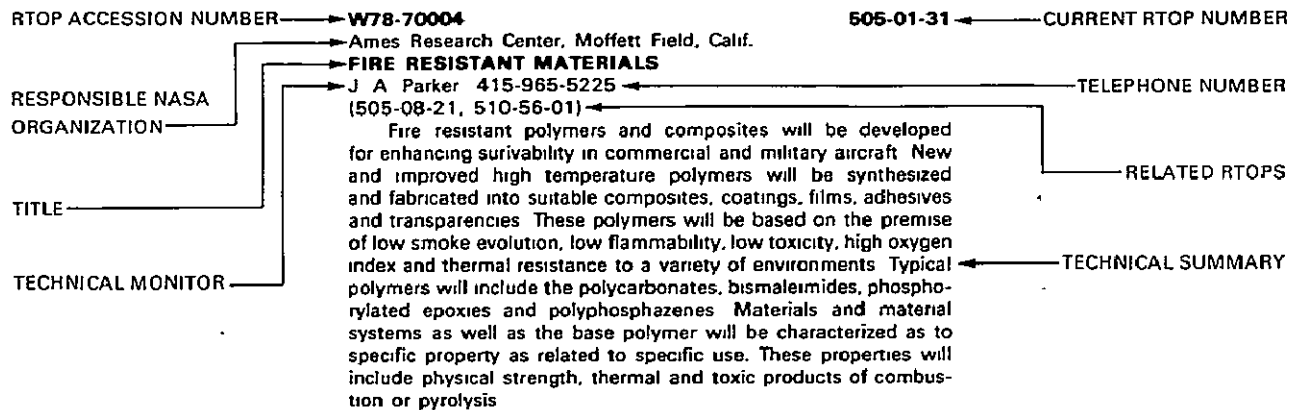
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TYPICAL CITATION AND TECHNICAL SUMMARY



RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS

a summary

FISCAL YEAR 1978

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics Research and Technology Base

W78-70001

505-01-12

Lewis Research Center, Cleveland, Ohio
ADVANCED PROPULSION MATERIALS
H B Probst 216-433-4000
(510-53-01, 506-16-12)

The objective of this RTOP is to provide improved materials (metallic and nonmetallic) and processes for use in advanced air-breathing propulsion systems, particularly for aeronautical applications. Materials are sought that offer improvements not only in technical performance but also in economy in terms of total life cycle costs. The classes of materials being investigated include directionally solidified eutectics, dispersion strengthened alloys, fiber reinforced superalloys, protective coatings, and ceramics. Basic research, both in-house and by university grants, relevant to the high temperature behavior of engine materials is conducted. Results of this basic effort then supply guidance for the more applications oriented program conducted in-house and by industrial contract. Material improvements are judged by mechanical and physical properties as well as quantitative evaluations of microstructural features and performance in simulated-engine environments. Ultimately, highly promising materials and processes that result from this program become candidates for the MATE program to accomplish scale-up and full scale engine testing. Emphasis is on advanced materials for aircraft gas turbine blades, vanes, disks, and seals. Specific phenomena encountered in the gas turbine are also studied, e.g., oxidation, hot corrosion, creep, and fatigue.

W78-70002

505-01-21

Ames Research Center, Moffett Field, Calif.
FATIGUE DAMAGE IN STEELS AND COMPOSITES
H. G. Nelson 415-965-6137
(778-11-02)

Experimental and analytical research will be continued to better understand the fracture behavior of metallic and composite structures in order to permit more efficient and reliable use of these materials in aircraft design. In metallic materials the emphasis will be placed on the development of an understanding of the mechanism of hydrogen degradation of low-strength ferritic alloys and austenitic alloys where degradation appears to result from hydrogen-dislocation interactions affecting deformation character at free surfaces or at a crack tip. Experiments will be conducted in order to establish the kinetic steps and absolute rate parameters associated with hydrogen chemisorption. This knowledge will be applied to the observed fracture behavior (crack growth) in ferritic and austenitic steels. In composite materials the emphasis will be placed on theoretical and experimental

studies directed toward the development of a damage growth law which will describe fatigue damage mechanisms in composite materials. This growth law will be used to help establish accelerated test programs which will enable the prediction of service durability of composite materials.

W78-70003

505-01-22

Lewis Research Center, Cleveland, Ohio
FATIGUE, LIFE PREDICTION METHODS AND FATIGUE CONTROL
M H Hirschberg 216-433-4000

The major objective is to obtain a better understanding of the failure mechanisms that are involved in the application of conventional as well as composite materials to aeronautical propulsion systems, so that presently available and advanced materials can be used more efficiently. A second major objective is to develop methods for predicting the life of specimens, as well as propulsion system components when they are subjected to constant temperature and monotonic loads, or to complex patterns of temperatures and cyclic loads as a function of time. To achieve these objectives, research is underway to extend existing life prediction techniques and analyses, to develop new methods for determining the stress and strain distributions in the vicinity of discontinuities such as flaws or cracks, as well as to understand the effect of these discontinuities on material behavior when subjected to various environmental conditions. In addition, microstructure as determined by composition and processing is being studied as an influence on the fracture properties of high strength alloys. Various approaches are also being examined for predicting the time to initiation of the first detectable cracks resulting from mechanical and thermal fatigue. Standard test methods are being developed to properly characterize the fatigue and fracture behavior of materials and to provide economical methods for alloy product quality control.

W78-70004

505-01-31

Ames Research Center, Moffett Field, Calif.
FIRE RESISTANT MATERIALS
J A Parker 415-965-5225
(505-08-21; 510-56-01)

Fire resistant polymers and composites will be developed for enhancing survivability in commercial and military aircraft. New and improved high temperature polymers will be synthesized and fabricated into suitable composites, coatings, films, adhesives and transparencies. These polymers will be based on the premise of low smoke evolution, low flammability, low toxicity, high oxygen index and thermal resistance to a variety of environments. Typical polymers will include the polycarbonates, bismaleimides, phosphorylated epoxies and polyphosphazenes. Materials and material systems as well as the base polymer will be characterized as to specific property as related to specific use. These properties will include physical strength, thermal and toxic products of combustion or pyrolysis.

W78-70005

505-01-32

Lewis Research Center, Cleveland, Ohio

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

COMPOSITES FOR PROPULSION COMPONENTS

T. T. Serafini 216-433-4000

(743-03-22, 510-57-02, 505-02-12)

The overall objective of this research is to develop metal matrix and polymer matrix composite materials with improved properties and processing characteristics for use in fabricating various aeronautical propulsion structural components. Recent cost-benefit studies show that the use of fiber reinforced composites in turbofan engines can provide significantly improved performance resulting in reduced fuel consumption and operating costs. Composites being considered include resin matrices reinforced with graphite, boron, Kevlar, and glass fiber, and aluminum matrices reinforced with boron and SiC fibers. In the metal matrix work, emphasis is placed on the development of fabrication processes and the improvement of impact resistance. In the area of polymer matrix composites, emphasis is given to developing moisture resistant resins, processable high-temperature resins, low-cost fabrication methods and correlating non-destructive evaluation (NDE) measurements with mechanical properties. Emphasis will also be placed on establishing the fundamental concepts necessary to provide quality assurance procedures and materials specifications for PMR polyimide matrix composites.

W78-70006

505-01-33

Langley Research Center, Langley Station, Va.

STRUCTURAL COMPOSITES AND ADHESIVES

N. J. Johnston 804-827-3041

The objective is to develop new or improved lightweight polymeric composite and metallic materials that have longer lifetimes, greater reliability and improved structural efficiency in aeronautical structures. Research will be aimed at improvement of structural resins and adhesives through systematic variation in polymer molecular structure and development of new or improved joining and fabrication methods for both metallic and composite materials. Research will also be directed at repair technology of composites including development of appropriate repair procedures and evaluation of their effectiveness. Studies of interfacial reactions and diffusion processes in advanced metal-matrix composites and structural alloys will also be made. Emphasis will be on relating service environments such as temperature and stress to corrosion behavior, and developing treatments which will substantially improve corrosion resistance. An additional objective is to quantify and study, with the aim to alleviate, moisture effects on polymer matrix composites and adhesive joints. These studies will help to identify new or advanced materials and processes for aeronautical structural applications and will provide important data on the behavior, capabilities and limitation of such materials.

W78-70007

505-02-12

Lewis Research Center, Cleveland, Ohio.

ENGINE COMPOSITE STRUCTURES

R. H. Johns 216-433-4000

(505-01-32, 510-57-02)

The general objective of this program is to develop the structures technology required to permit the timely introduction of composite materials into advanced turbine engine components such as fan blades, engine frames, blade containment systems and other structural components which can benefit from the unique strength, weight, and cost characteristics of composite materials. The initial program emphasis is on fan blade and fan blade containment systems. Engine frame and fan exit guide vane studies will also be undertaken. Fan blade and fan exit guide vane materials include graphite, boron, Kevlar, and glass fibers, and epoxy, polyimide and aluminum matrix materials. Hybrid systems consisting of selected fiber combinations will be developed for improved impact resistance, and superhybrid systems incorporating titanium and boron-aluminum plys within the composite layups will be used to obtain required local penetration resistance and blade torsional rigidity. Outer skin metallic layers will be incorporated as required for additional leading edge impact protection. Both ballistic impact and whirling arm impact tests under realistic temperature and moisture conditions will be used to evaluate material and design selections and to assess the effects of environmental variables. Fan blade containment

concepts utilizing both metallic and composite materials will also be evaluated by ballistic and spin impact tests to determine the containment effectiveness for both metal and composite blades and provide for comparative assessment of metallic and composite containment systems.

W78-70008

505-02-13

Langley Research Center, Langley Station, Va.

ADVANCED AIRCRAFT STRUCTURES

R. A. Pride 804-827-2869

(510-57-03, 505-01-33; 506-17-13)

The objective is to develop the technology required for obtaining improved efficiency and reduced costs in aircraft structures by the application of advanced composite materials and composite design concepts to commercial aircraft and by the investigation of thermal/structural concepts for high-speed aircraft. Research and development are being carried out to establish a technology base of advanced analytical methods for predicting the strength, stiffness, and stability of composite laminates, stiffened cover panels and shear webs. An adequate test data base is being established for substantiation. Effects of flaws and damage on composite component strength are being investigated. Confidence is being built in the use of composite aircraft components through longtime flight service programs on both commercial and military transport aircraft and helicopters. Outdoor environmental degradation of both materials coupons and structural components is being studied over ten-year exposure periods. Design methodology for structures and thermal control systems for high-speed vehicles is being developed by both experimental and analytical efforts on airframe concepts which will withstand the rigors of extended and repeated use in a high-speed environment. Research data obtained from both laboratory and wind tunnel experiments will serve to verify the design methods and provide guidance for future research.

W78-70009

505-02-14

Hugh L. Dryden Flight Research Center, Edwards, Calif.

HYPERSONIC AIRCRAFT STRUCTURES TECHNOLOGY

J. M. Jenkins 805-258-3311

The objective of this RTOP is to maintain a continuous line of research in the area of hot, radiating structures for hypersonic flight application. Using the heating and loading capabilities of the Flight Loads Research Facility (FLRF), heating and loading tests will be conducted on a laboratory test structure which represents a significant portion of a hot, radiating wing structure. Test results will provide information on design parameters, high temperature instrumentation, load calibration criteria, and performance data on beaded and tubular panels.

W78-70010

505-02-21

Ames Research Center, Moffett Field, Calif.

LOADS, AEROELASTICITY AND STRUCTURAL DYNAMICS

R. H. Petersen 415-965-6265

(505-06-21; 505-06-31, 505-10-21)

The objective of this RTOP is to develop the experimental and predictive techniques necessary to insure the successful development of advanced aeronautical systems for predicting unsteady aerodynamic loads and alleviating flutter, buffet and other undesirable aerodynamic phenomena. This research is specifically concerned with the prediction of unsteady aerodynamics of wings and rotors in the transonic speed range. To validate the prediction methods, an oscillatory apparatus is under development for testing two dimensional wings and rotor models in the Ames 11-by 11-foot transonic wind tunnel at Reynolds numbers to 12 x 10⁶. The wing models can be oscillated in any combination of pitch or heave, and a rotor section model can be programmed to simulate any periodic flapping and/or pitching motion of the blade. Analytical and numerical supporting research on unsteady transonic flow, with and without wind tunnel wall effects, will also be pursued.

W78-70011

505-02-23

Langley Research Center, Langley Station, Va.

LOADS, AEROELASTICITY, AND STRUCTURAL DYNAMICS

W. H. Reed, III 804-827-2265
(506-17-33, 743-01-03)

The objective is to develop and validate improved methods for the analytical determination of loads, structural response, and structural stability of aerospace systems considering the dynamic and aeroelasticity of the systems and structural interactions with flight control subsystems, 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, safety, and service life. Research will be conducted to provide more accurate unsteady aerodynamic theories, particularly in the transonic range. 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. Basic wind tunnel flutter studies will be used to gain a better understanding of the flutter characteristics of advanced aerodynamic configurations. Analysis/synthesis methods will be developed for use in interdisciplinary design support of future aircraft with advanced features such as active controls, aeroelastically-tailored wings and empennage, and propulsive lift augmentation. Methods will be developed and compared with experiment for predicting noise transmission through aircraft structures.

W78-70012 505-02-24
Hugh L. Dryden Flight Research Center, Edwards, Calif
FLIGHT LOADS AND AEROELASTICITY
J. M. Jenkins 805-258-3311

This RTOP has three primary purposes: (1) to study unsteady aerodynamic loads and flutter suppression at transonic speeds using an RPRV aircraft, (2) to evaluate the state of the art in prediction techniques of aerothermoelasticity, dynamic response, and structural mode control of the B-1 aircraft, and (3) to study airload measurement techniques on large, flexible aircraft.

W78-70013 505-02-33
Langley Research Center, Langley Station, Va
STRUCTURAL DESIGN METHODS
H. G. McComb 804-827-3121
(506-17-23; 743-01-03)

The objective is to provide improved methods for predicting the fatigue life and increasing damage tolerance of aircraft structures, for predicting and improving crashworthiness, and for advanced computer-aided analysis and design. To accomplish this objective it will be necessary to: (1) develop and demonstrate energy-absorbing concepts for general aviation aircraft structures to provide significantly improved crashworthiness; (2) assess the crash response behavior of composite structures; (3) determine the energy absorption characteristics of composite components; (4) develop qualitative analytical modeling capability for design of composite structures for specific fatigue service loadings, and (5) assess impact of advanced computer hardware on analysis and design methods.

W78-70014 505-03-11
Ames Research Center, Moffett Field, Calif
NOISE REDUCTION TECHNOLOGY FOR SHORT-HAUL AIRCRAFT
C. T. Snyder 415-965-5567
(505-10-41).

The work described in this RTOP will provide the technology for the reduction of noise of short-haul aircraft through wind tunnel measurements, large-scale data on the relative velocity effects on noise of modern turbofan and jet engines. Several experiments on forward velocity effects on jet noise were conducted in the 40- by 80-foot wind tunnel. The data from these studies will be reduced and analyzed in some depth. In addition, joint programs with RAE and ONERA will be conducted to prove and compare methods of jet noise measurements in wind tunnels. Experiments will be conducted with a JT-15D fan engine, modified to reduce core stator rotor interaction noise, and an analytical evaluation of the noise coupling of the wind tunnel turbulence with the fan rotor will be conducted to verify

that the 40- by 80-foot wind tunnel can be used for fan noise measurements.

W78-70015 505-03-12
Lewis Research Center, Cleveland, Ohio
NOISE REDUCTION TECHNOLOGY
C. E. Feiler 216-433-4000

The objectives of this RTOP are to provide data and a technology base for reducing aircraft propulsion-generated and associated noise with minimum weight, performance, and economic penalties and to develop techniques for accurate prediction of noise levels of operating and future aircraft. The generation and propagation of noise from all engine sources, both internal and external, are addressed. These include the turbomachinery (fan, compressor, turbine), core engine (combustor, internal surfaces) and the jet noise. In addition, the jet/surface interaction noise sources are addressed (flaps, reverser). Acoustic suppression (duct treatment) is a major element of the work. The work is distributed among basic research that provides knowledge of the fundamental principles and phenomena present in noise generation and propagation, applied research that explores concepts, and provides a data base, and demonstration of technology on full-scale engine systems. In-house activities are balanced by a number of contractual programs including university grants. In-house facilities include the Engine Fan and Jet Noise Facility (W-2) for model fan and jet experiments, several hot and cold flow jet rigs and two outdoor engine stands capable of full-scale engine tests including thrust performance. Forward velocity experiments are conducted in the 9x15 low speed wind tunnel and a 24-inch diameter free jet.

W78-70016 505-03-13
Langley Research Center, Langley Station, Va.
PROPULSION NOISE RESEARCH
H. H. Hubbard 804-827-3577
(505-09-13; 505-10-43, 505-05-23)

The objective of this research is to provide data and technology base for reducing aircraft propulsion generated noise with minimum weight, performance, and economic penalties, and to develop techniques for accurate prediction of ground noise levels of operating and future aircraft. Both theoretical and experimental noise reduction and control studies are involved, and work will be accomplished in-house and by grants and contracts. Emphasis in the experimental portion of the program is on laboratory and scale model experiments under closely controlled conditions with supplemental acoustic range and flight vehicle studies for validating theoretical methods and concepts. Included are the following specialty areas: precision measurements and calculations of the sound fields inside ducts with airflow, with varying geometry and with and without acoustic liners, advanced acoustic materials technology, optimization methods for design of acoustic liners; forward motion effects on inlet noise and jet exhaust noise, identification and location of sound sources in flow fields, noise generation by viscous flow fields and flow-surface interactions, atmospheric propagation including refraction and scattering, prediction of propeller noise, design of quiet and efficient propellers for general aviation aircraft; development and validation of single event flyover noise exposures from general aviation and CTOL aircraft and helicopters; and development of advanced methods of noise measurement and analysis.

W78-70017 505-03-15
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
BASIC NOISE RESEARCH
P. F. Massier 213-354-3549

The general objectives of this RTOP are: (1) to find methods of reducing jet noise by controlling the noise sources, (2) to determine how core flow disturbances increase the radiated noise from jets with the ultimate goal of developing efficient means of reducing jet noise emission by reducing core flow disturbances, (3) to develop prediction models for evaluating forward flight effects on jet noise and on core noise based on experiments, (4) to develop and evaluate methods of reducing jet noise for aircraft in flight, (5) to determine the source of 'jet crackle' and possible methods of reducing this source of noise, and (6) to

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determine the role of large scale coherent structures on jet noise production. Experiments of supersonic, subsonic and coaxial jets over a temperature range up to about 2000 F are conducted in an anechoic chamber, and at ambient temperature in a reverberant chamber. Fluctuating quantities are measured with hot wire probes, crossed laser beams and microphones. Shadowgraph and schlieren techniques are used for flow visualization. High-speed schlieren movies are also obtained and synchronized with signals from instruments that are used to measure fluctuating quantities.

W78-70018

505-03-22

Lewis Research Center, Cleveland, Ohio

PULSION POLLUTION REDUCTION RESEARCH

Donald A. Petrash 216-433-4000
(505-04-32, 511-55-02)

The objective of the programs conducted under this RTOP is to develop, evaluate and demonstrate combustor and general aviation intermittent combustion engine technology that will significantly reduce engine emission pollutants without adversely affecting efficiency, operating range, durability, and temperature distribution, and, that will meet future environmental standards. Fundamental combustion studies will be conducted in flame-tube type facilities to gain a better understanding of pollutant formation which in turn will be used to develop analytic models of the fundamental combustion process and the factors affecting pollutant formation. Investigations in combustor sector and full-scale facilities will be aimed at providing the technology base for the design of advanced combustor concepts to meet 1981 and future aircraft emission standards. Studies to evaluate and verify the adaptation of this emission reduction technology to modern aircraft engines will be undertaken in sector and full-scale facilities and in engine tests. Programs will be conducted to establish current emission levels to determine the emission reduction potential of minor (near-term) engine modifications, and to develop the technology required for longer-term solutions for reducing pollution from aircraft piston engines.

W78-70019

505-03-23

Langley Research Center, Langley Station, Va

BASIC COMBUSTION AND POLLUTION RESEARCH

C. J. Jachimowski 804-827-2065

The objectives of this research are the following: (1) to develop a chemical kinetic model that describes the combustion of a jet fuel and the formation of nitric oxide by the systematic study of the combustion mechanisms, reaction kinetics, and nitric-oxide formation kinetics for increasingly complex hydrocarbon fuels, and (2) to experimentally investigate the effect of fuel structure and composition on the optical properties of flame-generated soot. The facilities used in these studies include a chemical shock tube, a jet-stirred combustor, and a high-pressure burner.

W78-70020

505-03-25

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GAS TURBINE ENGINE POLLUTION REDUCTION TECHNOLOGY

W. A. Menard 213-354-5153

Unconventional combustor design concepts for application to aircraft gas turbines are being evaluated for their potential for providing significantly reduced emissions of oxides of nitrogen while maintaining efficient combustion. The central conceptual approach is to minimize NO formation rates by reducing flame temperature with off-stoichiometric burning. Under continuing evaluation is the feasibility of implementing the H₂ enrichment concept to provide for ultralean burning in the primary heat release zone of the combustor. Emphasis is placed on establishing an experimental burner configuration that demonstrates stable, high efficiency combustion with low pollutant emissions over a range of inlet air state conditions typical of contemporary, high performance turbine engines. A new intermediate objective for FY-78 is to extend ongoing work, which uses mixtures of neat H₂ and jet fuel, to the utilization of a H₂ bearing 'fuel gas' mixture such as can be produced from the partial oxidation or precombustion of jet fuel. For this intermediate feasibility evaluation a simulated product fuel gas is supplied from high

pressure bottle storage to the JPL research burner. There it is admixed with additional air and jet fuel and burned. Combustion and pollutant emissions are characterized. Providing that feasibility of using such a fuel gas is demonstrated, future efforts would emphasize incorporating a fuel rich precombustion stage in a two stage combustion system. Rich burning of hydrocarbons is insufficiently understood to specify at this time even a conceptual design for a thermal reactor required for a precombustion stage. Fundamentals of rich burning of fuels appropriate to current and future jet fuels will be investigated on a variety of laboratory burners. A conceptual design of a thermal reactor is the immediate objective of this portion of the work.

W78-70021

505-04-12

Lewis Research Center, Cleveland, Ohio

INLET AND NOZZLE RESEARCH

D. N. Bowditch 216-433-4000

Improved analytical and experimental design methodology for inlets and nozzles will be generated to achieve higher performance with increased propulsion system stability. Computer analysis programs for predicting internal flows will be synthesized in-house and by contracts and grants. These programs will make it possible to analyze viscous and inviscid flows in two and three dimensions. Inlet and nozzle hardware will be tested to guide and verify the analysis and to conduct exploratory research in areas that are not presently amenable to analysis. Also, benchmark testing will be done to define detailed flow phenomena. Analysis will be used to design components for focused applications such as SCAR or military applications which will be tested in 10x10 SWT, 8x6 SWT, CE22 or PSL.

W78-70022

505-04-13

Langley Research Center, Langley Station, Va

PULSION SYSTEM INTEGRATION

J. F. Runckel 804-827-2676

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

W78-70023

505-04-22

Lewis Research Center, Cleveland, Ohio

FAN, COMPRESSOR AND TURBINE TECHNOLOGY

M. J. Hartmann 216-433-4000

(511-51-02)

Approaches to improve efficiency, operating range, distortion tolerance, durability and reliability and to reduce weight, volume and cost of the wide variety of fans and compressors required for advanced propulsion systems will be investigated. Analytical methods to improve accuracy of performance prediction to reduce the time, cost and risk of incorporating advanced fans and compressors into future engine development programs will be developed and compared to experimental data obtained in advanced single and multistage compressors. The objective of the turbine program is the attainment of increased life and improved performance through improved design methods for both axial and radial flow turbines. Both analytical and experimental studies of the basic behavior of the mainstream fluid and boundary layers in the flow channels and in the cooling passages of turbine rotor blades, stator vanes, end walls, and rotor disks are being made. Transient heat transfer studies and analyses of stress and deformation of metals and ceramics are made for cooled turbine parts to identify critical areas and thereby improve life prediction.

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techniques. The work is conducted through in-house, contract, and university grant efforts

W78-70024

505-04-32

Lewis Research Center, Cleveland, Ohio

COMBUSTION AND AUGMENTATION SYSTEMS TECHNOLOGY

D. A. Petrash 216-433-6860

(505-03-32; 505-04-52, 511-55-02)

This RTOP covers base technology for combustors and augmentors to achieve high performance, low emissions and good durability at operating conditions typical of advanced commercial and military gas turbine engines. A swirl-can combustor will be developed for use in the High Pressure Facility (HPF) both as a heat source for the turbine rig and also as a research combustor for studies of high pressure combustion. A variety of new, staged combustor concepts will be investigated - in sector rigs at low pressure and in annular test facilities at 120 psia. Developed versions of these combustors will be tested in HPF at 580 psia. Combustion studies at high pressure will emphasize measurements of flame radiation, liner heat flux, NOX - pressure relationships, smoke-pressure relationships and combustor space rate. Conventionally designed combustors will be tested at high pressure to obtain these data. Advanced combustor performance improvements will be measured against this base-line. In addition, small reverse flow combustors will be studied to improve fuel injection, liner cooling, durability and emissions. Laser analysis of fuel sprays from advanced injectors will be conducted at ambient and high (400 psia) pressures. The low frequency instability of advanced military engine augmentors is being investigated.

W78-70025

505-04-42

Lewis Research Center, Cleveland, Ohio

POWER TRANSFER RESEARCH

W. J. Anderson 216-433-4000

(506-16-22, 511-54-02, 511-58-02)

The objectives of this work are to advance the technology for bearings, shaft seals, gas path seals, gears, shafts, lubricants, lubrication systems and mechanical power transmissions to achieve improved performance, life, reliability, efficiency, and reduced weight in the high-temperature, high-pressure, and high speed environments of turbojet and turbopropeller engines, and mechanical power transmission systems. Improved bearing, gear and seal and lubricants, bearing, gear and seal design theories and lubrication systems materials will be developed for the extreme conditions of advanced aircraft turbojet and turbo propeller engines and mechanical power transmission systems. Analytical techniques for balancing, determining and controlling the dynamic behavior of shafts and rotors will be developed and corroborated experimentally to provide better design tools for high-speed turbomachinery, shafting and transmissions.

W78-70026

505-04-52

Lewis Research Center, Cleveland, Ohio

FUELS RESEARCH

Donald A. Petrash 216-433-6860

(505-04-32, 505-03-32; 511-55-02)

The potential properties of future aviation turbine fuels derived from nonpetroleum sources such as oil shale and coal will be determined by synthesis and characterization techniques. The effects of these fuels, as well as petroleum-based fuels, synthesized to broader specifications than currently required on the performance and durability of jet engine components and materials, will be determined. Sufficient quantities of these fuels must be procured and/or simulated by blending of petroleum-based fuels and will be used to conduct research tests required to evolve the technology that may be needed to use these fuels in current and future jet aircraft engines. A joint program has been developed with the AFAPL and Lewis to implement an overall integrated effort to best utilize the technical capabilities of the AFAPL and Lewis to conduct the various activities necessary in conducting this program. Cooperative efforts on contract funding and management, and in-house test activities are currently underway and will be used throughout the planned life of this program. Overall coordination with other government agencies, such as

the USN, ERDA, EPA, and with industry will also be maintained in order to provide proper direction and scope to the program as it develops and proceeds

W78-70027

505-04-62

Lewis Research Center, Cleveland, Ohio.

PROPULSION INSTRUMENTATION RESEARCH

N. C. Wenger 216-433-4000

Present efforts in propulsion research are often limited by the inability to make rapid and precise measurements of the parameters of interest. Rapid advances in propulsion technology have in many cases pushed conventional instrumentation techniques to their limits. Further work on improving conventional instrumentation and measurement techniques will probably result in only incremental improvements. The objective of this RTOP is to expand the instrumentation technology base and to explore new concepts that have the potential for significantly advancing present measurement capabilities. Particular emphasis will be placed on six critical areas that have been identified as serious impediments to full scale engine and component testing. They are: (1) turbine blade temperature measurement; (2) gas temperature measurement; (3) gas flow measurement; (4) blade tip clearance measurement; (5) blade flutter measurement; and (6) rotary instrumentation systems. New and improved measurement concepts and techniques in each of the six areas will be explored with each study culminating in an experimental demonstration of a prototype instrument-or system.

W78-70028

505-05-12

Lewis Research Center, Cleveland, Ohio.

PROPULSION CONTROLS RESEARCH

D. I. Drain 216-433-4000

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

W78-70029

505-05-22

Lewis Research Center, Cleveland, Ohio.

ENGINE DYNAMICS AND PERFORMANCE RESEARCH

Ross G. Willoh 216-433-4000

The objective of this program is to provide an improved technology base for future engine system development. Experimental and analytical efforts are undertaken to acquire understanding and to improve the technology base for the various technical disciplines associated with the detailed behavior, both dynamic and steady-state, of the complete engine system. The objectives will be accomplished through research sub-programs on advanced subsonic and supersonic civil and military engines. Particular emphasis will be placed on seeking understanding and solutions for the dynamic interaction problems encountered when engine components are combined to form an engine system. The sub-programs will include investigations in areas such as aeromechanical instability, the use of mixers to improve turbofan engine fuel consumption, fan and compressor performance, inlet distortion and the performance of various components. The overall program is primarily concerned with significant technical areas where large discrepancies exist between theory and actual performance. Engines currently in the program include J85-21, TF-30, F-100 and the TF-34.

W78-70030

505-05-32

Lewis Research Center, Cleveland, Ohio.

V/STOL PROPULSION RESEARCH

Albert G. Powers 216-433-4000

An efficient, lightweight, reliable lift/cruise propulsion system is a critical requirement for the successful design of V/STOL

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aircraft The technology base to provide the required system will be developed in selected critical areas which are unique to the V/STOL concept Analytical and experimental analysis will be conducted in the aerodynamics of engine inlets and thrust deflectors

W78-70031

505-05-43

Langley Research Center, Langley Station, Va
HYPERSONIC PROPULSION TECHNOLOGY
R A Jones 804-827-2803
(517-52-03)

Program is aimed at the development of concepts for airframe-integrated, airbreathing propulsion systems to operate at speeds from Mach 3 to 10. Theoretical and experimental studies are conducted in fuel injection, subsonic and supersonic combustion, and 3-D turbulent reacting flows in ducts of complex geometry having lateral pressure gradients in order to advance prediction and design techniques Component investigations are conducted in-house with Langley facilities on inlets, which are applicable to several types of engines, and combustor and nozzle designs for modular scramjet engines Performance and design optimization tests are performed with complete but subscale, boiler-plate type engine models at Mach 7 conditions in the Langley Scramjet Facility Equipment received from Lewis Plumbrook is being installed in an existing Langley Propulsion Test Cell to provide a capability for test of complete, component integration models at Mach 4 The in-house program is augmented in several areas by R&D grants and contracts Design studies are conducted both in-house and under contract on flight-weight, fuel-cooled engine structures and systems This program is focused on providing the technology for lightweight, fixed geometry, airframe-integrated scramjet engine modules using a dual mode of H2 fuel injection to control mixing and combustion for a wide range of flight speeds This engine technology will also provide efficient propulsion for either cruise aircraft, accelerating and maneuvering aircraft, or with hydrocarbon fuel, high-speed highly maneuverable missiles

W78-70032

505-05-52

Lewis Research Center, Cleveland, Ohio
ADVANCED ENGINE SYSTEM CONCEPTS
R. J. Weber 216-433-4000

Studies will be performed of engine cycles, complete propulsion systems, and integrated engine/airframe combinations applied to representative airplane missions. The object of the studies is to determine desirable engine component and system design characteristics for future aircraft and to identify technology deficiencies and profitable areas for research The studies will explore the opportunities for satisfying environmental and natural resource constraints and their related impact on propulsion system selection and aircraft performance Supporting efforts will be included to develop new or improved techniques for estimating the cycle performance, weight, and other characteristics of advanced engine concepts.

W78-70033

505-05-62

Lewis Research Center, Cleveland, Ohio
ADVANCED GENERAL AVIATION PROPULSION RESEARCH
E A Willis 216-433-4000
(505-03-22)

The objectives are to (1) improve conventional spark-ignited engines; and (2) define the technology base for, and promote the development of, the most promising alternative engine(s) for general aviation use in the late 1980's The specific improvements and/or capabilities sought are multi-fuel; lower BSFC, weight, cost, and maintenance; and improved reliability--while still meeting the 1979 emission requirements Conventional spark-ignition engine improvements are being defined through improved analytical techniques and the use of advanced or new technology. Alternative engines are being defined through studies and experimental engine tests, supplemented by experimental investigations in key technology areas The specific work in this program is supported by contracts, grants, and Lewis in-house studies and experimental programs

W78-70034

505-06-11

Ames Research Center, Moffett Field, Calif
ANALYTICAL FLUID DYNAMICS
V. L. Peterson 415-965-5265
(505-15-31, 505-06-21)

The specific objective is to develop the capability for calculating complete aerodynamic characteristics of given complex aircraft shapes such that new configurations, optimized for specific missions, can be designed to a degree that new concepts can be evaluated and screened with reduced testing, time, and cost Efficient codes will be developed to solve fluid dynamics problems on large serial, parallel, and vector processing computers for the complete spectrum of flight speeds, from low subsonic, transonic, to supersonic, and for steady and unsteady, inviscid and viscous flow over two- and three-dimensional configurations Fundamental experiments will be performed to verify these codes and to provide the necessary modeling of turbulence The Reynolds number domain will extend from the relatively low values existing in conventional wind tunnels up to the practical range for existing and future aircraft Preliminary design studies will be performed for the Numerical Aerodynamic Simulation Facility, which will have the capability for solving the equations of fluid dynamics at speeds two to three orders of magnitude faster than possible now with general purpose computers The proposed facility is to serve as an engineering tool for obtaining numerical simulations in ten minutes for time-averaged viscous flows over three-dimensional configurations at flight Reynolds numbers The preliminary design study for this facility will provide sufficient information to begin detailed logic and hardware design as well as to determine cost, performance, and reliability

W78-70035

505-06-13

Langley Research Center, Langley Station, Va
COMPUTATIONAL AERODYNAMICS
P J Bobbitt 804-827-2627
(505-06-23, 505-06-53)

The purpose of this research is to develop the capability for calculating complete aerodynamic characteristics of given complex aircraft shapes and for defining new aircraft shapes aerodynamically optimized by numerical methods for various mission scenarios to a degree that preliminary aerodynamic concepts can be developed, evaluated and screened with reduced test time and cost Analytical and numerical procedures will be developed for the prediction of flow fields, pressure distributions, aerodynamic characteristics, skin friction and heat transfer for inviscid, viscous and coupled inviscid-viscous flows with attached and separated boundary layers, detached lee side flows with vortex formation and other interactions Both linear and nonlinear, exact and approximate flow equations will be applied as appropriate. Mathematical techniques required typically depend on the problem, however, finite-element, finite-difference relaxation, time-asymptotic, characteristics and integral methods are the most commonly used for solving nonlinear problems Linear problems will generally be solved by the distribution of various types of singularities whose strengths are determined by the solution of a matrix equation Several viscous and inviscid problems requiring large computer storage and/or time will be programmed for the STAR with particular emphasis on efficient explicit solution algorithms Research on inviscid-flow methods will concentrate on subsonic and transonic flows while viscous techniques will also involve supersonic flows.

W78-70036

505-06-21

Ames Research Center, Moffett Field, Calif
TURBULENCE AND MODELLING
Leonard Roberts 415-965-6116
(505-06-41; 505-06-31; 505-06-51)

The objective is to conduct analytical and experimental investigations into complex turbulent flow fields. Three specific tasks are considered (1) aerodynamics of turbulent flows interacting with shock waves, highly curved bodies and general three dimensional surfaces, (2) the interaction of electromagnetic waves and complex turbulent flow fields, and (3) the reduction of aerodynamic noise on short-haul aircraft. In the study of interacting turbulent flow fields, the emphasis is placed on obtaining detailed, accurate experimental data that may be used

to mathematically model the turbulence structure for use in analytical prediction techniques. The electromagnetic wave/turbulence interaction study consists of both theoretical and experimental efforts aimed at predicting the distortions of visible and near infrared radiation, and includes the use of advanced aerodynamic instrumentation on a full-scale flight test to observe turbulence at actual flight conditions. Special emphasis on airframe noise reduction is being placed on flap noise, since this high-lift device is paramount for short-field performance, and on bluff-body components such as landing gear struts and wheels. A parallel theoretical effort for the prediction of noise generated by flaps and landing-gear components is also underway.

W78-70037**505-06-23**

Langley Research Center, Langley Station, Va.

DRAG REDUCTION

D M Bushnell 804-827-4546

(505-06-13; 505-06-43, 505-06-53)

This RTOP involves research to significantly improve our ability to predict and control the behavior of general turbulent shear flows including boundary layers, free shear layers and recirculating/vortex flows. It includes theoretical and experimental research is needed to (1) reduce turbulent skin friction drag, (2) identify sources of and minimize airframe noise, (3) control stream disturbances in supersonic/hypersonic tunnels, and (4) improve understanding of physics/structure of turbulent shear flows and turbulence modeling for computational fluid dynamics. Drag reduction research investigates moving/compliant walls, fixed transverse and longitudinal surface waves, particle and slot injection, primarily for eventual CTOL transport application. Airframe aerodynamic noise effort determines acoustic characteristics of turbulent flows generated by components such as slats, landing gear, wheel wells and flaps, and investigates noise reduction methods for these flows and their interactions. Free stream turbulence research develops laminar flow nozzles and noise shields to improve validity of wind tunnel measurements, especially for data where transition and flow separation are present. Detailed experiments, using hot wires and LV/Raman systems, provide data for development and validation of turbulence closure models in three-dimensional boundary layers, three dimensional free mixing and corner/recirculating/vortex flows.

W78-70038**505-06-31**

Ames Research Center, Moffett Field, Calif.

AIRFOIL AND WIND DEVELOPMENT

Leonard Roberts 415-965-6265

(505-02-21; 505-06-51)

The objective of this RTOP is to develop analytical, numerical and experimental procedures to assist in the design of advanced airfoils and rotors. A key element of this program consists of a research project into the unsteady aerodynamics of pitching and plunging airfoils in subsonic and transonic flows. Research is underway on wind tunnel wall effects in unsteady flow, unsteady flow visualization and unsteady flow field measurements as well as conventional unsteady pressure measurements. Computer codes are under development for predicting steady and unsteady flows about airfoil sections and complete wings. Coordinated theoretical and experimental studies will be made to develop methods for the analysis and optimization of multi-element airfoils and wings. Emphasis will be placed on configuration optimizations for maximum lift, improved multielement airfoil drag analysis, and the analysis of three dimensional flows over finite wings with high lift devices.

W78-70039**505-06-33**

Langley Research Center, Langley Station, Va.

ANALYSIS AND DESIGN

P. K. Pierpont 804-827-4517

The Advanced Technology Airfoil Research (ATAR) Program is to provide analytical methods and computer codes coupled with experimental procedures and test facilities for the design and development of airfoils and airfoil systems in both steady and nonsteady flows and to employ these tools to design, develop, and evaluate new airfoils, wing profiles, and blade sections to extend and demonstrate the technology needed for all types of aircraft. These include both fixed- and rotary-wing aircraft and

range from large commercial passenger and cargo transports and transonic military aircraft, then down in speed through business and recreational aircraft, and finally down in size to miniature remote piloted vehicles. The program includes: (1) the application of both precise theoretical as well as rapid engineering analysis and optimal design methods to devise practical computational aerodynamic codes which can account for most aerodynamic phenomena, (2) the development of experimental test facilities and techniques which can provide high quality experimental data over the entire necessary range of aerodynamic parameters, (3) the establishment and demonstration of advanced airfoil design criteria for various aircraft types, (4) the application of the new airfoil design criteria for various aircraft types, and (5) the application of the new airfoil technology by focusing on supplying the needs of the user, the aircraft designer.

W78-70040**505-06-34**

Hugh L. Dryden Flight Research Center, Edwards, Calif.

AERODYNAMIC FLIGHT EXPERIMENTS

T. G. Ayers 805-258-3311

The objective of this RTOP is to conduct a flight experiment to define the transition Reynolds number for a precision fabricated and instrumented ten-degree included angle cone previously tested in 22 major wind tunnels. The correlation between boundary-layer transition Reynolds numbers in wind tunnels and free-flight through the atmosphere has been a long-sought and elusive goal. Since laminar/turbulent transition is influenced by free-stream flow disturbances, quantitative information on this effect can have great value for improved scaling of Reynolds-number-sensitive data in wind tunnels to the flight case. Wind tunnel environmental discrepancies cannot be fully assessed without having for reference the interference-free values obtainable from flight research. The ten-degree transition cone flight experiment will provide the flight reference data.

W78-70041**505-06-41**

Ames Research Center, Moffett Field, Calif.

AERODYNAMIC TEST METHODS AND INSTRUMENTATION

R. H. Petersen 415-965-5850

The general objective of this research is to develop by FY-80, the technology for increased ground-based aerodynamic experimental research capability required to improve prediction of performance and flight characteristics of conceptual or new aircraft designs and the exploration of advanced aerodynamic concepts. Tunnel wall constraints, flow quality and means for simulating higher Reynolds number flows will be investigated analytically and experimentally to improve the quality of test results. To improve the state-of-the-art in non-intrusive measurement capability, advanced laser velocimetric and holographic instrumentation systems will be developed to obtain fundamental fluid mechanic measurements such as mean velocities, turbulence intensities, and Reynolds stress components. Infrared camera technology will be explored as a means of locating shockwaves and regions of separation on wind tunnel models.

W78-70042**505-06-43**

Langley Research Center, Langley Station, Va.

TRANSONIC TEST TECHNIQUES AND INSTRUMENTATION

E. C. Polhamus 804-827-3711

The technical objective is to provide the technology for improved wind-tunnel test capability for experimental prediction of performance and flight characteristics of conceptual or new aircraft designs and basic aerodynamic research in the critical high subsonic and transonic speed regimes. In house, contract and grant research, both analytical and experimental, will be utilized to (1) advance cryogenic wind-tunnel technology in the areas of test techniques, operating envelopes, and operating techniques to assure efficient and maximum utilization of the unique research capabilities, (2) provide the techniques for a quantitative assessment of wall interference and for its minimization by combined data corrections and advanced wall test section designs, (3) develop the technology needed for the design of superconducting magnetic suspension and balance systems, in the size range from 0.3 to 1.0 meter, for support interference

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free testing including high angle of attack dynamics, (4) perform research required to assess and improve the flow quality in transonic wind tunnels and perform design analysis to assure sound design of cryogenic tunnels, (5) develop design criteria for models to be tested under high pressure and cryogenic conditions, and (6) develop instrumentation and measuring techniques for a wide range of aerodynamic testing requirements

W78-70043

505-06-51

Ames Research Center, Moffett Field, Calif

WING BODY AERODYNAMICS

R H Petersen 415-965-5859

(505-06-21; 505-06-61, 516-50-11)

The objective of this research is to expand the aerodynamic technology base and provide a basic understanding of the aerodynamic flow fields about complete wing-body-tail configurations as well as individual components throughout the anticipated range of angle of attack and flight speeds. To provide a structure for using various theoretical techniques and analyzing experimental results, a research program entitled Comprehensive Aerodynamics Prediction for Aircraft (CAPAIR) is being developed. This program integrates the input and output functions using graphical displays with a data base and executive system that permits a great deal of flexibility in assessing the available analytical tools and experimental data. Integral to this is the development of advanced computational and experimental methods. Primary among the theoretical methods is the development of a transonic wind-body tail code using the full potential equations, and the development of an advanced linear panel code applicable to both subsonic and supersonic flow. In addition, methods will be developed to combine various analytical techniques to numerically optimize wing geometries accounting for viscous effects. To demonstrate the feasibility of integrating theoretical and experimental techniques to provide a more comprehensive prediction of aerodynamic characteristics, a fundamental integration program will be conducted.

W78-70044

505-06-53

Langley Research Center, Langley Station, Va.

ADVANCED FLIGHT DYNAMICS RESEARCH

E C Polhamus 804-827-3711

The technical objective is to increase the aerodynamic technology base for design of wings, wing/bodies and generalized aircraft configurations through the generation and application of an expanded experimental data base and the development and evaluation of improved theoretical and empirical design and analysis methods. The expansion of the experimental data base will be accomplished through parametric wind tunnel tests, guided by theoretical analysis, with emphasis on favorable interference of multiple lifting surfaces, interacting vortex flows and vortex lift optimization, investigation of elastically tailored swept forward wings, various types of nonplanar configurations, and application of variable geometry concepts. The two dimensional body cross flow data base will also be expanded by extension to full scale Reynolds number and high Mach number. The improved theoretical capability will be accomplished by the development of aerodynamic design methods capable of defining configuration shapes required to optimize specified aerodynamic characteristics for either attached flow or vortex flow concepts and methods of predicting the complete surface aerodynamic load distribution, with particular emphasis on the critical aerodynamic and structural design conditions involving edge separation induced vortex flows, and aerothermodynamics compatible with computer aided design methods such as PICASSO will be developed.

W78-70045

505-06-54

Hugh L. Dryden Flight Research Center, Edwards, Calif

WING-BODY AERODYNAMICS

T G Ayers 805-258-3311

The objective of this RTOP is to provide a continuing research and development effort into the problems associated with the fundamental understanding of fluid and flight mechanics with special emphasis on the relationship to large-scale vehicles operating in a real world environment free of interference effects. These efforts include experimental aerodynamic studies to improve our ability to predict the efficiency of vehicles moving through

the atmosphere, and to define the effects of Reynolds number, surface condition, excrescences, and local and freestream flow conditions on lifting surfaces and complete configurations. Also included will be investigations in support of or verification of wind tunnel studies. Experimental research pertaining to laminar and turbulent boundary layer phenomena and on the separation characteristics of turbulent flow over afterbodies will also be conducted as will analytical studies appropriate to support the fluid mechanics disciplines.

W78-70046

505-06-61

Ames Research Center, Moffett Field, Calif

FLIGHT DYNAMICS

R. H. Petersen 415-965-5861

(505-06-51)

The objective of this RTOP is to provide a basic understanding of the aerodynamic and flight dynamic characteristics of highly maneuverable aircraft through the development and utilization of improved wind tunnel measurement techniques, including both static and dynamic methods. Ultimately, through application of improved methods of testing and application of the test results including better simulations resulting from improved aerodynamic mathematical models, new criteria can be established for designing vehicles capable of performing controlled maneuvers over an expanded angle-of-attack envelope. Investigations are in progress to evaluate various experimental methods for determining dynamic characteristics of aircraft, and experimental capabilities are being upgraded for testing at high angles of attack and high Reynolds numbers, both for static and dynamic characteristics. Dynamic apparatus are being investigated or constructed to evaluate aerodynamic coefficients which are pertinent to all phases of high-maneuver flight from controlled motions to fully developed spins.

W78-70047

505-06-63

Langley Research Center, Langley Station, Va

FLIGHT DYNAMICS

J R Chambers 804-827-2184

The broad objective is to develop a better understanding of basic phenomena, improved analytical and experimental techniques, and new concepts related to dynamic and handling quality characteristics of aircraft in all flight regimes. Specifically, the effort is directed at: (1) analytical techniques for extracting stability and control parameters from flight tests, (2) theoretical and experimental studies to determine stall/spin behavior, for establishing fundamental aerodynamic phenomena and for achieving spin resistance, (3) approaches for analysis of handling qualities for achieving specified aircraft response. The approach includes static and dynamic wind-tunnel force tests, dynamic model flight tests, piloted simulator studies, and theoretical analyses.

W78-70048

505-06-64

Hugh L. Dryden Flight Research Center, Edwards, Calif

FLIGHT DYNAMICS

E E Kordes 805-258-3311

The overall objective of this effort is to develop a better understanding of the basic phenomena, improved analytical and experimental techniques, and new concepts related to dynamics and handling quality characteristics of aircraft in all flight regimes. Studies will be conducted to develop analytical techniques for determining stability and control derivatives from flight data and to develop new techniques for evaluating handling qualities and for achieving desired aircraft responses. Analytical studies, computer algorithm development and programming, and flight tests will be performed both in-house and under contract and grants to meet these objectives, will be made. Improved techniques for estimating the unknown parameters of the math model and for improving the identifiability of the systems will be studied on flight test data. The stochastic control based on the estimates will then be tested in flight to assess the improvement of the systems. Also the range of command responses of augmented vehicles that optimizes pilot-vehicle performance for a specific mission or task within a mission will be investigated. Emphasis will be on criteria for command response that is meaningful to systems designers.

W78-70049**505-07-11**

Ames Research Center, Moffett Field, Calif.

APPLICATION OF GUIDANCE AND NAVIGATION THEORY TO OPERATIONS OF FUTURE SHORT-HAUL AIRCRAFT

C T. Snyder 415-965-5450

The objective of this research is to extend and apply modern guidance and navigation theory to optimize future short-haul aircraft operations in a high-density air traffic environment. Two major efforts support this objective. The first is to develop methodology and onboard computer algorithms for rapidly synthesizing and flying along time constrained or 4D trajectories which minimize fuel use, direct operating costs, or noise. Techniques from optimal control and estimation theory will be applied to develop automatic and computer-aided guidance logic to fly the aircraft along these trajectories in uncertain wind and temperature profiles. The most promising of the techniques obtained in the analyses will be incorporated in the design of a complete system to be evaluated in piloted simulations and flight tests onboard STOL, VTOL, and rotorcraft vehicles. The second major effort is concerned with investigating, jointly with the FAA, 4D guidance concepts to optimize capacity and aggregate fuel efficiency of the future air traffic control system. The Ames Air Traffic Control Simulation Facility, along with several piloted simulators, will be used to evaluate such concepts in simulated short-haul air traffic.

W78-70050**505-07-13**

Langley Research Center, Langley Station, Va

DIGITAL OPERATIONS TECHNOLOGY

H. J. E. Reid, Jr. 804-827-3551

(512-52-03)

Development of advanced systems such as NAVSTAR/GPS, coupled with the rapid advances in electronics and RF technology can have tremendous impact on future aircraft and ATC operations. Work done under this RTOP will, in conjunction with FAA and DOD, identify potential candidate concepts for such future systems, develop the technology required for, and perform, proof-of-concept experiments to develop the data base required for future aircraft and ATC system planning. The technology will also be developed for special applications such as multi-purpose radars for weather and turbulence detection and weather penetrating mapping functions. Studies will be performed to define user-class requirements for GPS equipment, and to develop low-cost technology for implementation of L-band spread-spectrum user equipment. Experiments will be performed to validate user-class capabilities, and to develop dual-fail-operational redundancy techniques which will be required in future systems. Digital data link technology will be extended to use with the GPS system, and combined experiments run in conjunction with FAA.

W78-70051**505-07-18**

Wallops Station, Wallops Island, Va

DIGITAL OPERATIONS FOR GENERAL AVIATION

Lloyd C Parker 804-824-3411

The objective is to demonstrate systems feasibility of utilizing advanced low cost digital systems technology to provide: (1) automatic voice airport advisory information at uncontrolled airports of weather conditions, active runway and existing hazardous conditions for VFR & IFR traffic; (2) automatic voice air traffic and mid-air collision advisories to traffic at uncontrolled airports using standard NAV-COM frequencies without transponder requirement; (3) a solid-state general aviation crash recorder having critical accident investigation parameters retained in non-volatile storage; and (4) an advanced general aviation pilot training system for single and twin engine aircraft which provides inflight simulation and evaluation of piloting procedures for private, commercial, multiengine and instrument training. Approach includes studies of systems concepts, systems definition, engineering model development, evaluation and demonstration of technology improvements achieved.

W78-70052**505-07-21**

Ames Research Center, Moffett Field, Calif

COCKPIT AVIONICS: AUTOMATED V/STOL AVIONICS

C T Snyder 415-965-5444

(505-07-31)

The objective of this program is to develop and assess information/display concepts for use with integrated flight control/avionics systems for V/STOL aircraft. Display concept will be defined, developed, and assessed through in-house and contract studies to provide display information required with integrated flight control/avionics concepts developed under RTOP 505-07-31.

W78-70053**505-07-23**

Langley Research Center, Langley Station, Va

COCKPIT AVIONICS TECHNOLOGY

J J Hatfield 804-827-3551

(505-07-33, 513-52-03, 512-52-03)

This effort is directed toward developing advanced technology, for aircraft control/display interface and toward developing advanced sensing techniques for laboratory use. The first area focuses on display media development such as plasma, electrochromic and liquid crystal panels. The application of microcircuit/microprocessor technology will be assessed and incorporated in these experimental designs as appropriate to determine the impact on processor load, characteristics and final media performance. The second area is directed to developing advanced sensing techniques for aeronautical research. Particular emphasis will be placed on non-intrusive gas flow field measurement for application to wind tunnel aerodynamics and fluid physics to eliminate measurement errors and interference effects. In addition new and improved ultrasonic non-destructive evaluation techniques are under development, these include engine wear monitors, stress measurement for threaded fasteners and analytical measurement techniques for composite materials.

W78-70054**505-07-31**

Ames Research Center, Moffett Field, Calif

INTEGRATED CONTROL FOR STOL, VTOL, AND ROTORCRAFT

C T Snyder 415-965-5567

(513-50-11)

Advanced technology will be developed to provide effective integration of airframe, propulsion, and subsystem control functions to enhance the efficiency, economics, and safety of future short haul aircraft. A study of digital full flight envelope autopilot (FFEAP) will be completed in flight on the Augmentor Wing Jet STOL Research Aircraft. This system uses corrective closed loop control sequences to follow and regulate air traffic control commands. Studies of integrated control will continue with the total automatic flight control system (TAFCS) which adds to the FFEAP provision for inputs by the pilot, stability and control augmentation, and active controls. This system will be first applied to helicopters, and then to all flight modes of tilt rotor aircraft. Integrated control will require advanced concepts for design, integration, and verification of complex software. A program will be initiated with the goal of transforming operational requirements into specifications for the total avionics system and of assessing cost/benefit/configuration trade-offs in the application of integrated systems to short-haul aircraft. University grants will be pursued to examine questions associated with exploiting functional redundancy to enhance the reliable operation of flight systems.

W78-70055**505-07-34**

Hugh L. Dryden Flight Research Center, Edwards, Calif

ANALYTICAL REDUNDANCY MANAGEMENT FOR FLIGHT CONTROL SYSTEMS

C R. Jarvis 805-258-3311

(512-51-04)

The objective is to study and develop cost effective methods for implementing advanced, reliable flight control systems that will permit greater operational capability and increased performance of future aircraft. Initial emphasis will be toward developing an analytical redundancy management algorithm for sensor fault detection using software techniques to minimize hardware requirements in redundant fly-by-wire system applications. The concept will be developed for and flight tested using the F-8 DFBW research aircraft.

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W78-70056

505-08-14

Hugh L. Dryden Flight Research Center, Edwards, Calif.

KNOWLEDGE OF HIGH ALTITUDE ATMOSPHERIC PROCESSES

E. E. Kordes 805-258-3311

The objective of this work is to measure and mathematically model environmental and behavioral characteristics of the atmosphere required for improved understanding of superior aircraft design and more efficient operations. Data from instrumented aircraft flight tests will be used to update models of turbulence and provide basis for definition of atmospheric conditions in which turbulence, temperature transients, pressure altimetry problems and excessive wind shear occur. Development and acquisition of sensors needed to measure atmospheric phenomena are also included in this effort. The math modeling and analysis of associated meteorological conditions will be studied both in-house and on contracts or grants. Results of this work will be applicable to aircraft system design and flight test activities and to flight operations, routing and scheduling.

W78-70057

505-08-18

Wallops Station, Wallops Island, Va

KNOWLEDGE OF ATMOSPHERE - ADVANCED MEASUREMENT TECHNIQUES

R. E. Carr 804-824-3411

The objective is to develop advanced measuring techniques, to measure, and mathematically model varying atmospheric wind conditions associated with the air-sea interface, various surface roughness and low-level atmospheric turbulence. Data for model development are being collected from 0-250 feet at 50 foot intervals using 3 dimensional anemometers having wind response frequencies to 100 Hz. Empirical statistics derived under various atmospheric conditions are being analyzed for correlation with existing theory and development of new theory and modeling parameters.

W78-70058

505-08-19

Marshall Space Flight Center, Huntsville, Ala.

KNOWLEDGE OF ATMOSPHERIC PROCESSES

D. W. Camp 205-453-2087

The objectives are (1) to define, model, and simulate the wind and turbulence environments for aircraft accident investigation; (2) the definition and investigation of severe environments relative to the identification of aircraft operating hazards; (3) the development of techniques and procedures whereby the knowledge of the natural environment can be better utilized for the safe operation of aeronautical systems; and (4) research relative to the need for new and/or improved meteorological instrumentation for use in enhancing the safe operation of aeronautical systems. To accomplish the objectives, the following four-prong approach is to be used: (1) the development of models of atmospheric boundary layer flow properties; (2) the development of probabilistic models of turbulence and the conditions which lead to turbulence; (3) performing analytical and laboratory tasks relative to the life cycle of fog; and (4) the development and/or modification of meteorological instruments as needed to meet the requirements of the first three parts of the approach. To accomplish the above objectives, the following tasks are to be performed: (1) induced wind environments and the correlation of lateral and longitudinal gusts and their effect on aeronautical systems; (2) natural environment reconstruction for accident and operating hazard investigation; (3) definition of free atmosphere perturbation, turbulence studies, and thunderstorm investigation; (4) fog modification model development; (5) development of new (or modification of) meteorological instrumentation needed for use relative to the safe operation of aeronautical systems; and (6) hypersonic vehicle design criteria.

W78-70059

505-08-21

Ames Research Center, Moffett Field, Calif

AVIATION SAFETY OPERATING PROBLEMS AND SURVIVABILITY MATERIALS, NTSB ASSISTANCE

Leonard Roberts 415-965-5567

(505-01-31, 510-56-01, 505-09-03, 505-08-01)

The objective of this RTOP is to improve aviation safety by increasing the understanding of the causes of accidents, by

developing materials and piloting techniques for avoiding accidents, and by increasing the probability of survival of accidents when they occur. The approach to operations studies will include developing new techniques for sensing and displaying wind shear. Additionally, as part of a joint NASA/FAA program, simulator investigations will be conducted on the effectiveness of integrated head-up displays (HUD) on reducing hazards associated with wind shear and low visibility in the landing approach. The fire hazards program pertains to the exploration of fire-hardened concepts for civil aircraft cabin materials systems such as lavatories, galleys, cargo compartments, and aircraft interior passenger compartments in order to enhance human survivability in aircraft in-flight, ramp, and post-crash fires. The technology base for fire safe aircraft systems will be developed utilizing the outputs of the R&T programs on fire-resistant materials and fire control systems. Laboratory and sub-scale tests will be conducted to assess the flammability, smoke and other properties of state-of-the-art and advanced cabin materials which have a potential for increasing the fire-hardening of aircraft. Post-accident analysis is a cooperative program with the National Transportation Safety Board, Bureau of Aviation Safety (NTSB-BAS). The general objectives are to develop improved data processing techniques for analyzing aircraft accident recordings. In addition, the effects of solid fire extinguishments on engine nacelle fires will be assessed and the flammability characteristics of hydraulic fluids will be evaluated.

W78-70060

505-08-22

Lewis Research Center, Cleveland, Ohio.

AIRCRAFT PROPULSION SYSTEMS SAFETY TECHNOLOGY

J. W. Gregory 216-433-4000

The purpose of this research is to provide a broad base of safety oriented technology for identifying, defining and dealing with hazards associated with aeronautical propulsion systems, establish criteria for systems design and operating techniques leading to reduction in accidents, loss of life and injuries, and loss of equipment; support and perform research and technology activities that lead to solutions of problems impacting on aviation safety with particular emphasis on propulsion systems, and coordinate activity results with the FAA, NTSB, DOD, other interested government agencies and the aviation community. Specific areas of current activities include rotor burst protection, general aviation engine tolerance to substitute fuels, aircraft fire technology, and measurement of ozone concentrations in aircraft interiors.

W78-70061

505-08-23

Langley Research Center, Langley Station, Va

AVIATION SAFETY TECHNOLOGY - FLIGHT SAFETY

A. W. Hall 804-827-3274

A technology base will be developed which can be used to reduce the number of aviation accident opportunities and to minimize the fatalities and damage resulting from accidents. This will be accomplished by programs aimed at providing a data base for continued knowledge of the usage of various types of general aviation and transport aircraft relative to their original design criteria. Research on equipment and systems will be undertaken to improve the accuracy and reliability of operational information relative to visibility and meteorological phenomena. Research will also be conducted to provide improved protection of the aircraft and its systems from hazards such as lightning, turbulence, and wind shear.

W78-70062

505-08-25

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

AVIATION SAFETY TECHNOLOGY - APPLIED FLUID MECHANICS

W. E. Bachman 213-354-4420

The overall objective of this effort is directed toward improving aircraft safety. The studies include those aspects of safety associated with (1) the reduction of fire hazard by modification of the fuel and by the development of analytical methods for predicting thermochemical behavior of the polymers in a fire environment, (2) the development of an enclosure fire modeling methodology for the prediction of aircraft fire characteristics and

the associated dynamic response of materials in an accidental fire environment, and (3) the marking of trailing vortices generated by large aircraft with emphasis placed on injection of nonpolluting aerosol into the vortex to identify its location.

W78-70063 505-08-27
Lyndon B Johnson Space Center, Houston Tex
AVIATION SAFETY R&T - FIRE TECHNOLOGY
R W Bricker 713-483-3166

The effort defined in this RTOP consists of a continuation of fire resistant materials development work originally started in FY-75 and continued into FY-77. It also provides for the additional tasks of developing polyimide molding compounds, adhesive, potting, and edging compounds, flexible coated fabrics, thermal acoustical insulation, and fibers for textiles.

W78-70064 505-08-31
Ames Research Center, Moffett Field, Calif.
AIRCRAFT SYSTEMS OPERATIONAL SAFETY AND EFFICIENCY IMPROVEMENT
S. R. Ricciutiello 415-965-5986

The objective of this RTOP is to improve aircraft safety and efficiency through the use of advanced materials in aircraft tires. This involves the evaluation of new tire formulations having wear characteristics superior to state-of-the-art tires. The wear characteristics of the new formulated tires will be compared to the state-of-the-art formulations in actual flight testing by commercial airlines and compared to the limited flight test evaluation accomplished through the FAA. The evaluation sample for this test comprises a fifty (50) tire set. In addition to the tire tests being conducted by the airlines, tire tests will be conducted at the Langley Research Center to establish relationship between runway surface conditions and tire composition. Another area to be investigated is that of tire tread and side wall flaws resulting from use and manufacturing procedures. The method to be considered to determine flaws will be holography which is nondestructive and could represent a possible quality control procedure for all tires used on aircraft.

W78-70065 505-08-33
Langley Research Center, Langley Station, Va
AIRCRAFT LANDING SYSTEMS EFFICIENCY IMPROVEMENTS
J L McCarty 804-827-2796

The specific objective is to examine new concepts and techniques in aircraft systems in order to determine their potential to reduce both operational complexities and costs with a view toward use of the improved systems by air carriers. Aircraft operations on prepared runways under adverse weather conditions and on certain unprepared surfaces present requirements of braking and steering systems, tires, and the runway that are vital to aircraft safety and passenger comfort. The objectives of programs covered by this RTOP are: (1) to improve the performance of braking systems, (2) to improve the wet performance and lifetime of pneumatic tires, (3) to develop new landing gear systems that would permit operations on unprepared fields, including water, and permit continuous use of prime runways for all-weather operations, (4) to evaluate tire cornering behavior with and without braking such that high-speed turnoffs can be designed to increase the flow of traffic at congested airports, and (5) to relate the character of the runway surface to aircraft braking and steering performance. Research to meet these objectives will employ full-scale aircraft, landing gear systems and subsystems, and scaled pneumatic tires. The test facilities will consist of the Landing Loads Track, airport runways, including the landing research runway at Wallops Flight Center, ground test vehicles, flight-type aircraft simulators, and various laboratory equipment.

W78-70066 505-09-11
Ames Research Center, Moffett Field, Calif.
ACCEPTANCE OF AIRCRAFT OPERATIONS - TECHNOLOGY ASSESSMENT
H P Klein 415-965-5094

The objective of this program is to develop an understanding of the social and psychological effects of large scale technological

innovations, as exemplified by air transportation systems, and to attempt to model such effects so as to impact the design of these systems. Studies of both the short and long term social impacts (including psychological, political, environmental, and economic) of air transportation as an element of the total transportation system will be continued. Field studies of existing systems such as the Dallas-Fort Worth Regional Airport and other regional airports will be conducted as needed to meet the objective. Supporting work developing theory and methodology for assessing community acceptance of aircraft operations and social and psychological impact of related technologies will be conducted.

W78-70067 505-09-13
Langley Research Center, Langley Station, Va
HUMAN RESPONSE TO NOISE
D G Stephens 804-827-3561

The objective of this research is to define and quantify stimulus, environmental, and human factors responsible for affecting individual and community response to aircraft noise and operations. Research studies will include laboratory tests to subjectively evaluate the properties of aircraft-generated noise that are responsible for causing individual annoyance and field surveys to study the broader problems of community acceptability including psychological and sociological factors. The laboratory program is aimed at developing criteria for evaluating the noise from single aircraft events as well as evaluating the response to longer term multiple aircraft exposures. Subjects will experience the recorded noise of aircraft or the synthesized noise of future systems under simulated indoor and/or outdoor conditions. Various psychophysical measures such as annoyance and speech interference will be used by the subjects to judge or rate the noise. The resulting single event dose-response relationships will be directly applicable to the engineering assessment of source noise modifications and to aircraft certification procedures whereas the multi-event results will be applicable to the evaluation of aircraft/airport operations. The community acceptance studies are directed toward the development of a predictive model of community acceptance which includes, in addition to the details of each noise exposure, other physical and psychological characteristics such as the ambient noise level, the frequency of events, the time of day/night, and community attitudes. The model will be formulated such that it can be used to assess the noise abatement resulting from A/C modifications, A/C operations, and land use strategies.

W78-70068 505-09-23
Langley Research Center, Langley Station, Va
AIRCRAFT INTERIOR NOISE REDUCTION
D. G. Stephens 804-827-3561

The objective of this research is to provide design guidelines for reduction of aircraft interior noise by attenuation of noise and vibration transmitted via air and structural paths. The design criteria are to be based on consideration of human response. Interior noise research will concentrate on improved noise control for aircraft including STOL, helicopter, general aviation and turboprop aircraft where levels are particularly high. The technology base will include results from studies being conducted with STOL (AMST) vehicles, helicopters, and general aviation aircraft to identify noise source/path relationships. The development of structural noise transmission prediction methods is fundamental to this program and includes the definition of the near-field-noise inputs in terms of spatial distribution, frequency content, and correlations, the response of structural panels individually and in combination, and the coupling of the structural models with the interior cavity modes over a range of forward speed, curvature, and pressurization. The results will be included in a prediction program capable of minimizing the interior noise within the practical constraints of cost, weight, and operations. Finally, acceptable levels (criteria) of interior noise will be established for the safety and comfort of crew and passengers. Safety considerations will include speech intelligibility and auditory effects whereas the comfort studies will emphasize passenger acceptability and speech interference.

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W78-70069

505-09-31

Ames Research Center, Moffett Field, Calif

FLIGHT MANAGEMENT SYSTEMS

H. P. Klein 415-965-5094
(515-51-11, 505-08-21)

This program will investigate flight management and crew/system interaction mechanisms and requirements for current and advanced aircraft. Specific objectives are to develop (1) procedures for the measurement and assessment of aircrew performance for current and future systems under varied conditions of automation, ground authority, traffic complexity and environmental conditions; (2) new technology and methodology for training; and (3) principles of optimal crew utilization. The research will include exploration of (1) new technology for improved current and future man-system information interfaces such as navigation charts, operating manuals, warning and status annunciator systems, pilot input systems, head-up displays, and panel displays, and (2) the fundamental characteristics of human cognitive and decision-making behavior and their relationships to pilot performance. To accomplish these objectives, manned full-mission and part-task simulations will be conducted to evaluate performance and workload measurement methodology and aircrew perception and decision-making functions in a variety of tasks and mission scenarios. These in-house studies, in conjunction with those supported by University Grants, will be used to develop principles of optimal crew utilization and to evaluate training effectiveness. Collaborative studies with the FAA, Industry and the Military will be pursued to evaluate specific subsystems such as speech synthesis and recognition systems, head-up displays and crew procedures.

W78-70070

505-09-33

Langley Research Center, Langley Station, Va

FLIGHT MANAGEMENT

M. C. Kurbjun 804-827-2282
(513-52-03)

The objectives of this effort are to define crew responsibilities and interactions, flight procedures and control and display requirements for the future civil air transportation system of the 1980-1990's. These tasks will be accomplished by taking the following approach: (1) continue to develop tools and techniques that will define the crew responsibilities and interactions, and measure their workload; (2) apply these tools and techniques to assess current and contemplated flight systems; and (3) develop analytical techniques that will assess advanced system requirements and human operation, and define cockpit displays and controls needed for a satisfactory flight management system. This concerted effort should result in improving the safety and efficiency of advanced transport systems and will require research in hardware, software, and human elements to systematically carry out the program objectives.

W78-70071

505-09-41

Ames Research Center, Moffett Field, Calif.

SIMULATION TECHNOLOGY FOR AERONAUTICS

H. P. Klein 415-965-5094
(505-09-31, 515-51-11)

The general objective of this research and development activity is to provide a scientific and technical base that can be used as a resource to develop valid, reliable and economical simulators for aeronautical research, development and crew training. Specific objectives are: (1) to develop advanced hardware and software concepts for high fidelity simulation of vision, motion and aural systems; (2) to evaluate existing and prototype simulator systems using comprehensive assessment techniques; (3) to develop task related fidelity criteria for simulators based on a detailed analysis of human operator requirements and engineering principles; and (4) to develop computer systems appropriate for simulation of advanced aircraft. These objectives will be accomplished by: (1) continuing study of advanced perception and performance with an emphasis on developing task related fidelity criteria and associated fidelity measurement techniques; (2) evaluating existing simulators using both traditional assessment methods and new methods developed in (1) above; (3) continuing development of new visual scene technology with an emphasis on reduced visibility scenes; (4) continuing development of a flexible high-fidelity sound

system for recreating aircraft cockpit noise; and (5) studying improved simulation computing techniques and hardware system concepts.

W78-70072

505-09-43

Langley Research Center, Langley Station, Va

APPLICATION OF FLIGHT SIMULATION TECHNOLOGY

Roland L. Bowles 804-827-3304

The objective of this RTOP is to apply simulation technology to existing flight simulators to support Langley's research programs. This RTOP will cover both in-house and contractual studies which address current constraints in Langley simulator equipment, in the formulation and validation of simulation math models, and in the linkage of the hardware/software systems to provide, in the closed-loop pilot/simulator environment, effective simulations. Principle tasks for FY-78 include studies of simulation requirements for directional control on runways, evaluation of kinesthetic cues for DMS and VMS, development of improved real-time simulation computing techniques for the Real-Time Simulation System, development of interactive performance assessment techniques and validation of the man-machine systems model for analysis of flight simulator engineering requirements. Results of this effort will be documented in NASA Technical Notes and Contractor Reports, and will be applied to simulations of interest to Langley Research Center.

W78-70073

505-10-11

Ames Research Center, Moffett Field, Calif

GENERAL AVIATION AERODYNAMIC PERFORMANCE TECHNOLOGY

C. T. Snyder 415-965-5567
(505-06-51)

The objectives of this program are to provide an advanced technology base for the design of future light aircraft that are safer, more productive, and clearly superior to foreign competition, including the development of advanced techniques and design data on aerodynamic performance, stability and control, and handling qualities. The approach is to analyze wind-tunnel and flight tests of optimized airfoils and wings, to develop techniques for reducing aerodynamic and engine-cooling drag, to develop techniques for improving stall/spin characteristics; to obtain a data base with which mission-related stability, control and handling qualities criteria may be established, and to optimize procedures for configuration design. In order for the results of this research program to be valid and meaningful, full-scale tests need to be conducted in the Ames 40- by 80-foot wind tunnel. This will assure the user that scale effects have been thoroughly investigated and that proper generalization can be made to new designs.

W78-70074

505-10-13

Langley Research Center, Langley Station, Va

GENERAL AVIATION AERODYNAMICS AND HANDLING QUALITIES TECHNOLOGY

A. W. Hall 804-827-3274

An advanced technology base will be developed to permit the design of general aviation aircraft that are safer, more productive, and clearly superior to foreign competition. This technology includes aerodynamic and propulsive performance; stability and control; and handling qualities. The work will be accomplished by computer analysis and techniques; simulator studies; and wind-tunnel and flight tests of models and full-scale aircraft. The work will involve tests and analysis for: (1) interference and design optimization; (2) drag reduction; (3) engine cooling drag; (4) improved airfoil design capability; (5) mission related stability, control and handling qualities criteria; (6) improved stall/spin characteristics; (7) propeller/nacelle or fuselage integration; and (8) airplane response to turbulence.

W78-70075

505-10-14

Hugh L. Dryden Flight Research Center, Edwards, Calif.

GENERAL AVIATION MANEUVERABILITY, SAFETY AND PERFORMANCE IMPROVEMENT

S. W. Gee 805-258-3311

Experiments and studies are being conducted to identify and demonstrate optimum levels of performance, stability and control,

and handling qualities for general aviation that can be achieved through the application of advanced technology. The potential application of the free-wing concept is the present center of effort. Both in-house and contracted studies are indicating that the gust alleviating concept is feasible with significant improvements over conventional designs in ride quality performance, maneuverability, and safety. A radio-controlled model of the free-wing concept is providing a limited amount of flight data that tends to verify the present studies. Results of these and future studies could lead to the development of a manned free-wing research aircraft.

W78-70076**505-10-18**

Wallops Station, Wallops Island, Va.

GENERAL AVIATION AIR TRAFFIC FLOW DYNAMICS

Lloyd C Parker 804-824-3411

The objective is to collect and analyze general aviation piloting procedures and aircraft flight dynamics data to define significant performance and operational parameters during landing approach and departure from airports. A data base has been collected which is comprised of over 3000 three dimensional radar tracks of arrival and departure flight profiles and the corresponding environmental conditions which existed for each flight. Math models for the analysis and quantitative definition of pilot and aircraft performance and piloting procedures have been developed. Math models for analysis of the mid-air collision hazard in uncontrolled airspace, simulation of existing air traffic and for assessment of new air traffic pattern concepts have also been defined and prototype models demonstrated. Utilizing these models, pilot procedures will be characterized for various aircraft type and environments and simulations of various uncontrolled traffic pattern concepts conducted to minimize the mid-air collision hazard and improve community noise exposure created by present patterns.

W78-70077**505-10-21**

Ames Research Center, Moffett Field, Calif

ROTORCRAFT AERODYNAMIC PERFORMANCE, DYNAMICS AND HANDLING QUALITIES

L Roberts 415-965-5066

This RTOP covers research on all aspects of rotor aeromechanics (aerodynamics, dynamic loads and stability, performance, and noise characteristics) and rotorcraft flight dynamics. Theoretical and experimental research will be conducted to develop techniques to design optimum airfoils for rotary wing applications and to predict their dynamic performance, particularly at high subsonic and transonic speeds. The benefits of optimum airfoil sections upon complete rotor performance will be studied, and methods for predicting optimum tip shapes based on theoretical and experimental results will be developed. The design and fabrication of an advanced research rotor will be continued. This rotor will incorporate the latest concepts in rotor airfoils, camber, twist, etc., and will be used to evaluate rotor aeromechanics prediction methods. Specific advanced rotor configurations will be tested in the full scale wind tunnel to verify predicted performance, and to obtain data on which to base the design of advanced rotors. Rotorcraft flight dynamics research will be directed to development of flying qualities and flight control design criteria for specific military and civil tasks (for example, low level operations such as nap-of-the-earth (NOE) maneuvers and pipeline surveillance). Fixed and moving base piloted simulations will be used to evaluate task performance. Selected results will be verified with flight experiments using a variable stability helicopter as an inflight simulator. Advanced control systems will be applied to the tilt rotor aircraft.

W78-70078**505-10-23**

Langley Research Center, Langley Station, Va

HELICOPTER AEROELASTICITY, ACOUSTICS AND FLIGHT DYNAMICS

R. J. Tapscott 804-827-3149

University grants and contracted studies will be continued to define wake geometry and analytical procedures which include unsteady aerodynamic effects and wake characteristics in predicting airloads, structural response, vehicle dynamics, and performance. In-house experimental studies will be continued to

better define local flow parameters for improved prediction of rotor blade airfoil performance. Analytical, wind-tunnel, whirl tower, and flight investigations will be made to define configuration improvements for better performance and operational suitability. In-house analytical and experimental studies will be made to evaluate potential of higher harmonic control inputs for vibration reduction and to evaluate the effects of higher frequency fluctuating blade loads and airfoil thickness distribution on radiated noise. Both ground-based simulation and flight vehicles will be used to conduct experimental studies exploring advanced control and display concepts based on computer-centered flight control technology, computer-generated symbology for enhancing real-world scene displays, and synthesized integrated control/display formats. A specially equipped CH-53 helicopter will be used to conduct real-world instrument flight operations studies in congested, remote, and offshore areas to establish the technology base for design of IFR suitable vehicles, guidance systems, and navigation and air traffic control procedures.

W78-70079**505-10-31**

Ames Research Center, Moffett Field, Calif.

VTOL AERODYNAMIC PERFORMANCE AND HANDLING QUALITIES

L Roberts 415-965-5066

(505-03-11)

The objective of this RTOP is to provide the technology required to enable the development of viable military and civil aircraft having VTOL capability with mission capabilities comparable to current conventional aircraft. More specifically, research on high speed aerodynamics includes development of a comprehensive data base, the identification of critical areas of aerodynamic uncertainty to guide future research efforts, development and application of three-dimensional aerodynamic prediction schemes, and development and use of small scale propulsion simulators to insure that all major propulsion system/airframe interactions are accounted for properly. Low speed aerodynamic research will concentrate on the development of high performance augmentors, a large scale V/STOL fighter model, new concepts for VTOL, and prediction methods for low speed transition aerodynamics and ground effects including reingestion of exhaust gases. The augmentor and large scale model tasks will be integrated so that results from the augmentor studies can be applied on the model. Flight control system and display requirements will be investigated primarily through piloted simulation. Control system and display requirements will be investigated concurrently, since each influences the overall task performance and pilot assessment. The X14B variable stability aircraft will be used in studies of specific response requirements for hovering flight. The flight control and display requirements obtained from simulation will be verified for all VTOL lift fan or jet flight phases when a suitable research aircraft becomes available.

W78-70080**505-10-41**

Ames Research Center, Moffett Field, Calif

R/STOL AIRCRAFT AERODYNAMIC PERFORMANCE AND HANDLING QUALITIES

C T Snyder 415-965-5567

(505-06-31, 505-06-21)

The objective of this RTOP is to develop the technology to attain the integrated performance, noise and handling qualities for a viable civil or military short-haul transport having significantly reduced takeoff and landing distance. Aerodynamics research in FY-1978 will include theoretical ground effect studies with a thick jet, an investigation of the characteristics of thick jets, and further studies of the combined blowing concept. Noise research will include studies of flap noise and thrust reversers. In addition, studies to improve corrections for wind tunnel boundary effects will continue. Results of cruise augmentors continue to be promising. Analysis, simulation, and flight research will provide data for revision and extension of existing handling qualities and certification criteria for STOL aircraft. The data will apply to the following critical areas: flight path, airspeed, and attitude control, landing flare in presence of ground effect, roll and yaw control for cross-wind landings, and control of powered-lift STOL following loss of an engine. Flight research in these areas

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will be accomplished using the Augmentor Wing Jet STOL Research Aircraft, a spoiler equipped DHC-6; and the QSRA, YC-14, and YC-15 as they become available.

W78-70081

505-10-43

Langley Research Center, Langley Station, Va
R/STOL AEROACOUSTICS AND LOADS
D. L. Lansing 804-827-2617

The objective of this research is to establish the technology for reducing the community noise and acoustic loads induced vibrations of conventional and advanced design commercial transports, in particular, those having reduced or short-takeoff and landing capability based on the use of propulsive lift or mechanical high lift flaps. The activity addresses a broad range of noise and fluctuating loads problems common to R/STOL, EBF, and USB configurations. In-house and contract studies are providing data and prediction methods pertaining to critical acoustic and loads phenomena. The mean and turbulent flow field around jet impinged wing-flap combinations are being measured and predicted as inputs to the development of validated noise prediction methodologies. Trailing-edge noise is being studied using laboratory models to determine flap noise source locations. A new formulation of the equations of aeroacoustics - the Bernoulli enthalpy theory - is being explored as a means of predicting noise from jet impingement flow field data. The shielding benefits of over-the-wing engine location are being measured. A data base on jet impingement induced structural loads is being collected and used to derive and verify scaling laws. Computer programs for predicting steady loads on USB and EBF configurations will be written and will be verified against flight data.

W78-70082

505-10-51

Ames Research Center, Moffett Field, Calif
HYBRID ROTOR/AIRSHIP FLIGHT CONTROLS AND AERODYNAMIC PERFORMANCE
W. H. Deckert 415-965-5887
(505-10-21; 791-40-31)

The objective of this RTOP is to provide aerodynamics technology development for promising modern airship concepts. Emphasis will be on the flight dynamics simulation of an airship concept employing substantial amounts of rotor lift and designed for transporting heavy payloads over short ranges. The program will initially concentrate on areas known to have the greatest uncertainties, modeling and control of interconnected rotors, and aerodynamic interactions of rotors and envelopes. Later efforts will concentrate on gust and turbulence modeling, effects of structural flexibility, and control law development. The work to be done includes analytical studies, computer simulation, and wind tunnel testing, and would lead to a control system design and flight simulation program. Because of military interest in the heavy-lift/short-haul airship concept, close coordination will be maintained with the Airship Project Office at the Naval Air Development Center and it is anticipated that some of the technology development for this concept will be jointly supported by NASA and the Navy.

W78-70083

505-11-11

Ames Research Center, Moffett Field, Calif
OBLIQUE WING AERODYNAMICS
Richard H. Petersen 415-965-6133
(505-06-51)

The primary objective of this research will be to support the aerodynamic design of the low-cost oblique wing demonstrator (AD-1) proposed by the Dryden Flight Research Center. This support shall include analytical, wind tunnel, and simulation studies to define the aerodynamic configuration with a specific emphasis on identifying the wing geometry and its aeroelastic characteristics.

W78-70084

505-11-13

Langley Research Center, Langley Station, Va
MEDIUM AND LONG HAUL CRUISE AIRCRAFT AERODYNAMICS AND FLIGHT DYNAMICS
R. T. Whitcomb 804-827-2252
(516-53-01)

The objective of this research is to develop practical means

for improving the aerodynamic performance of high subsonic and supersonic cruise aircraft. Innovative configurations with improved cruise efficiency will be investigated analytically and experimentally. For the most promising of the proposed new configurations both theory and wind tunnels tests will be used to assure that the performance, buffet, loads, stability, and controllability are acceptable over their entire flight envelopes. Further, theory and experiments will be used to investigate advanced high lift systems for landing and takeoff and means for increasing the off-design performance of configurations with high cruise efficiency. Work will be conducted in-house and by contracts and grants.

W78-70085

505-11-14

Hugh L. Dryden Flight Research Center, Edwards, Calif
AERODYNAMIC FLIGHT RESEARCH
W. G. Schwerkhard 805-258-3311

The objective is to develop new methods, techniques, sensors, and analyses for evaluating the performance of modern flight test vehicles. The effort will be accomplished through in-house and contract support.

W78-70086

505-11-22

Lewis Research Center, Cleveland, Ohio
NON-AXISYMMETRIC NOZZLE AEROTHERMODYNAMICS
Ross G. Willoh 216-433-4000
(505-04-12)

The objective of this program is to establish through analytical studies, system design efforts, and full-scale test programs, the technology base required for the application of unique configurations to future combat aircraft. Current activities are specifically directed toward providing the technology required for the design of nonaxisymmetric exhaust nozzles for turbine engines. The high maneuverability requirements anticipated in future aircraft designs lead to the application of nonaxisymmetric nozzles capable of thrust vectoring and reversing. Experimental and analytical efforts will be undertaken to improve the technology available for the design of nonaxisymmetric exhaust systems. Principal areas of concern will include cooling, heat transfer, structural design, weight and internal aerodynamics. The objectives will be accomplished through contract studies, nozzle design and fabrication carried out under this RTOP, and altitude testing of existing hardware under the Inlets and Nozzle RTOP (505-04-12). Particular emphasis will be placed on solutions to the complex cooling, structural and internal aerodynamic problems associated with nonaxisymmetric nozzles. Close coordination will be maintained with Langley Research Center and the Air Force to assure that work in the propulsion area appropriately supports Air Force requirements and the aerodynamic work at Langley.

W78-70087

505-11-23

Langley Research Center, Langley Station, Va
COMBAT VEHICLE AND MISSILE AERODYNAMICS AND FLIGHT DYNAMICS
C. M. Jackson 804-827-3134

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 such as supercritical aerodynamics, wing warp, maneuver devices, thrust-induced lift, nonaxisymmetric nozzles, and component interference. Similar studies will be made to expand the aerodynamic technology base for missile systems including conventional cruciform stability and control concepts, air-breathing propulsion integration, and monoplane concepts.

W78-70088

505-11-24

Hugh L. Dryden Flight Research Center, Edwards, Calif.
HIGH-SPEED AIRCRAFT AERODYNAMICS
T. G. Ayers 805-258-3311

The broad objectives of this RTOP are to (1) provide a continuing research and development effort for the cost effective evaluation of new and emerging aerodynamic, propulsion, flight controls, and man-vehicle interface technologies for high performance aircraft, (2) assess the feasibility and validity of

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predicting full-scale airplane stall, departure, spin entry, and recovery characteristics from small-scale wind tunnel and free flight tests through a phased major flight program; and (3) provide an aerodynamic data base for application to preliminary design of future high performance aircraft

W78-70089 505-11-33
Langley Research Center, Langley Station, Va
HYPERSONIC AIRCRAFT AERODYNAMICS AND FLIGHT DYNAMICS
F S Kirkham 804-827-3877

The primary objective of this effort is to provide an aerodynamics technology base for future airbreathing hypersonic aircraft through theoretical analysis and experimental investigations of configuration aerodynamics, stability and control, aerodynamic heating, and propulsion system integration. Areas to be emphasized are those which hold the highest potential for future pay-offs, such as deriving benefits in vehicle performance from mutual interactions of the aircraft and its propulsion system and the development of configurations which minimize areas of interference heating. Many aspects of this program such as the advanced analysis and design techniques are generally applicable to supersonic aircraft and future space transportation systems as well as to hypersonic vehicles. The approach to be used will emphasize the development and application of advanced analytical and experimental methods which are capable of addressing complex flow phenomena such as the propulsion system exhaust. Analysis methods will include such effects as viscous flows, inlet spillage, embedded shocks, and finite rate chemistry. Experimental methods will include provisions for making force measurements in conventional wind tunnels of models with simulated exhaust flows. A systematic conceptual design and evaluation procedure will be implemented with which meaningful trade studies can be made and the conceptual design work will be used to guide future technology development.

W78-70090 505-11-41
Ames Research Center, Moffett Field, Calif.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
L Roberts 415-965-5848

Technical assistance, consultative services and support, through the use of NASA facilities, will be provided to outside agencies and the aircraft industry. Principal assistance is to the Department of Defense (DOD) for aircraft and missile systems development programs. Additionally, joint activities will be conducted with other government agencies and industry on a fee or reimbursable basis. Areas of support include research activities to aid in assuring satisfactory aerodynamic and handling qualities of piloted aircraft in routine operational flight and in advanced weapon delivery tasks, and in assuring satisfactory flight path and attitude control of these aircraft in given automatic flight modes such as radar-guided approaches and landings on an aircraft carrier. Also included are efforts to define and develop techniques for improvement of marginal or unsatisfactory characteristics of new airplane designs. Wind tunnels, flight simulators, and central computer facilities (360, 7600), together with applications of advanced control theory, will be employed as required. Specific systems for which support is planned during FY-1978 include: Type A VTOL, AV-8, XFV-12, HIMAT, F-18, F-16, Advanced Fighter Technology Integration Program (AFTI), B-1, F-4, A-6E, S-3A, F-14, McDonnell-Douglas DC-X-200, Boeing 7X and 7N-7 Aircraft Programs and Advanced Missiles.

W78-70091 505-11-42
Lewis Research Center, Cleveland, Ohio
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
D N Bowditch 216-433-4000

The objective is to support requests from the Department of Defense, Department of Transportation and other Federal agencies outside of NASA for aerodynamic testing in the facilities of the Lewis Research Center. Facilities typically used under this RTOP include 10x10 SWT, 8x6 SWT, 9x15 SWT, icing tunnel and PSL.

W78-70092 505-11-43
Langley Research Center, Langley Station, Va.
INTERAGENCY AND INDUSTRIAL ASSISTANCE AND TESTING
W P Henderson 804-827-2676

The broad objective is to provide technical assistance and consultative services to outside agencies and the 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. Current activity is focused in the areas of stall/spin; aerodynamic characteristics at subsonic, transonic, and supersonic speeds; flutter and aeroelasticity; structures; landing loads and simulation. 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 committees.

W78-70093 505-11-54
Hugh L Dryden Flight Research Center, Edwards, Calif
REMOTELY PILOTED RESEARCH AIRCRAFT TECHNOLOGY
P C Loschke 805-258-3311
(723-01-04)

This RTOP covers effort in three areas, the AD-1 oblique wing research vehicle, the RPRV capability development program, and the RAV development. An exploratory low speed flight study of the piloting characteristics of oblique wing aircraft is proposed using a low cost experimental manned jet-powered model. Objectives have been selected with a view to providing a basic framework of data and flight experience for planning a more comprehensive transonic evaluation of the concept using a TF-8 aircraft. A remotely piloted research vehicle (RPRV) capability will be developed for performing flight research with supersonic, maneuverable vehicles, and for conducting flight research using a supersonic RPRV as a versatile high performance research test bed. A Firebee II target drone on loan from the USAF has been modified to the RPRV configuration. The RAV development covers conceptual investigation of several candidate interfaces between simplex ground computers and multichannel airborne fly-by-wire control systems. The effort will include pilot-in-the-loop control and FMEA analysis for these systems. Applications of this effort will include the PA-30, F-16 CCV, and F-8 DFBW airplanes.

W78-70094 505-15-31
Ames Research Center, Moffett Field, Calif.
APPLIED MATHEMATICS AND COMPUTER SCIENCE
H Lomax 415-965-5124
(505-06-11)

The objective is to develop new mathematical methods and models for computer simulation of fluid flows. Various numerical techniques for the solution of the complete governing partial differential equations of fluid dynamics with attendant boundary and initial conditions will be analyzed, tested, and evaluated for reliability, accuracy, and efficiency. Splitting of the finite difference operators, implicit algorithms, and direct elliptic solvers are some of the approaches to be studied. Numerical analysis will be emphasized rather than the physical phenomenon. The ultimate objective is the efficient use of the ILLIAC IV, CDC 7600, and other large computers in the simulation and understanding of fluid dynamics phenomena.

W78-70095 505-15-33
Langley Research Center, Langley Station, Va
APPLIED MATHEMATICS AND COMPUTER SCIENCE
W D Erickson 804-827-2471

This RTOP provides for the conduct of basic research in applied mathematics and computer science. 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 numerical solutions of differential

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and algebraic systems, data analysis, computer graphics, symbolic and algebraic manipulation, data base management, programming languages, microprocessor software, and software engineering. The broad research areas pursued in ICASE include the efficient use of vector and parallel computers, numerical analysis, computational research in selected areas of science and engineering of interest to NASA, and computer systems and software.

System Studies (Aeronautics)

W78-70096 791-40-11
Ames Research Center, Moffett Field, Calif
SHORT HAUL AIR TRANSPORT CONCEPTUAL DESIGN STUDIES
W H Deckert 415-965-5887
(516-50-11, 511-57-01)

Technology is constantly being developed through analytical and experimental programs in all the traditional aeronautical disciplines--aerodynamics, propulsion, structures, materials and avionics. Currently, through programs such as Aircraft Energy Efficiency (ACEE), there is renewed emphasis in improved subsonic transport aircraft design and the integration of these technologies into a total aircraft system. The objective of this RTOP is to identify the potential payoff of these aeronautical technologies applied to short- to mid-range transport aircraft. Also, the output from this work will be used to define the need for additional experimental and flight research projects.

W78-70097 791-40-13
Langley Research Center, Langley Station, Va
AIR TRANSPORTATION SYSTEM STUDIES
D. W. Conner 804-827-3838
(516-50-23)

The objective is to develop through studies and analyses an overview of the technical, economic, and benefit aspects of existing and potential air transportation systems and systems elements. The approach will be to identify the technology needs for advancing these systems; to assess the impact of these advanced technologies on present and future civil and military air transportation, to assess the impact on total transportation; and to establish a basis for planning future technology programs. Both in-house and contractual efforts will be utilized.

W78-70098 791-40-21
Ames Research Center, Moffett Field, Calif
MILITARY V/STOL AIRCRAFT CONCEPTUAL DESIGN STUDIES
W H Deckert 415-965-5887
(505-10-31, 505-10-36)

The objective of this RTOP is to support DOD programs, with emphasis on technologies that parallel ongoing civil programs. Current emphasis is placed on the conceptual design of Navy V/STOL supersonic and high subsonic aircraft. The approach will be the modeling and integration of advanced technologies into in-house military aircraft synthesis programs and utilization of these programs in the analysis of V/STOL aircraft systems intended to meet mission requirements obtained from or developed in cooperation with appropriate DOD planning personnel. These design studies are closely coordinated with both the low speed and high speed V/STOL test programs currently underway at the Ames Research Center. Experimental results will be factored into the design studies, and in turn, the study results will define future test requirements. Historically, NASA has supported the DOD by generating advances in technology and by providing analysis, test, and development assistance when requested (on specific designs). This RTOP seeks to involve NASA in assessing the readiness of advanced technologies and assisting the military services in exploring the same for future aircraft.

W78-70099 791-40-23
Langley Research Center, Langley Station, Va
FUTURE MILITARY AVIATION SYSTEM STUDIES
W C Sawyer 804-827-3181

The technical objective of this work is to identify aerodynamic, propulsion, and structural technology areas significant to the development of future generations of military systems including missiles and aircraft. In close coordination with DOD, one or more technology studies will be conducted to evaluate alternative vehicle and system concepts and build an information base for research program planning in support of future military aviation systems.

W78-70100 791-40-31
Ames Research Center, Moffett Field, Calif
UTILITY AIR VEHICLE SYSTEM AND CONCEPT STUDIES
W H Deckert
(514-50-01)

The objective of this RTOP is to identify the potential payoff of advanced aeronautical technology applied to short range utility air vehicles. Emphasis is placed on rotorcraft, but lighter than air vehicles are considered as well. Definition of applicable technologies is found primarily in the R&T base through analytical and experimental programs in all the traditional aeronautical disciplines--aerodynamics, propulsion, structures, materials and avionics. In turn, output from this work will be used to define the need for additional experimental and flight research projects.

W78-70101 791-40-38
Wallops Station, Wallops Island, Va
AIRBORNE EXPERIMENT PLATFORMS
H C Needleman 804-824-3411

This study effort is directed toward establishing the utility and technology requirements of two classes of unmanned air-borne experiment platforms - high altitude powered platforms, including heavier than air and lighter than air vehicles, and aircraft or shuttle launched balloon borne platform - for use by the scientific and applications experimenter community as tools to complement existing research techniques. User applications, mission concepts, and system concepts will be investigated with emphasis on high altitude and development operations, compatibility with science user requirements, and system integration.

W78-70102 791-40-41
Ames Research Center, Moffett Field, Calif
AERONAUTICAL SYSTEMS & PLANNING ANALYSIS
J. L. Jones 415-965-5566

The objective of this effort is to define and clarify economic and government policy issues affecting aviation and transportation, to assess technology impacts and benefits, and to develop methods and an information base for use in OAST R&T program planning. This work will: (1) develop an understanding of the important factors influencing the growth of aviation and a methodology for assessing the potential benefits and costs associated with the introduction of improved aeronautical R&T on future civil aircraft, (2) enhance NASA's understanding of the contribution of aeronautics in providing adequately for the Nation's future transportation needs, including air transportation's relationship to other transportation modes and its role in inter-modal systems, develop and utilize a systems methodology, encompassing socio-economic, technological, demographic, and political factors, to identify transportation systems, hence technology, requirements for selected developing nations, and assess the technology required to design large-scale computers capable of providing wind tunnel type data, and so supplement wind tunnel testing. This effort will allow NASA to better identify, and quantify, the research with the greatest potential for application to improve the air transportation system.

W78-70103 791-40-43
Langley Research Center, Langley Station, Va
SYSTEMS AND PLANNING ANALYSIS
D. W. Conner 804-827-3838
(791-40-41, 791-40-13)

The objective of this effort is to define and clarify economic and government policy issues affecting aviation and transportation, to assess technology impacts and benefits, and to develop methods and an information base for use in OAST R&T program planning. The approach will be to search out and develop an understanding

of the important factors influencing the growth and use of aviation for transportation of passengers and cargo, to identify, through analysis of present situations, opportunities for technology advancements which can significantly reduce operational costs or improve operations of civil systems, and to develop and exercise methodology for assessing the potential market demands, economics, and cost/benefits for air transportation as affected by the introduction of improved technology in future aircraft and their operations.

W78-70104 **791-40-53**
Langley Research Center, Langley Station, Va.
GENERAL AVIATION SYSTEM STUDIES
A W Hall 804-827-3274

The objective of this work is to undertake studies to evaluate missions and aircraft concepts in order to identify the technology requirements for increased productivity of general aviation aircraft. These studies will define the technology requirements for existing missions as well as studies of new missions. The initial thrust of this work is to study system design requirements for an overall aerial application system to identify potential new concepts for implementing advanced technologies to aerial applications. Aerial and ground systems will be explored, along with cost and benefits, to improve productivity, systems integration, environmental compatibility, and safety of systems for aerial planting, fertilizing, and pest control. Operations analysis of current agricultural aviation systems will be made to establish state of the art as an engineering design datum.

Aeronautics Systems Technology Programs

W78-70105 **510-53-02**
Lewis Research Center, Cleveland, Ohio
MATERIALS FOR ADVANCED TURBINE ENGINES (MATE)
N T. Saunders 216-433-4000
(505-01-12)

The purpose of this program is to accelerate the application of advanced materials technologies to aircraft turbine engines in order to achieve improved engine performance benefits. The program involves the application of previously laboratory-verified advanced materials technologies for engines planned for the 1980-85 time frame. It covers the advanced development, rig testing, and engine testing necessary to demonstrate the potential of the new materials for use in future engines. The program is conducted through contracts with domestic engine manufacturers and their vendors. New materials that have shown laboratory feasibility in exploratory development programs have been selected for further development and evaluation under this program. Cost/benefit and risk analyses are conducted to help guide the selection of the best candidate materials. The selected materials are then scaled-up, manufactured into appropriate engine hardware, extensively evaluated to provide preliminary design data, and tested in both engine-simulation rigs and experimental engines to demonstrate their potential for future engine use.

W78-70106 **510-54-03**
Langley Research Center, Langley Station, Va.
INTEGRATED PROGRAMS FOR AEROSPACE-VEHICLE DESIGN
R E. Fulton 804-827-2887
(505-02-33, 743-01-03, 524-71-03)

The objective is to reduce vehicle design cycle time by 50 percent and design costs by 25 percent by 1980 through development of a computer-aided design system for industry. A statement of work incorporates results of Boeing and General Dynamics IPAD Feasibility Studies, critiques of those studies, and a missile system design application study. Industry interface approach has been formulated and summarized in a prospectus disseminated to industry. An advisory group to the prime contractor was organized by the prime contractor and contains representatives from the aerospace and computer industries. Industrial development has been undertaken with a prime contractor.

In-house work will be aimed at monitoring the contractor to ensure development of software which will improve the productivity of the U S aerospace industry.

W78-70107 **510-55-02**
Lewis Research Center, Cleveland, Ohio
AEROELASTICITY OF TURBINE ENGINES
M J. Hartmann 216-433-4000

The aeroelastic program is directed toward improving flutter boundary design criteria so that the occurrence of flutter in fans and compressors for advanced propulsion systems is essentially avoided. If flutter is encountered these criteria may also be used to expeditiously clear flutter from the operating region. The program will also provide, through analytical and experimental research, a more fundamental basis for reliable analysis, prediction, and thus the avoidance of instability regions. Analytical methods and computer codes will be developed to predict the unsteady aerodynamic forces under various flutter conditions, and to calculate the structural modes of blades, shrouds and disks as utilized in fans and compressors for advanced engines. The unsteady aerodynamic analysis will be verified in cascades in which the blades are driven as if they are in flutter. The structural analysis will be verified in a vacuum spin rig and in vibration rigs. The coupling of the aerodynamic forces and structure will be verified in suitable instrumented experimental fans. The prediction methods will be further verified by application to realistic data such as that obtained in full scale engine research programs. This aeroelastic program is the NASA portion of an interdependent and coordinated program involving LeRC and AFAPL. The effort involves inhouse projects, as well as contract research with aerospace companies, and grants to various universities.

W78-70108 **510-56-01**
Ames Research Center, Moffett Field, Calif.
FIRE-RESISTANT MATERIALS ENGINEERING
D A Kourides 415-965-5226
(505-01-31; 505-08-21)

Appropriate materials technology will be developed in conjunction with the airframe manufacturers to make aircraft components as fire resistant as feasible in order to provide an increased probability of passenger and crew survivability in aircraft interior and crash fires. Fire-resistant materials technology will be utilized for possible application in the design of fire safe airframe structures and aircraft interiors. Laboratory and small scale tests will be conducted to assess the flammability and other properties of the state-of-the-art and improved materials. Fire resistant composite systems will be evaluated for ultimate application as lavatory, ceiling and sidewall sandwich panels. In addition, these and other composite structures will be evaluated for fire protection against postcrash fuel fires. Various films and adhesives will be evaluated for aircraft interior applications which will result in significant reduction of flame propagation and associated hazards. Fire resistant materials including foams and fabrics will be evaluated as components of aircraft seats. This program will be conducted primarily with the major airframe manufacturers.

W78-70109 **510-56-05**
Jet Propulsion Lab., Calif Inst of Tech., Pasadena
FIRE RESISTANT MATERIALS ENGINEERING
J. D Ingham 213-354-4401

The objective of this RTOP is to reduce the fire hazard associated with materials used in aircraft. This objective will be accomplished by research on the modification of polymeric materials by developing additives, fillers and compositional changes which will reduce the flammability while also reducing the smoke and toxic gases generated during combustion compared to conventional flame retardants that usually contain halogens, phosphorous or other elements that evolve toxic, smokey products. The approach in this work will be to formulate polymers which contain large amounts (60 wt % or more) of fillers that can evolve nontoxic gases and enhance char formation under pyrolysis conditions. In addition, on the basis of theoretical analyses, fillers will be coated to extend the ignition times and reduce volatile evolution rates after ignition.

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W78-70110

510-56-17

Lyndon B Johnson Space Center, Houston, Tex
FIRE SYSTEMS AND FULL SCALE TEST
R W. Bricker 713-483-3166
(505-08-21)

The effort defined in this RTOP consists of a continuation of work originally started in FY-76 and maintained to FY-77. It provides for the full-scale baseline, calibration, and newly developed material tests in aircraft cabin and cargo bay simulators. It provides for flammability testing of components in the JSC 737 fuselage at JSC utilizing GFE materials. In addition, the RTOP provides for the continuation of the task for the delivery of technical data and reports which will expedite the evaluation and analyses of the various program segments and for the in-house support and coordination of the overall total program. It further provides for the development of new polymer molding techniques and processes and the development of improved techniques for evaluating the toxicity of new materials.

W78-70111

510-57-01

Ames Research Center, Moffett Field, Calif.
COMPOSITES DURABILITY TECHNOLOGY
H G Nelson 415-965-6137

The objective of this work is to develop the necessary understanding of composite behavior to permit the design and performance of accelerated tests to establish the durability of advanced composite materials under the combined effects of environmental exposure and cyclic loads. This will be accomplished by a combined program of analysis and experiment directed at defining the relationships between time, temperature, environmental parameters, and material characteristics which control the amount and rate of moisture uptake and its distribution in the material, determining the effects of moisture content and distribution on material properties such as tension, compression, and shear strengths, and fatigue life; identifying the mechanisms for such environment-induced property variations and establishing the effects of combined environmental exposure and cyclic loading, developing an analytical method for predicting an accelerated time environmental exposure sequence for producing any expected long-time moisture content and distribution, and conduct tests under accelerated conditions to confirm the adequacy for inducing material property variations similar to real-time exposures.

W78-70112

510-57-02

Lewis Research Center, Cleveland, Ohio.
ENGINE COMPOSITES DURABILITY
R L Davies 216-433-4000
(505-01-32, 505-02-12)

The overall objective of this research is to develop long-life, durable composite engine components such as fan blades and engine static structures. This will be accomplished through programs aimed at developing improved composite blade designs and demonstrating their durability through rotating rig foreign object damage (FOD) tests, and also fatigue and other life-cycle survivability requirements. In addition, the necessary quality assurance (QA) procedures for long-life, durable composite engine components will be established. The QA procedures should permit manufacture and acceptance of uniform quality fiber-reinforced polymer matrix composites. The cost effective use of composites requires that components be designed and manufactured in an efficient manner with an ability to assure reproducibility and integrity. The effort will initially focus on generating the technology needed to upgrade quality assurance procedures with emphasis on improved testing methods for quality control and inspection. Subsequently, efforts will be directed at applying the improved QA procedures to the manufacture of a few selected engine components and then demonstrating the durability benefits of the improved-quality parts in long-term tests under simulated engine operating conditions.

W78-70113

510-57-03

Langley Research Center, Langley Station, Va
COMPOSITES DURABILITY TECHNOLOGY
E E Mathauser 804-827-2036
(505-02-13)

The objective is to develop and demonstrate methods for relating composite materials characteristics to the lifetime performance of airframe components under operating load and environments. Included are studies to develop fundamental understanding of environmental effects, to develop improved design concepts, and to develop criteria that will assure long-term service life. Emphasis will be directed at identification of significant parameters and development of procedures for quality control of graphite/epoxy composites. Studies will be made to develop reliable composite materials test methods and to establish accelerated test and analysis methods to predict long-term performance. Composite materials will be exposed in the flight environment to determine effects of moisture and other degradation mechanisms on mechanical properties. Fatigue tests will be undertaken to identify failure modes in typical wing-type composite structures. Compressive strength tests of structural panels will be made to provide a data base for composite structures and to indicate failure modes and failure strain levels. The results of this program are expected to give added confidence in structural design by providing information on the durability and long-term service life of composite structures.

W78-70114

511-53-02

Lewis Research Center, Cleveland, Ohio.
QUIET, CLEAN GENERAL AVIATION TURBOFAN (QCGAT)
G K Sievers 216-433-4000
(505-03-12)

An experimental program is being conducted to provide the technology for quiet, clean and economical general aviation turbofan engines. The program utilizes existing general aviation turbine-driven gas generator cores in experimental, quiet, high bypass turbofan engines. The experimental engines incorporate the latest quiet engine technology derived from the Quiet Engine Program, the Quiet, Clean Short-Haul Experimental Engine Program, and other related component technology programs. The approaches selected for noise reduction are those considered appropriate for one or more specific engine applications. They include both source noise reduction and noise suppression techniques. Three study contracts awarded to three engine manufacturers to provide NASA with information required to start an experimental engine program (QCGAT) have been completed. Two contractors for the current phase have been selected and both are under contract. Each will design, fabricate, assemble, ground test, and deliver an experimental turbofan engine.

W78-70115

511-54-02

Lewis Research Center, Cleveland, Ohio
ENGINE COMPONENT IMPROVEMENT PROGRAM
Joseph A Ziemanski 216-433-4000

The objectives of the Engine Component Improvement Program are to: (1) develop components with improved performance which would reduce fuel consumption of current engines and be ready for introduction into new production of these engines in the 1980-1982 time period or sooner, and (2) provide additional technology which can be used to minimize the performance degradation of current and future engines. The program has been divided into two parts: performance improvement and engine diagnostics. The performance improvement part is aimed at developing fuel saving components for new production of the JT8D, JT9D and CF6 engines and for upgrading of existing JT8D, JT9D, and CF6 engines. The primary elements of this part of the program are feasibility analysis, component rig/model tests, and full-scale engine tests. Components to be evaluated will include seals, clearance controls, exhaust nozzle mixers, and engine digital electronic fuel control. The engine diagnostics part of the program will consist of analysis and test of the JT9D and CF6 engines to identify and quantify the sources and the causes of engine performance deterioration with time. This information will be used to improve current engines and aid in the design of future engines.

W78-70116

511-55-02

Lewis Research Center, Cleveland, Ohio
STRATOSPHERIC CRUISE EMISSION REDUCTION
D A Petrash 216-294-6860
(505-03-22)

The objective is to establish and demonstrate the technology necessary to reduce exhaust emissions from modern gas turbine aircraft engines to environmentally acceptable levels over the entire subsonic flight envelope with minimum adverse effects on performance, weight and complexity. Special emphasis will be placed on achieving extremely low ($<3\text{g NO}_2/\text{kg}$ fuel burned) oxides of nitrogen (NO_x) emissions at stratospheric cruise conditions. NO_x emissions will be reduced by operating the combustion system at extremely lean fuel-air mixtures. Initially, fundamental in-house, grant, and contract studies will examine practical problems associated with this technique. Studies will be conducted to examine NO_x production in lean combustion systems, flashback and autoignition limits, fuel preparation and stability augmentation techniques, and combustor constraints imposed by the engine. With the design information from the initial studies, combustor concepts will be integrated into engine system designs and assessed. Concepts which show potential for achieving program goals will be tested and screened. The most promising designs will be developed through component tests leading to an engine verification. If resultant optimized concepts cannot be incorporated into an existing engine, a preliminary engine design compatible with the combustion system will be developed.

W78-70117

Lewis Research Center, Cleveland, Ohio
VARIABLE CYCLE ENGINE COMPONENTS
 Albert G. Powers 216-433-4000

Advanced supersonic transport aircraft are required to operate over a wide variety of flight conditions. This creates conflicting requirements on the propulsion system which, in many cases, can be most effectively met by a variable cycle engine (VCE). A VCE typically has 2 or more distinct operating modes, each tailored to provide optimum efficiency at one of the major flight conditions, e.g., takeoff, subsonic cruise and supersonic cruise. SCAR engine studies conducted under RTOP 743-03-41 have identified two VCE candidates of primary interest. These are the variable stream control engine (VSCE) and the double bypass engine (DBE). Both engines offer significant potential improvements over conventional engines in terms of both performance and environmental impact. Each depends, however, on the efficient functioning of novel and unique components including their compatibility with each other and with other engine subsystems when integrated into the selected engine configuration. It is the objective of this RTOP to provide the component technology and component/engine integration data required in the most critical areas of both selected engines to demonstrate the critical components technology required for supersonic cruise engines with high propulsive efficiency together with reduced noise and emissions.

W78-70118

Ames Research Center, Moffett Field, Calif.
ADVANCED TURBOPROP PROGRAM - INSTALLATION AERODYNAMICS
 Leonard Roberts 415-965-5887

The objective of this research is to support the development of the technology required to demonstrate the feasibility of advanced turboprop transport aircraft capable of cruise speeds and altitudes up to 8 Mach number and 35,000 ft. System studies will be conducted to analyze specific aircraft design tradeoffs. These studies will serve to identify the most promising directions for future research and the potential market for advanced turboprop aircraft. To provide an analysis of the flow field about the actual propeller blades, an advanced computational method using finite difference techniques will be developed. The method will identify the near and far field flow conditions which can be used in the analysis of the acoustic and aerodynamic characteristics of the propeller. Through a combination of theoretical and experimental studies, the aerodynamic technology required to integrate advanced turboprop propulsion systems with transport aircraft using supercritical wing technology will be developed. Detailed flow interactions among the propeller slipstream, nacelle, and wing surface will be examined and methods identified to optimize the installation. Theoretical analyses will include existing

linear methods and the development of an advanced method capable of handling the transonic slipstream-nacelle-wing interaction. Experimentally, the flow interactions will be investigated using (1) a slipstream simulator to define the characteristics of the slipstream-supercritical wing interaction, and (2) a powered semispan model to provide an accurate simulation of the actual flow conditions.

W78-70119

Lewis Research Center, Cleveland, Ohio.
ADVANCED TURBOPROP PROGRAM
 James F. Dugan 216-433-4000
 (511-50-01, 716-01-01, 505-04-72)

The objective of the Advanced Turboprop Program is to demonstrate technology readiness for efficient, reliable, and acceptable operation at cruise conditions comparable to current turbofan-powered aircraft. The Advanced Turboprop Program will be implemented in three phases. This RTOP covers Phase 1 of the program. In Phase 1, wind tunnel tests will be performed to determine the aerodynamic and acoustic performance of two-foot-diameter models. The sound pressure level of an advanced two-foot-diameter propeller model will be determined in flight tests or in wind tunnel tests at Mach 0.8. Propeller noise prediction programs will be developed to include thin swept propeller blades experiencing airflow greater than Mach 1.0. Propeller blade materials and structural concepts will be screened for feasibility and aeroelastic behavior. Preliminary designs for advanced large-scale propeller blades will be evaluated. Through analysis and wind tunnel model tests, the interactions of the propeller, nacelle, and wing will be evaluated. Propeller noise attenuation will be investigated by conducting fuselage wall acoustic attenuation studies, by performing model tests, and by investigating the feasibility of scaling fuselage acoustics. Design concepts for advanced gearboxes and pitch change mechanisms will be evaluated. Existing gas turbine shaft engines and cores will be screened for use as a propeller drive for Phases 2 and 3.

W78-70120

Hugh L. Dryden Flight Research Center, Edwards, Calif.
ADVANCED TURBOPROP PROGRAM - FLIGHT TEST
 W. G. Schweikhard 805-258-3311
 (511-57-02)

The objective is to develop and demonstrate by flight tests the technology for advanced turboprop propulsion systems having high propulsion efficiencies at cruise speeds and altitudes up to Mach 0.8 and 35,000 feet. This technology could provide fuel savings of 20% to 25% relative to current high-bypass turbofan engines while meeting reliability requirement and environmental noise constraints. A two-foot diameter scale model of an advanced high tip speed propeller will be installed on a subsonic aircraft capable of flying Mach .8 at 30,000 feet altitude. Microphones will be placed on wing and fuselage, and acoustic flight test will be performed to obtain near field noise data. A feasibility study by one or more aircraft manufacturers will be performed to investigate the various approaches to evaluate advanced full-scale turboprop engines either as a testbed engine or as a replacement of existing aircraft engines.

W78-70121

Lewis Research Center, Cleveland, Ohio
HELICOPTER TRANSMISSION SYSTEMS TECHNOLOGY
 W. J. Anderson 216-433-4000
 (505-04-42, 506-16-22)

The objectives of this work are to develop the technology required for the design of advanced transmission systems for helicopter applications, to extend bearings, gearing, lubrication and traction concepts to achieve lightweight, compact, low-noise, long-life, low-cost, mechanical-power transmission systems for advanced commercial helicopters, and to evaluate these concepts in component and transmission tests. A helicopter hybrid traction drive which has the potential of being more compact and more reliable while being less costly and quieter than conventional transmissions will be designed and tested. Advanced NASA bearing, gearing, seals and lubrication technology will be demonstrated on standard type transmission systems to evaluate improvements in life, load carrying capacity and survivability.

511-57-02**511-56-02****511-57-04****511-57-01****511-58-02**

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

W78-70122

512-51-03

Langley Research Center, Langley Station, Va
DIGITAL FLY-BY-WIRE FLIGHT EXPERIMENT
J R Elliott 804-827-4681
(505-07-33; 512-51-04)

The overall objective of this effort with DFRC is to provide the technology necessary for the implementation of advanced reliable Digital Fly-By-Wire systems in future aircraft. The program is to be carried out in accordance with the schedules and resources identified by the Digital Fly-By-Wire Project Plan. The Phase I flight-test program to establish Digital Fly-By-Wire systems feasibility has been completed. In Phase II which is currently underway, a multi-channel digital system has been developed and is undergoing flight tests in the F-8C aircraft. This is a three-channel system utilizing redundancy management concepts similar to Space Shuttle applications and providing the capability to evaluate, in flight, advanced control laws being developed jointly with DFRC. In FY-78, flight evaluations of an adaptive control law will be completed and analytical redundancy management concepts developed for evaluations in FY-79.

W78-70123

512-51-04

Hugh L. Dryden Flight Research Center, Edwards, Calif.
DIGITAL FLY-BY-WIRE FLIGHT EXPERIMENT
C R Jarvis 805-258-3311
(512-51-02)

The overall objective of this effort with LaRC is to provide the technology necessary for the implementation of advanced reliable digital fly-by-wire systems in future aircraft. The program is to be carried out in accordance with the schedules and resources identified by the digital fly-by-wire project plan. The Phase I flight test program to establish digital fly-by-wire systems feasibility has been completed. In Phase II, which is currently underway, a multichannel digital system has been developed and is undergoing flight tests in the F-8C aircraft. This is a three-channel system utilizing redundancy management concepts similar to space shuttle applications and providing the capability to evaluate, in flight, advanced control laws being developed jointly with LaRC. In FY-1978, flight evaluations of an adaptive control law will be completed and analytical redundancy management concepts developed for evaluations in FY-1979.

W78-70124

512-52-01

Ames Research Center, Moffett Field, Calif.
GENERAL AVIATION ADVANCED AVIONICS SYSTEMS
C T Snyder 415-965-5427
(512-52-02; 513-50-11)

The objective of this program is the design and demonstration of a totally integrated advanced, low-cost avionics system to enhance the safety, reliability, and utility of future general aviation aircraft. The approach is to synthesize various subsystem concepts and conduct supporting studies of the projected microelectronic and fluidic technology, aircraft design, and air traffic control environment of the 1980's, to formulate a system definition which can be scrutinized against requirements and cost-benefit criteria to formulate final specifications and designs. The system design will be verified in simulations and flight tests with active participation of the FAA and the aviation industry. This is a joint program between ARC and LaRC. The lead center is ARC who, in addition to subsystems development, is responsible for the overall final system design, fabrication, simulations and flight tests. LaRC is responsible for the development of fluidic and other avionic subsystems with emphasis directed toward the light aircraft end of the general aviation spectrum.

W78-70125

512-52-03

Langley Research Center, Langley Station, Va
GENERAL AVIATION ADVANCED AVIONICS
H. J. E Reid, Jr. 804-827-3551
(505-07-13)

The objective of the work under this RTOP is the development of subsystem concepts, using fluidic and electronics technology, which will enhance the safety and utility of general aviation light aircraft. The approach is to develop and test in simulation and flight, navigation, control, and display components, instrumentation, and subsystems. Potential reliability and low cost are

stressed in this work. Control concepts for autopilot application, which are independent of aircraft primary control, and with a reduced authority, are examples. A fundamental thrust of this work is to develop autopilot concepts which eliminate expensive, high-maintenance components such as gyroscopes. This is a joint program between ARC and LaRC. The lead center is ARC which, in addition to subsystems development, is responsible for the overall final system design, fabrication, simulations and flight tests. LaRC is responsible for the development of fluidic and other avionic subsystems with emphasis directed towards the light aircraft end of the general aviation spectrum.

W78-70126

513-50-11

Ames Research Center, Moffett Field, Calif.
SYSTEM TECHNOLOGY STUDIES
C. T. Snyder 415-965-5567

The overall objective is to analyze the operational compatibility and safety of future air transportation systems and concepts, identify technology and systems requirements, and evaluate the critical cost-benefit parameters. The three following programs will be carried out to accomplish this: (1) demonstrate the feasibility of low cost microwave landing system (MLS) avionics by designing, fabricating and testing a MLS airborne receiver for small community operations and assess suitable cost/performance/technology tradeoffs; (2) through contractor and in-house studies, simulation methods for the validation and failure effects analysis of advanced digital flight control and avionic systems will be identified, evaluated, developed and demonstrated through a joint NASA/FAA/Industry program to improve the certification process, encourage the technology transfer of advanced flight control and avionic concepts and to increase confidence in failure modes analysis methods, and (3) the operation of commuter transport aircraft at major hub airports will be investigated to determine flight path control, terminal access turn around time, aircraft/airport compatibility, congestion reduction, operational aspects, safety and environmental impacts such as noise, emission, public acceptance, etc.

W78-70127

513-50-13

Langley Research Center, Langley Station, Va.
SYSTEMS TECHNOLOGY STUDIES
B L Dove 804-827-3681

An Omega navigation aircraft receiver, developed in-house, will be evaluated in a flight test program at the Wallops Flight Center. Receiver performance when operating in the difference mode, to expand distinct lane width, will be assessed as will the standard and differential operational modes of Omega. Also, a generalized capability will be developed to analyze the functions and safety of hardware and software designs of representative digital systems.

W78-70128

513-52-13

Langley Research Center, Langley Station, Va.
TERMINAL CONFIGURED VEHICLE PROGRAM
J P Reeder 804-827-2377
(505-07-31)

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

compatibility with the microwave landing system (MLS) under development by DOT/FAA and with traffic control systems.

W78-70129**513-53-11**

Ames Research Center, Moffett Field, Calif

STOL OPERATING SYSTEMS

C T Snyder 415-965-5424

Experiments will be conducted on navigation, guidance, control, and flight management systems concepts for STOL aircraft using advanced integrated airborne avionics including advanced strapdown laser gyros and a time-reference scanning beam (TRSB) microwave landing system. The results will be used to define design criteria and operational procedures for STOL aircraft in the terminal area. Investigations will be conducted encompassing analysis, simulation, flight experiments, and supporting studies. These investigations will emphasize the terminal area navigation, guidance, control, and flight management problems which must be solved to take maximum advantage of STOL aircraft capabilities for making steep ascents and descents, tight turns, and slow speed approaches and landings. The flight experiments will be conducted using the flexible airborne digital research avionics system (STOLAND) and the strapdown laser gyro inertial reference system in conjunction with DHC-6 (Twin Otter) aircraft, Augmentor Wing Jet STOL Research Aircraft, YC-15 AMST aircraft, and Quiet STOL Research Aircraft (QSRA). The ground navigation aids used in these investigations include VOR/DME, TACAN, and a prototype TRSB microwave landing guidance system furnished by the FAA.

W78-70130**513-54-11**

Ames Research Center, Moffett Field, Calif.

VTOL OPERATING SYSTEMS EXPERIMENTS

C T Snyder 415-965-5430

(513-53-11)

The objective is to develop a data base for use in establishing navigation, guidance, and control system concepts, design criteria, and operational procedures for VTOL aircraft. This technology base will aid the development of efficient, economical VTOL short haul operations with minimum adverse environmental impact. The objective also includes a research and technology program to support Army requirements for assuring a VTOL operational capability into a wide variety of landing sites, under reduced visibility conditions. The approach will utilize: analytical studies, piloted closed-loop simulations, and flight experiments. Analytical studies will be carried out in-house and under contract. Piloted simulation studies will be accomplished at Ames prior to flight tests. Flight experiments will be carried out in the Tilt Rotor Research aircraft (XV-15) using the V/STOLAND avionics system. Two V/STOLAND systems are being procured and will be installed alternately in the S-19 dual-purpose (UH-1H & XV-15) fixed-base simulator cab and in the UH-1H and XV-15 aircraft. The simulator installation will be used for piloted simulation studies and computer software development for the NASA and Army programs. The navigation, guidance, and display concepts being developed for use in the XV-15 operating systems flight experiments will first be evaluated on the UH-1H/VSTOLAND system. The XV-15/VSTOLAND will be used to investigate alternative functional configurations, time-constrained flight paths, and omnidirectional approaches.

W78-70131**513-54-13**

Langley Research Center, Langley Station, Va.

ROTARY WING VTOL OPERATING SYSTEMS EXPERIMENTS

J F Garren 804-827-3621

(505-07-13)

The program will encompass the investigation of operating systems and piloting techniques for operations from downtown vertiports under all-weather conditions. Terminal air traffic procedures, airspace requirements, and avionics system requirements will be defined. The scope of the objective includes technical integration of advanced control and display concepts with advanced navigation and guidance systems, coupled with development of suitable terminal-area operating procedures, to permit the routine utilization of trajectories optimized from the standpoint of noise, airspace, fuel, and overall efficiency.

considerations. Flight vehicles and simulation facilities equipped with electronic display systems and advanced control concepts will be used to define the degree of automation required in the aircraft control system and in the guidance, display, and communication systems onboard the aircraft for VTOL terminal-area operations.

W78-70132**514-50-01**

Ames Research Center, Moffett Field, Calif.

ADVANCED ROTORCRAFT DESIGN AND APPLICATION STUDIES

W H Deckert 415-965-5887

(505-10-27, 791-40-31)

The objective of this effort is to investigate advances in rotorcraft technology which offer unique performance and operational advantages for civil and military application. Advanced technology applied to the problem areas of vibration, noise, safety and gust response will be evaluated in terms of the overall vehicle configuration. It is anticipated there will be numerous tradeoffs for reduced weight and improved fuel economy which will vary for different configuration-mission combinations. In addition, the detailed design integration study of a hingeless tilt rotor XV-15 aircraft will be continued to clearly identify major design problems and provide design solutions. This study will define both a test program and a flight research program for evaluating this advanced tilt rotor technology.

W78-70133**514-52-01**

Ames Research Center, Moffett Field, Calif

WAKE VORTEX MINIMIZATION

C T Snyder 415-965-5567

The objective of this program is to reduce the wake vortex behind aircraft in order to reduce the landing separation distance imposed on transport aircraft by lift-generated wake vortices from the present 3 to 6 miles to 2 miles without significant detriment to aircraft performance. Experiments will be conducted in flight and in ground-based facilities and theoretical studies will be made on innovative techniques to reduce the wake vortex behind transport aircraft.

W78-70134**514-52-03**

Langley Research Center, Langley Station, Va.

WAKE VORTEX MINIMIZATION

A W Hall 804-827-3274

The objective of this effort is to reduce the hazard potential of wake vortices shed by transport aircraft through aerodynamic means without significant detrimental effects on aircraft performance. This objective will be met by developing experimental techniques and theoretical numerical methods to enhance the understanding of the fundamental flow mechanisms associated with the generation of multiple vortex wakes, their interaction, and turbulent decay. A detailed understanding of the relationship of aircraft span-load distribution and turbulence effects will be obtained.

W78-70135**514-52-04**

Hugh L Dryden Flight Research Center, Edwards, Calif.

WAKE VORTEX MINIMIZATION

M R Barber 805-258-3311

This RTOP covers continuing DFRC activities related to full-scale, flight test evaluations of various aerodynamic wake vortex alleviation devices. These devices have been, and/or, are being developed in ground facility tests at ARC and LaRC. The approach taken is that of flying the devices on actual transport aircraft (e.g., 747's, DC-10's, L-1011's etc). Comparisons of the vortex characteristics with and without the devices are made by probing the aircraft's wake with specially instrumented probe aircraft (e.g., DFRC's T-37, ARC's Lear Jet, and the FAA's DC-9). To facilitate wake probing, specialized vortex visualization systems are being used and developed.

W78-70136**514-54-04**

Hugh L Dryden Flight Research Center, Edwards, Calif

AIRFRAME/PROPULSION SYSTEM INTERACTION

T W Putnam 805-258-3311

(505-06-34)

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Two F-15 aircraft are being flown at DFRC to obtain flight data for correlation with wind tunnel data and analytical results. These data are being obtained in order to improve predictive techniques. The specific objectives of this effort are to determine full scale F-15 airframe/propulsion system interference drag for correlation with scale model wind-tunnel test data; assess F-15 engine/inlet compatibility for correlation with wind tunnel data; evaluate an improved in-flight thrust measurement technique; assess F-15 high alpha and agility flight characteristics for correlation with wind tunnel test data and 3/8-scale model flight data; and support the USAF in determining the acceptability of F-15 component improvement items.

W78-70137 514-55-03
Langley Research Center, Langley Station, Va
LAMINAR FLOW CONTROL
R. J. Muraca 804-827-2045
(516-53-13)

The broad objective of this Laminar-Flow Control (LFC) element of the NASA Aircraft Energy Efficiency (ACEE) Program is to demonstrate that predicted reductions in fuel consumption are attainable for new-design commercial transports through the application of laminar-flow control and to validate acceptable economics in the manufacture and safe commercial operation of LFC airplanes. The technology developed will be applicable to although insufficient for military transports. The LFC element of ACEE consists of three phases: (a) precursor activities and systems definition, (b) systems development, (c) flight validation. The Phase I activities which will be accomplished in fiscal years 1976 through 1978 are covered by this RTOP.

W78-70138 515-51-11
Ames Research Center, Moffett Field, Calif
HUMAN FACTORS IN AVIATION SAFETY
H. P. Klein 415-965-5094
(505-09-31, 505-08-21)

This research is designed to obtain information regarding factors in the national aviation system that cause or contribute to the occurrence of human errors in aviation operations, to evaluate the risks attributable to those factors, and to examine ways of eliminating them from the aviation system, or of ameliorating their potentially harmful effects. Descriptive and analytic studies of occurrences, incidents and accidents are used to determine system and other factors associated with human errors in aviation operations. Full mission simulation studies are performed to evaluate the ways in which these factors influence human performance. These studies are supplemented where required by laboratory studies of human behavior in complex systems. Candidate solutions and intervention strategies are examined in full mission simulations or in flight. The program is carried out in close collaboration with other government and industry groups which must implement promising solutions designed to reduce the number of seriousness of human errors in the aviation system.

W78-70139 516-50-01
Ames Research Center, Moffett Field, Calif
SHORT-MEDIUM RANGE ADVANCED TECHNOLOGY AIRCRAFT DESIGN STUDIES
W. H. Deckert 415-965-5887
(791-40-13)

The objective of this work is to help develop a sound technological base for future decisions relating to the design, development, and operation of commercial air transportation systems. This objective will be achieved through studies and selected experiments that examine the relationships between aircraft technology, airline economics and markets, and environmental constraints, and also through the support of advanced analytical techniques that will provide an effective tool in analyzing advanced configurations. This work will be done in sufficient detail to provide a realistic assessment of the critical technical problems regarding transport aircraft design, development and operations and their development and operational costs. Results will be used to help define the future direction of productive technical (and system related) activity for air transportation systems. This will include defining the need for a flight research

program to demonstrate the integration of technologies. During the next year this work will concentrate on determining the potential for advanced short-haul commuter aircraft incorporating the most promising applications of advanced technology to improve the aircraft performance while reducing costs. These investigations will be performed in-house and under contract.

W78-70140 516-50-23
Langley Research Center, Langley Station, Va.
ADVANCED TRANSPORT AIRCRAFT TECHNOLOGY
D. W. Conner 804-827-3838

The objective will be to provide technology for advanced transport aircraft through (1) studies of all-new total aircraft configuration concepts, (2) studies of incorporating promising new subsystem concepts in advanced aircraft configurations, and (3) precursor studies to generate the technology identified as critical to advanced subsystems where such technology needs are not otherwise being addressed. These studies, covering future needs for both passenger and cargo transports, are aimed at improving aircraft economics, fuel use, noise, emissions and airport congestion. Subsystem areas involve advanced structures, advanced aerodynamics, including laminar flow control and advanced propulsion systems, including use of alternate fuels. The approach will be to utilize both in-house and contractual efforts.

W78-70141 516-51-04
Hugh L. Dryden Flight Research Center, Edwards, Calif
YF-12 FLIGHT EXPERIMENTS
B. M. Kock 805-258-3311

The YF-12, the only aircraft capable of triple sonic speed for long durations, is used as a true environment facility for testing full-scale advanced technology experiments. Technology readiness and feasibility can be assessed by experimentation on the YF-12 far in advance of future military or civil needs and can supply the confidence of full-scale and true aircraft environment. Numerous structures, aerodynamics and propulsion concepts are being tested and evaluated against other predictions and analysis techniques, thereby updating the capability to more confidently apply the predictive techniques for more advanced aircraft of the future.

W78-70142 516-53-03
Langley Research Center, Langley Station, Va.
ENERGY EFFICIENT TRANSPORT
W. J. Alford 804-827-2396

The objectives are to expedite industry acceptance and application of advanced aerodynamics and active controls technology in an integrated manner to achieve significant energy, economic, and aircraft sales benefits. In-house and industry experimental and analytical efforts will be continued in the areas of supercritical aerodynamics, high-lift systems, propulsion/airframe integration, viscous drag reduction, and wing/empennage/active controls integration utilizing reliable, maintainable flight control systems. The industry activities are generally oriented at near-term derivative aircraft and the in-house activities are generally focused at the longer term new generation aircraft technologies that have higher potential with commensurately higher risks. Emphasis will be placed on technologies having the greatest benefits to long-haul subsonic transport aircraft.

W78-70143 516-53-04
Hugh L. Dryden Flight Research Center, Edwards, Calif
ENERGY EFFICIENT TRANSPORT FLIGHT RESEARCH
M. R. Barber 805-258-3311
(516-53-01, 505-02-24)

Flight tests of Whitcomb winglets on a KC-135 aircraft will be conducted. This effort is directed toward the development of a system integration technique resulting in the design of an active control system to provide gust alleviation, maneuver load control, and flutter suppression for the Aeroelastic Research Wing Vehicle (ARW-2). A determination will be made of the extent of natural laminar flow that can be achieved in a flight environment over the upper surface of a subsonic cruise airfoil.

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W78-70144

516-57-02

Lewis Research Center, Cleveland, Ohio

AERIAL APPLICATIONS DISPERSAL SYSTEMS EVALUATION AND IMPROVEMENT

W. C. Strack 216-433-4000

Existing and new technologies for dispersal system improvement will be evaluated analytically and, if sufficiently promising, by limited experimental testing. Improvement in liquid droplet size uniformity is specifically sought, although conceptual improvements in other areas such as dry material spreaders and automatic flow control will also be addressed.

W78-70145

516-57-03

Langley Research Center, Langley Station, Va.

AERODYNAMICS OF AERIAL APPLICATIONS AIRCRAFT AND SYSTEMS

A. W. Hall 804-827-3274

(791-40-53)

The objective of aerial applications research is to improve the effectiveness and efficiency of agricultural production systems through application of aeronautical technology. Specifically, the technology will be developed for both short- and long-term improvements in the accuracy of distribution, environmental, health, and safety aspects of aerial applications, and improvements in aircraft aerodynamics, flight controls, and structures. The program will take an integrated systems approach to the total process of aerial applications of agricultural chemicals, fertilizers, and seeds.

W78-70146

516-57-08

Wallops Station, Wallops Island, Va.

AERIAL APPLICATIONS SYSTEMS PERFORMANCE EVALUATION AND MEASUREMENT

Lloyd C. Parker 804-824-3411

The objectives are to identify and define systems for evaluation and measurement of aerial application systems performance, and to conduct field measurements and experiments which validate instrumentation requirements and provide baseline data on aerial application systems performance. Studies will be conducted which define current state of the art, deficiencies in present knowledge and measurement concepts and new technological approaches. Field test experiments will be planned and conducted to provide baseline data on present systems performance and to evaluate sensor concepts. Based on these studies a field test and measurement system will be defined.

W78-70147

518-51-01

Ames Research Center, Moffett Field, Calif.

ROTORCRAFT SYSTEMS FLIGHT VALIDATION

Leonard Roberts 415-965-5066

(505-10-24, 516-50-01)

The objective of this systems technology program is to exploit the potential for significantly improved helicopters in the broad areas of performance, efficiency, noise and dynamics through a program of advanced rotor technology advancement. The goals of this program are to substantially improve the performance, utility, efficiency, dynamics, noise, maintainability and ownership cost of civil and military helicopters and tilt-rotor aircraft through system design studies, focused small and large scale tests in ground-based facilities and selected flight tests of current state-of-the-art rotors and advanced concept rotor systems. This RTOP also covers the tasks involved in the transfer of helicopter research from Langley to Ames. This includes the transfer of the two Rotor Systems Research Aircraft; the AH-1G, UH-1H, SH-3, and CH-47 helicopters with associated equipments as specified in the transfer plan; and transfer of the CH-53 helicopter since it is currently being used in the helicopter operating systems program which is being transferred to Ames. As soon as funds become available, a coordinated series of system design studies and wind-tunnel investigations will be initiated to define advanced rotor concepts for flight investigations on the Rotor Systems Research Aircraft and the Tilt-Rotor Research Aircraft.

W78-70148

518-51-03

Langley Research Center, Langley Station, Va.

ROTOR SYSTEMS RESEARCH AIRCRAFT (RSRA) OPERATIONS

S. White 804-827-3864

(505-10-23; 745-01-03)

The Rotor Systems Research Aircraft (RSRA) operations objective is to provide Langley in-house support to bring into operation two versatile flight research aircraft to provide economical rotorcraft research capability in the dynamic environment of flight. These research aircraft will provide research capabilities that cannot be duplicated in ground-based facilities. This is in support of a joint project with the Army, in accordance with the Memorandum of Understanding between NASA and the Army dated November 1, 1971. The project will be managed through a joint Project Office in accordance with the NASA/Army Rotor Systems Research Aircraft Project Plan which was jointly approved by NASA and the Army on February 23, 1973, and updated February 7, 1974.

Aeronautics Experimental Programs

W78-70149

716-01-02

Lewis Research Center, Cleveland, Ohio

ENERGY EFFICIENT ENGINE

Neal T. Saunders 216-433-4000

(511-54-01; 510-53-01, 505-04-02)

The objective of this program is to develop and demonstrate technology for a next generation turbofan engine having 10 to 15% lower specific fuel consumption, about a 5% reduction in direct operating cost, and reduced emissions and noise levels as compared to current high-bypass turbofan engines. Contracts for engine definition were awarded to two engine companies in order to define engine type and performance characteristics on the basis of both engine preliminary design and aircraft integration considerations. Each engine company is working with three airframe company subcontractors to provide the aircraft integration data. Two airlines are under direct contract to NASA to evaluate the studies from a user point of view. From these studies, the energy efficient engine design characteristics will be chosen. The major part of this program will then be initiated with award of parallel component development and integration efforts to two engine companies. Engine system analysis, design, and integration will continue in order to provide refinement to the engine designs and performance estimates. Technology (analysis, design and small-scale concept testing) in areas not covered by related programs will be performed. Advanced engine components will be designed and developed, and performance will be verified by rig tests. The high-spool core system will be designed, fabricated, and tested to evaluate its performance characteristics and to further refine the design of the components. The low-spool assembly will be integrated with the core to evaluate two-spool integrated performance.

W78-70150

723-01-03

Langley Research Center, Langley Station, Va.

HIGHLY MANEUVERING AIRCRAFT TECHNOLOGY

W. P. Henderson 804-827-2676

The objective of this research is to promote and stimulate the application of new and innovative technologies in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of the new technologies for the design of future fighter aircraft. A vital part of this research will be to support the ongoing NASA HiMat programs. The study of the highly integrated canard-wing concept will be pursued with the objectives of defining the stability and control characteristics at high angles of attack. Promising ideas for obtaining high aerodynamic performance for maneuvering fighter aircraft will be examined analytically and experimentally with primary emphasis on investigating their aerodynamic performance, propulsion, stability, and control characteristics. Representative promising concepts which may be incorporated into the basic canard-wing concept include a high aspect ratio, two-dimensional, vectoring nozzles and anti-spin devices. The experimental studies will be conducted in the Langley 16-foot, full-scale and spin tunnels.

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and simulator studies in the Differential Maneuvering Simulator (DMS)

W78-70151 **723-01-04**
Hugh L. Dryden Flight Research Center, Edwards, Calif
HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY
P. C. Loschke 805-258-3311
(505-11-54, 505-02-24)

This RTOP covers the flight-test phase of a program to provide improved technology for the design of highly maneuverable aircraft. Present design restraints will be relaxed to permit complete freedom in the application of state-of-the-art systems such as integrated, computerized controls, composite structures, propulsion augmentation of lift and control, and the like, in order to achieve maximum benefits from synergistic effects. The complex and innovative configurations such as the HiMAT design can only be validated and the high risk technology matured for manned vehicle application through extensive testing of the complete configuration in the real and dynamic environment of flight. The high level of technical risk inherent in the HiMAT designs precludes their application to manned prototype vehicles because of pilot safety concerns and the enormous cost of these aircraft. This program will use large scale free-flying models controlled by remote piloting techniques to acquire actual flight-test data at a minimum cost. The facility for these tests exists at DFRC and is currently being extended to handle supersonic vehicles.

W78-70152 **734-01-13**
Langley Research Center, Langley Station, Va.
COMPOSITE COMPONENTS (ACEE)
L. F. Vosteen 804-827-3081
(734-02-13)

The objective of the composite components program is to accelerate the introduction of composite structures in commercial transport aircraft. This will be accomplished through the progressive introduction of selected components in current aircraft production. Design technology for typical secondary structure components and medium-sized primary structures will be developed. Manufacturing processes suitable for production will be developed and verified through comprehensive ground testing.

W78-70153 **734-02-13**
Langley Research Center, Langley Station, Va.
COMPOSITE WING (ACEE)
L. F. Vosteen 804-827-3081
(734-01-13)

The composite wing is part of the ACEE composite structures program. The objective is to develop design and manufacturing technology to accelerate the introduction of composite structures in new and derivative commercial transport aircraft. Multiple contracts will be awarded to investigate the utilization of composites in wing structure. Following the completion of the studies, a contractual program will be initiated to develop composite wing structure.

W78-70154 **738-01-02**
Lewis Research Center, Cleveland, Ohio
QUIET CLEAN SHORT-HAUL EXPERIMENTAL ENGINE
Carl C. Ciepluch 216-433-4000
(505-05-32)

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

W78-70155 **743-01-01**
Ames Research Center, Moffett Field, Calif.
SCAR FUEL TANK SEALANTS
R. W. Rosser 415-865-5244

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

W78-70156 **743-01-03**
Langley Research Center, Langley Station, Va.
SCAR-STRUCTURES AND MATERIALS TECHNOLOGY
E. E. Mathauser 804-827-2036
(743-05-03)

The objective of this program is to establish a supersonic structures and materials technology base by developing capability in structural concepts and design, loads and aeroelasticity, and in materials, fatigue, and manufacturing methods. The development of capability for computer-aided analysis and synthesis will be undertaken, and validation of the computer tools and methodology by applications to SCAR configurations will be made. Advanced transonic/supersonic flutter methodology and aeroelastic load prediction methods will be developed. Validation of active landing gear design methodology will be made and a description of high altitude atmospheric turbulence environment obtained. Included also is work on strength, fatigue and fracture to establish structural integrity of materials and representative components; performance of time-temperature-stress studies to determine capabilities of advanced materials, application of advanced resins and adhesives; development of fabrication methods including superplastic forming of titanium, and fabrication, ground test, and installation of components on the YF-12 and Boeing 737 aircraft for flight service evaluation. The structures and materials technology from this program will permit major reductions in structural weight, improved structural integrity and lower cost for supersonic cruise aircraft.

W78-70157 **743-01-04**
Hugh L. Dryden Flight Research Center, Edwards, Calif
SCAR STRUCTURES AND MATERIALS TESTING
J. M. Jenkins 805-258-3311

The objective is to determine the structural performance of candidate supersonic materials and fabrication techniques. A coordinated program of flight tests on the YF-12 airplane and supporting laboratory tests in the DFRC Flight Loads Research Facility will evaluate such advanced concepts as corrugated and honeycomb sandwich, composites, skin stringer, and superplastic formed titanium concepts in a load and thermal environment.

W78-70158 **743-03-22**
Lewis Research Center, Cleveland, Ohio.
SCAR PROPULSION TECHNOLOGY
R. J. Weber 216-433-4000

Advances in propulsion system technology will be required to permit the development of a quiet, clean, economical commercial supersonic transport. Contracts for the study of such airplanes have been let by Langley Research Center, and other supporting work is being performed at each of the NASA Research Centers. As part of that effort, LeRC is studying the propulsion system in order to define the most desirable engine cycle, identify technology requirements, and advance the various component disciplines peculiar to supersonic flight to the point where development of an actual engine could be undertaken when desired. The effort involves in-house and contracted research in engine cycles, noise and pollution, stability and control, materials, and various unique components.

W78-70159 **743-04-13**
Langley Research Center, Langley Station, Va.

SCAR - AERODYNAMIC PERFORMANCE TECHNOLOGY
F. E. McLean 804-827-4576

The objectives of this program are to advance the state of the art in supersonic aerodynamics through the generation of comprehensive data bases on promising advanced supersonic configuration concepts, through the development of better tools for aerodynamic design and analysis, and through continued research on important sonic boom phenomena. Aerodynamic advances resulting from this program will be studied in concert with technology advances in the related disciplinary areas of propulsion, structures and materials, and controls through detailed systems integration and technology studies of representative supersonic cruise aircraft concepts. Throughout the studies, major consideration will be given to the factors which influence and improve the noise, pollution, energy efficiency, and overall performance of potential future supersonic cruise aircraft. Objectives of the program will be accomplished through construction and tests of models of industry and NASA supersonic configuration concepts, through support of in-house, industry and university approaches to the development of critical design and analysis methods, and through in-house and university studies of sonic-boom. In-house NASA and industry design integration teams will build up to an adequate level to perform meaningful technology studies and provide reliable direction to the future research effort.

W78-70160 743-05-03
Langley Research Center, Langley Station, Va
SUPERSONIC CRUISE AIRCRAFT RESEARCH--ACTIVE CONTROL OF AEROELASTIC RESPONSE
W H Reed, III 804-827-2265
(743-01-03)

In order that dynamically scaled aeroelastic wind tunnel models may be used to study and validate active control applications for the minimization of aircraft aeroelastic response, the state of the art of modeling technology, including model design and construction and testing techniques, will be advanced as required for active control applications. In addition to basic technique development, considerable emphasis will be placed on validating model procedures by correlating wind tunnel results with analytical and flight data. So that future supersonic cruise aircraft can take full advantage of the potential benefits of active control for the minimization of aeroelastic response, research will be conducted to develop new active control concepts and approaches that are particularly applicable to SCAR class aircraft. These efforts are designed to help meet the general objective of establishing an expanded supersonic stability and controls technology base in parallel with the expansion of other supersonic disciplinary technologies which will provide major control system advances applicable to aircraft operating at supersonic cruise speeds.

W78-70161 743-05-04
Hugh L. Dryden Flight Research Center, Edwards, Calif.
SCAR STABILITY & CONTROL TECHNOLOGY
D. T. Berry 805-258-3311

Significant handling qualities problem areas generic to supersonic cruise vehicles have been observed during XB-70 and YF-12 flight tests. This RTOP is concerned with analytical techniques suitable for the development of handling qualities criteria for supersonic cruise flight. The problem areas of concern include airframe, propulsion and structural interactions, requirements for automatic control, atmospheric influences, and inadequacy of current criteria for high speed cruise flight. These goals are being pursued by university grants and/or contracts to private industry.

W78-70162 744-01-01
Ames Research Center, Moffett Field, Calif
TILT ROTOR RESEARCH AIRCRAFT
W H Deckert 415-965-5442

The objective of this RTOP is to design, develop, and conduct flight research in two XV-15 Tilt Rotor Research Aircraft to prove the tilt rotor concept for potential military and civil missions. The following proof-of-concept tasks utilizing the two XV-15 aircraft will be performed: (1) investigate through flight research

the viability of the tilt rotor concept, particularly by verifying rotor/pylon/wing dynamic stability and aircraft performance over the entire operational envelope; (2) experimentally establish a safe operating envelope and initially assess the handling qualities of the XV-15 Tilt Rotor Research Aircraft for use in follow-on advanced flight research; (3) investigate tilt rotor aircraft gust sensitivity; and (4) investigate the effect of tilt rotor disc loading and tip speed on downwash and noise.

W78-70163 744-01-04
Hugh L. Dryden Flight Research Center, Edwards, Calif
TILT ROTOR RESEARCH AIRCRAFT
R E Klein 805-258-3311

This RTOP covers DFRC's support to the Ames Research Center in the segments of the Tilt Rotor Aircraft flight test program that may impose a high risk to surrounding communities in the event of an emergency. The Edwards Air Force Base complex with its dedicated airspace suggests that all the high-speed testing be performed at the DFRC facility. The DFRC would support a joint flight test team with Operations, Aeronautical Projects and Research Directorates expertise as needed to successfully complete the high-speed flight test program. High speed is defined as speeds equal to or greater than 250 knots.

W78-70164 745-01-03
Langley Research Center, Langley Station, Va.
ROTOR SYSTEMS RESEARCH AIRCRAFT (RSRA)
S White 804-827-3864
(505-10-23, 518-01-03)

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

W78-70165 769-02-01
Ames Research Center, Moffett Field, Calif.
QUIET SHORT-HAUL RESEARCH AIRCRAFT (OSRA)
Wallace H Deckert 415-965-5662

This RTOP covers the design, fabrication, and test of a quiet propulsive-lift research aircraft which will permit flight research beyond the flight regime of the AMST and the existing augmented jet flap Buffalo aircraft. The approach stresses low-cost modification of another existing Buffalo aircraft. Key design simplification guidelines are use of fixed landing gear, 160 knot maximum speed, +2g, -0.5g limit load, and design life of 500 flight hours. The flight research will advance technology for future development of reliable, quiet, and economical propulsive lift transports. The test program will provide specific information on flight characteristics, and powered lift performance, as well as information on design, noise, operational features and propulsive-lift system economics. The research aircraft design goals include capability of usable approach lift coefficients greater than 4.6, 90 EPNdB noise footprint smaller than one square mile, and roll control power greater than 1 rad/sec². The project will include modification of an existing C-8 Buffalo aircraft into an advanced hybrid/upper surface blowing propulsive-lift configuration with updated Lycoming YF-102 engines and A-9A gearbox accessories to power the aircraft in its flight research program. Please refer to the following documents for all the required additional RTOP information: (1) Project Plan for QSRA, May 11, 1977, (2) Flight

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Test Plan for QSRA, March 1977, and (3) Environmental Impact Statement for QSRA, July 1976.

W78-70166

769-02-02

Lewis Research Center, Cleveland, Ohio.

QUIET PROPULSIVE LIFT TECHNOLOGY - QSRA PROPULSION SUPPORT

M. F. Valerino 216-433-4000

LeRC is supporting ARC relative to the propulsion system of the QSRA aircraft. This support has included the study of engines potentially suitable for the research aircraft in achieving its powered lift, noise, and near terminal performance goals. Based upon the results of the engine and the aircraft studies, the hybrid upper surface blowing system was selected for incorporation into the Buffalo Aircraft and the Lycoming YF-102 series, and this turbofan engine was selected as most suited for the application. The propulsion support has included the determination of the updating required to government-owned YF-102 engines to meet the needs of the research aircraft, the use of one YF-102 engine for supporting ground-test studies by LeRC, the provision of a nonoperational mockup engine to the airframe contractor, and the provision of four updated/refurbished/acceptance-tested engines for the flight aircraft. The continuing support effort will include (1) provision of a fifth (spare) flight engine, (2) review of propulsion system performance and acoustic results obtained during the flight acceptance tests, and (3) participation as required in all other propulsion aspects of the aircraft program.

Space Research and Technology base

W78-70167

506-15-21

Ames Research Center, Moffett Field, Calif

ADVANCED ELECTRONICS AND MATERIALS RESEARCH E. E. Whiting 415-965-5690

The objective is to investigate the atomistic structure and physical properties of epitaxially absorbed layers of metallic and semiconducting materials on well defined single crystal substrates, and to study the change of adsorption properties when co-adsorbing active gases. The critical material parameters that control the achievement of very low work function surfaces by adsorption will be defined. Improvements on the new Auger-microprobe will be initiated after performance testing determines the application limitations of the instrument. Another objective is to continually advance the state of the art of computing wave functions for molecules and atomic clusters. The wave functions will in turn be used to compute molecular properties such as dissociation energies, potential surfaces and optical cross sections. The computed properties will be of great utility in the areas of reentry physics, stratospheric pollution studies, and materials science.

W78-70168

506-15-23

Langley Research Center, Langley Station, Va.

ADVANCED ELECTRONICS AND MATERIAL SCIENCE E. J. Conway 804-827-3127

This basic research program is composed of two major thrusts: R&D on high-efficiency GaAs solar cells for space application and computational chemistry of solids, surfaces and gaseous reactions. The technology for high efficiency (18.5% AM-Q) GaAs-GaAlAs solar cells with high-temperature (200-300 °C) operating capability and high radiation resistance is being developed for potential space applications, such as solar electric propulsion/Halley's Comet rendezvous mission, or a space-power station. With the goal of 18 to 20% AM-Q efficiency at the beginning of life achieved, this effort emphasizes radiation and high-temperature stability to maximize end-of-life efficiency. Detailed experimental and theoretical investigations of cell parameters which affect radiation stability, e.g., band-gap grading and junction depth, are made. In addition, radiation damage measurements are performed on GaAs crystals. The metallurgy and electronics of electrical contacts to GaAs solar cells at high temperature are studied. Quantum theoretical techniques are

developed and used to study covalently bonded solids (e.g., diamond) and a variety of gaseous molecules. By developing a method for computing the energy and structure of solids and surfaces, general chemical trends are obtained. Computational chemistry on atmospheric gases investigates rapid molecular reactions of trace reactive species, such as NO₃. This approach avoids the experimental difficulties associated with low concentrations and side reactions of short-lived intermediate species by fundamental computations of reactions and chemical and spectroscopic properties.

W78-70169

506-15-25

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

G. W. Lewicki 213-354-4530

(506-16-15)

This program pursues basic investigations into new technologies needed to meet NASA's requirements for electronics. Investigations are directed at thin metal-oxide-silicon (MOS) structures, advanced GaAs solar cells, advanced cryogenic infrared detectors, superconducting digital microcircuits, and high temperature superconductivity. Thin MOS (metal-oxide-silicon) structures with oxide thicknesses of 100 Å or less are being investigated in order to (1) solve basic instability problems in LSI (large-scale-integration) technology, and (2) establish the properties and limitation of thin MOS structures which are precursors of ultrahigh-density microelectronics 10 to the 8th power bits/sq cm. Another task is aimed at new methods of achieving low-cost, high-efficiency gallium arsenide solar cells. Variations of Schottky barrier structures are being used because of their inherent simplicity, reproducibility, and radiation resistance. Deposition of these structures by chemical vapor deposition and the use of selective chemical etches can lead to ultrathin light-weight solar cells and lower costs by allowing for the use of reusable substrates. Detectors based on phenomena existing at cryogenic temperatures are being investigated for applications in the millimeter and submillimeter wavelengths. Studies are also being undertaken to develop superconducting detectors operating at high temperatures in order to reduce demands on the supporting cryogenic system. Another task involves the study of digital microcircuits based on superconducting technology and Josephson effect devices which could provide improvements of two orders of magnitude in speed, power consumption, and circuit density. This program is aimed at developing a technology base for microcircuits embodying these features. The possibility of synthesizing a high temperature superconductor, e.g., T_{sub c} approximately 100 K, is being investigated for future applications in space and energy technologies. The approach involves a coordinated physics and chemistry effort directed towards the study of quasi-one-dimensional organic metals (which represent the most promising system for achieving high T_{sub c}). The task is focused on understanding and controlling the major obstacle, i.e., interchain coupling, which inhibits the attainment of a high temperature superconducting state.

W78-70170

506-16-11

Ames Research Center, Moffett Field, Calif

SURFACE PHYSICS AND COMPUTATIONAL CHEMISTRY E. E. Whiting 415-965-5690

Understanding of metal interface properties are expanded by probing their structure on an atomistic scale. Knowledge of surface/environment interaction (corrosion) is improved by studying gaseous surface reactions and their relationship to microscopic material properties. Well-defined metal clusters will be used to simulate preferential surface interactions which will be correlated with basic catalytic processes. Another objective is to develop efficient computer codes to calculate reliable wave functions and thereby compute many basic properties of matter such as dissociation energies, optical absorption cross sections, and catalytic properties of small particles. The codes will be continually upgraded for use on the CDC 7600 and other 'super computers' to enable more precise results and the consideration of larger systems. Emphasis will be placed on studies of chemisorption, monolayer growth, catalysis, and modeling of hydrogen embrittlement.

W78-70171

Lewis Research Center, Cleveland, Ohio.

PHYSICS AND CHEMISTRY OF SOLIDS

R. A. Lad 216-433-4000

The objective of the basic research is to increase the base of understanding of the relationships between the electronic, atomic, molecular, and microscopic structures of solids and their mechanical, structural, and chemical properties. The focus is mainly on problems associated with the strength and impact behavior of metal matrix composites, the high temperature corrosion processes in gas turbine engines, and battery material problems in the Ag-Zn battery. The emphasis in composites is on factors that limit the strength and impact resistance and on the properties of the fiber-matrix interface that play a role in limiting strength and fatigue resistance. The high temperature corrosion studies center on (1) measurement and identification of the role of the chemical species involved in corrosive combustion systems, (2) the establishment of the thermodynamics that pertain, (3) study of the contributory roles of species such as HCl, NaCl, and NaOH, and (4) theoretical and experimental studies of the process of deposition of Na₂SO₄ on hot surfaces from flames. The battery materials research is designed to determine how the electrochemical processes occurring in the battery are affected by the separator material and its structure and by the charging cycle.

506-16-12**W78-70172**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

VISCOELASTIC PROPERTIES OF POLYMERS

J. Moacanin 213-354-3178

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

506-16-15**W78-70173**

Lewis Research Center, Cleveland, Ohio

ADVANCED MATERIALS, MANUFACTURING, AND LUBRICATION PROCESSES

W. D. Klopp 216-433-4000

(505-04-42; 511-54-02; 511-58-02)

The objectives of this program are to characterize the suitability of present materials, develop improved materials and manufacturing processes, and better understand the friction, wear, and adhesion behavior of materials for advanced space systems, such as power-generation, propulsion, and communications systems. Materials and manufacturing studies include space environment effects on mechanical properties of superalloys and improvement of alumina/aluminum and boron/aluminum composites. Lubrication studies are directed toward advancement of technology of aerospace devices by application of improved materials and designs, utilization of advances in aerospace materials, lubricants, and lubrication methods for the general benefit of mankind, and pursuit of solutions for anticipated materials and lubrication problems in aerospace vehicle mechanical components.

506-16-22**W78-70174**

Langley Research Center, Langley Station, Va.

MATERIALS FOR SPACE STRUCTURES

R. T. Swann 804-827-2969

(743-01-03; 524-71-03)

The objectives of this research are: (1) to identify mechanisms

506-16-23

of mechanical property degradation in advanced materials such as metal matrix composites; (2) to expand capability to predict mechanical property degradation of these materials; (3) to define the operating conditions for which these materials are suitable, and (4) to modify the materials to improve properties and reduce degradation. Metal matrix composites such as Borsic/Ti, B/Al, and Borsic/Al, as well as other advanced structural materials will be subjected to thermal, environmental and mechanical cycles. Residual mechanical properties will be evaluated, and degradation of these properties will be correlated with microstructural and physical changes. Analyses of diffusion, phase change, and chemical reactions will be developed, and these analyses will be applied to predict microstructural changes. Atomic models will be developed of point and extended defects and their interactions. These analyses will then be extended to predict residual mechanical properties directly in terms of thermal and loading histories. Finally, with this quantitative analysis in terms of materials variables available, the materials will be modified to reduce degradation.

W78-70175

Ames Research Center, Moffett Field, Calif

HEAT PIPE TECHNOLOGY

C. R. McCreight 415-965-6525

The objectives of this RTOP are: (1) to develop basic control mechanisms by which heat pipes may achieve variable conductance, feedback control, or thermal diode performance, (2) to improve liquid transport capacity and reliability, and (3) to participate in flight tests of advanced heat pipe technology to establish flight level confidence. Ames Research Center shall act as the lead OAST Center and provide guidance to OA, OSS, and OSF in this capacity as a means of extending basic understanding into practical missions. Development of basic control techniques will be continued with sustained emphasis on cryogenic thermal diodes, cryogenic gas-controlled heat pipes, and gas absorption reservoir heat pipes. Liquid transport capacity and reliability will be increased through the continued development of non arterial heat pipes, flexible arteries, and the application of improved evaporative and arterial priming concepts. A high performance cryogenic diode heat pipe will be developed, tested, and delivered for flight aboard the Long Duration Exposure Facility (LDEF).

506-16-31**W78-70176**

Lewis Research Center, Cleveland, Ohio

HIGH TEMPERATURE HEAT PIPES

James F. Morris 216-433-4000

(506-23-32)

Heat pipes afford unique capabilities for thermal control of environmental effects. These simple self-contained, self-pumped systems operate with no moving parts except their working fluids to transfer and transform heat from nuclear, solar, or chemical sources. In effect heat pipes transport great thermal power densities with slight temperature gradients, low weights, and small volumes at high, intermediate, or low temperatures. Such characteristics are invaluable for many space heating, cooling, and thermal control applications. Accordingly a major NASA objective is to provide efficient, durable, economical heat pipes in appropriate temperature ranges for anticipated space applications. And the approach to these intended accomplishments is to establish materials, designs, and processing for space-effective heat pipes and to verify their efficacy through performance evaluation and life testing.

506-16-32**W78-70177**

Langley Research Center, Langley Station, Va.

SPACE ENVIRONMENTAL EFFECTS ON MATERIALS

W. S. Slomp 804-827-3041

An experimental program is in progress to provide improved materials and techniques for long lifetime and greater reliability of spacecraft under space environmental conditions. Specific thrusts are: (1) developing thermal control materials; (2) determining effects of solar radiation on materials for large space structures, and (3) establishing an interplanetary/planetary meteoroid environment model. The development of accelerated solar radiation test techniques will be emphasized. The ap-

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proach shall include (1) the initiation of an experimental program to evaluate the effects of solar radiation on materials for large space structures, (2) the development of a model of the meteoroid environment in the solar system; and (3) completion of Shuttle qualification testing on the nonspecular second-surface mirror coating.

W78-70178

506-16-36

Goddard Space Flight Center, Greenbelt, Md

FLIGHT TESTING OF HEAT PIPES

R. McIntosh 301-982-6071

The objective of this RTOP is to improve the quality and reliability of spacecraft, subsystem and sensor temperature control through the use of heat pipes. During FY78 primary emphasis will be placed on design of reliable low temperature heat pipes which can be used for cryogenic sensor temperature control and/or solid cryogen cooler life-time enhancement. As part of the testing program a cryogenic heat pipe experiment will be designed for flight aboard the LDEF or another suitable spacecraft.

W78-70179

506-16-39

Marshall Space Flight Center, Huntsville, Ala

THERMAL CONTROL COATINGS

Donald R. Wilkes 205-453-2405

As a continuation of work in the thermal control field, efforts will be directed toward methods of improving NASA's capabilities of controlling spacecraft temperatures. Development will be completed on a new improved white paint based on a ZnTiO₄ pigment. Environmental tests of this new coating, along with other thermal control surfaces, will be carried out to determine their long-term stability in the space environment. The continued development and testing of an improved white paint with an ultimate solar absorbance of 0.08 has been determined as essential technology by the Space Transportation System Technology (STST) Thermal Control Working Group.

W78-70180

506-16-41

Ames Research Center, Moffett Field, Calif.

TPS MATERIALS AND SYSTEMS EVALUATION

H. K. Larson 415-965-5369

(506-26-21)

The objective is to provide thermal protection systems concepts and materials for heat shields to protect earth and planetary entry vehicles and planetary probes during atmospheric entry. The specific objectives are to (1) evaluate the performance of and improve the space shuttle thermal protection system; (2) develop improved minimum weight TPS for fully reusable advanced space transportation systems; (3) to develop planetary probe heat shield materials and determine methods to minimize heat shield weights; and (4) develop concepts and heat shield materials for safe earth entry of radioactive power sources and to support DOD requirements. The system requirements for each end use are defined. Thermal protection materials parameters are determined that meet these requirements. Materials are either selected from the extensive technology in existence or new materials with optimized properties are developed. Candidate thermal protection concepts and materials are subjected to systematic analysis and testing to qualify them for the defined end use. Extensive Ames arc plasma test facilities developed for space shuttle and planetary entry probes 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 environment, and material response to obtain in-depth understanding of the material characteristics. Detailed temperature dependent radiation properties are computed for gaseous species required for thermal response analysis. Materials are often developed as a result of these studies to meet the ever more stringent requirements for atmospheric entry thermal protection.

W78-70181

506-16-43

Langley Research Center, Langley Station, Va.

TPS MATERIALS FOR SPACE TRANSPORTATION SYSTEMS

R. T. Swann 804-827-2969

The objectives of this RTOP are to provide heat shield testing

to support the space shuttle program, and to develop improved thermal protection materials and systems for advanced space transportation systems. Available arc-tunnel and other facilities will be used as required to validate the space shuttle TPS. If problems are discovered in the course of this testing, in-house programs will be undertaken to find solutions. Environmental exposure testing of RSI will continue. Technology studies of alternate shuttle TPS will be continued. For advanced vehicles, new materials and materials configurations will be developed with emphasis on metallic materials. High temperature creep will be studied, data will be generated on various alloys and a design methodology will be developed based on statistical analysis of the data. A model for cyclic creep will be developed. Thermomechanical processing techniques which improve creep resistance and other properties of materials will be evaluated.

W78-70182

506-17-13

Langley Research Center, Langley Station, Va.

ADVANCED SPACE STRUCTURES

M. F. Card 804-827-3054

(505-02-13)

The objective is to develop the technology required for obtaining improved efficiency and reduced costs in space structures and space transportation systems by the application of advanced materials, advanced structural concepts, and advanced analysis and design methods. Research and development is being carried out to establish a technology base of advanced analytical methods for predicting the strength, stiffness, dynamic, and thermal behavior of typical structural components. An adequate test data base is being established for analysis verification as well as for building confidence. New concepts are explored by conducting preliminary trade studies followed by detailed design and experimental evaluation of selected configurations. Rapid design procedures are being developed to provide reliable weight and performance characteristics of advanced concepts so that meaningful trade-offs can be made on total vehicle design studies.

W78-70183

506-17-22

Lewis Research Center, Cleveland, Ohio.

COMPOSITE STRUCTURES ANALYSIS AND DESIGN METHODS

R. H. Johns 216-433-4000

Composite materials offer a high potential for reducing the weight of many structural components. However, before full advantage can be taken of the unusual properties of composite materials in such applications, considerable design and material property information is needed. It is proposed that studies be continued that will develop analytical design techniques for (1) predicting structural characteristics of given composite configurations and for optimizing composite structures for minimum weight, cost, and structural efficiency through finite element analyses such as NASTRAN, (2) predicting high velocity impact characteristics; and (3) predicting defect growth and arrest under simulated service environments. Other studies will experimentally determine the mechanical properties of appropriate composite systems under complex loadings and environments, i.e., multi-axial loading, cyclic loading, high velocity impact, and in the absence or presence of various representative defects. The results of this work will also serve to verify the analytical design techniques referred to above. Current programs involving composite pressure vessels and fracture control technology, which were funded under other RTOPs, will be completed under this RTOP in FY-78.

W78-70184

506-17-23

Langley Research Center, Langley Station, Va.

VEHICLE DESIGN METHODS

M. F. Card 804-827-3054

The objective of this effort is to provide advanced structural analysis and design methods which will accurately and economically predict the performance and durability of future space systems. Theoretical analysis and design efforts include research to devise new equations representing structural behavior and rapid solution techniques to make complex analysis/design feasible. In addition, the effort includes computer code development of large scale analysis tools as well as selected structural experiments to confirm the accuracy of advanced methods. In current studies, efforts

are dedicated to completion of new coding development for two major analysis tools for structural analysis of complex structures. Studies will be conducted to develop methods for including damage criteria in both the sizing for residual strength and in the prediction of fatigue life of composite structures. Design techniques to increase the residual strength of damaged structures will also be evaluated. In addition, new methods for predicting loads and non-linear behavior or large flexible space structures will be investigated.

W78-70185**506-17-33**

Langley Research Center, Langley Station, Va

SPACE VEHICLE DYNAMICS

M F Card 804-827-3054

The objective of this effort is to develop and validate advanced analysis and test methods for the prediction of dynamic, acoustic, and aeroelastic response of space transportation systems and payloads. A major part of the effort is to establish new analysis and test techniques for dynamic response which will permit rapid, accurate prediction of the response of new candidate payloads from knowledge obtained on early launch vehicle flights. In current studies, refined methods of vehicle payload coupling will be investigated, as well as advanced methods of measuring and reducing in-flight dynamic data on a candidate shuttle payload. Research will also be conducted on the dynamic response of very large, flexible structures with distributed control force loadings and deployment motions. The effort also includes studies of the control of dynamic and aeroelastic phenomena associated with space vehicle performance including flutter and ground wind loads and the thermal acoustic response of thermal protection systems. Current efforts in this area involve tests on wind tunnel models and TPS panels to provide critical data, evaluate analytical prediction techniques, and investigate advanced aeroelastic test techniques.

W78-70186**506-17-35**

Jet Propulsion Lab, Calif Inst of Tech., Pasadena

SPACE VEHICLE DYNAMICS

E Heer 213-354-3060

The principal objective of this five-year effort is to perform research and advanced development in dynamics criteria, design, analysis, and testing to develop and update analysis and test methods. These methods will be used for the prediction and verification of structural response and stability in support of advanced design, optimization and qualification of space transportation systems and payloads. The activities will be coordinated with NASA headquarters; other NASA Centers, and the Dynamic, Acoustic, and Thermal Environment (DATE) Working Group chaired by GSFC. The task will utilize existing data from flight programs (Viking, Voyager, and others) until the shuttle orbiter bay flight data are available.

W78-70187**506-17-36**

Goddard Space Flight Center, Greenbelt, Md.

PAYLOAD ENVIRONMENTS AND DYNAMICS

J. P. Young 301-982-4284

The overall objective is to develop and validate improved analysis and test methods for the prediction of structural dynamic/acoustic environments, for response computation, and for the verification of hardware flightworthiness. Near term specific objectives are to develop an improved method to predict STS payload random vibration environment, to improve the accuracy of analytical predictions of the vibration response of structures to acoustic excitation, and to plan for the acquisition and analysis of STS flight data that is specifically suited for providing verification of environment prediction methods. The approach to satisfy the above near term objectives will be to develop empirically based transfer functions that relate payload random vibration environment spectra to acoustic input excitation, to perform an experimental evaluation of the significance of spatial correlation effects on the random vibration response of spacecraft structures, and to participate in the DATE Working Group activities.

W78-70188**506-17-39**

Marshall Space Flight Center, Huntsville, Ala

SPACE VEHICLE DYNAMICS

R. S. Ryan 205-453-2481

The objective is to develop and validate dynamic, acoustic response, and stability prediction capability to provide for improved design optimization of space transportation systems and payloads. The thrust of this technology enhancement shall be to improve the accuracy and efficiency of analytical predictions through improvements in structural/environmental modeling, numerical methods and computer applications, response computations, structural dynamic testing, and analysis/test correlations. The approach will be to conduct basic literature and experience searches, develop concepts and approaches, formulate analytical and/or test procedures, equations, etc., and verify by analysis and test. The following major task areas will be undertaken to accomplish the objective: (1) component design and test criteria (high frequency), and (2) improved structural and fluid dynamics analysis capability.

W78-70189**506-18-13**

Langley Research Center, Langley Station, Va

INFRARED ULTRASENSITIVE DETECTORS

H D Hendricks 804-827-3418

(506-20-33)

The objective of this research is to develop advanced ultrasensitive detectors required for application in future aerospace missions such as earth resources, pollution and environmental monitoring. The main thrusts are: (1) to develop monolithic indium antimonide detector arrays with on chip signal processing and readout of infrared sensors utilizing charge coupled (CCD) technology, and (2) to develop improved pyroelectric detectors with greater D^* (increased sensitivity) that will operate near room temperature. Materials processing, device technology and fabrication technology will be developed to give improved signal to noise ratios, increased resolution and broader spectral sensitivity.

W78-70190**506-18-15**

Jet Propulsion Lab, Calif. Inst. of Tech., Pasadena

ADVANCED IMAGING SYSTEMS TECHNOLOGY

D. D. Norris 213-354-6350

(186-68-52)

The objective of this work is to continue and extend the development of Charge Coupled Device (CCD) technology for two dimensional, monolithic imaging arrays with emphasis on the following items: (1) completion of the small pixel technology and extension of array size within the limits of state-of-the-art optical lithographic methodology, (2) determine the optimum approach for extending spectral sensitivity into the ultraviolet spectral range, and (3) determine a feasible approach consistent with future NASA programmatic plans for extending monolithic CCD technology for area array images into the infrared (IR) spectral range. The use of CCD's will increase imaging spectral range by more than 2, increase imaging sensitivity by 100X and reduce unit cost, weight, and power at increased reliability. Planned use of the 800 x 800 CCD's includes exploration of the solar system on spacecraft (including comets), Mars surface exploration, planetary observations from spacelab, and space telescope wide field camera and faint object spectrograph.

W78-70191**506-18-16**

Goddard Space Flight Center, Greenbelt, Md

ASTRONOMICAL HIGH RESOLUTION SENSORS

J. T. Williams 301-982-5095

The objective of this RTOP is the development of high performance astronomical sensors which will complement the telescopes and optical instruments now being developed for use on shuttle astronomy flights and advanced NASA space astronomy missions. In particular, we will investigate a photon counting TV, using Intensified Charge Coupled Devices (ICCD) arrays, development of improved CCD arrays for photon counting applications, and development of a windowless intensified charge coupled device for far UV applications.

W78-70192**506-18-23**

Langley Research Center, Langley Station, Va

ELECTRO-OPTICAL SENSOR TECHNOLOGY

S. L. Ocheltree 804-827-2791

(750-03-03)

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

The objective of this research is to investigate advanced laser and electro-optic sensor concepts, develop related systems technology and perform proof-of-concept field demonstrations for remote and in situ sensing of oceanographic and atmospheric properties. Sensor concepts to be investigated are laser backscatter and fluorescence techniques for marine and estuarine water parameter measurement; and continuously tunable visible and infrared laser techniques for high resolution absorption and emission spectroscopy and measurement of low concentration atmospheric constituents.

W78-70193

Goddard Space Flight Center, Greenbelt, Md

HIGH RESOLUTION LASERS

M W Fitzmaurice 301-982-4948

(645-40-01)

The thrust of this RTOP is to develop the high performance components and high resolution measurement techniques needed to support the NASA programs in Geodynamics, Climatology, and Earth Observation. Special emphasis is placed on instrumentation systems which can provide global coverage from an orbiting platform such as the Space Shuttle. Specific objectives are (1) to develop an efficient flash-pumped, mode-locked Nd:YAG with a 0.1 ns pulse width for use in a Shuttle-based laser ranging system, (2) to develop a swept image converter detector with solid state readout for use as a space qualified picosecond precision ranging receiver, (3) to develop designs and fabrication techniques for low cost ground-based optical cube corners, (4) to develop arc-second pointing and control system techniques for ground-based and space-based optical systems, and (5) to develop Shuttle-compatible cloud lidar and visibility instruments for global climatological studies.

W78-70194

Langley Research Center, Langley Station, Va.

BROADBAND MICROWAVE RADIOMETER TECHNOLOGY

W F. Crosswell 804-827-3631

The objective of this program is to develop the technology of and demonstrate the feasibility of an array of broad-band microwave precision radiometers for simultaneous imaging of earth surface parameters on an all-weather basis. The technical approach will be to improve the basic radiometers by improving the performance, resolution, bandwidth stability, and reliability of these devices through the development of low loss front end components, broadband devices with flat frequency response, microwave integrated circuit devices, broadband antenna feeds, etc. Broadband laboratory breadboard sets of improved microwave radiometer arrays with simultaneous imaging will be constructed, calibrated and evaluated.

W78-70195

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

DEVELOPMENT OF SUBMILLIMETER WAVELENGTH RECEIVERS

J. W. Waters 213-354-3025

This RTOP is for a five-year program to develop low noise, coherent, submillimeter wavelength receivers for multifunctional uses. The goal of the program is to provide the technological developments necessary for constructing receivers operating up to 1000 GHz frequency (0.3 mm wavelength) with noise temperatures less than 1000 K. These receivers will be of importance to the following areas of the space program in the time period beyond 1980: (1) Terrestrial atmospheric observations from aircraft and from Earth orbit, (2) Astronomical observations from aircraft and from Earth orbit, (3) Missions to planets and comets, and (4) Supporting laboratory spectroscopy. A logical five-year program will be followed to develop low noise receivers operating at frequencies up to 1000 GHz. Four major technical areas must be addressed: (1) Development of efficient quasi-optical techniques for submillimeter receiver front ends, (2) Development of techniques for efficient coupling of submillimeter radiation to nonlinear devices, (3) Development of appropriate nonlinear devices capable of efficient operation at submillimeter wavelengths, and (4) Development of local oscillator sources. Some of the new techniques to be developed here will initially

be tested at frequencies in the 100-200 GHz frequency range, and will be applied to higher frequencies in steps where each step is an approximate doubling of the previous operating frequency. At each step a prototype receiver will be constructed and its performance evaluated. Development of this receiver technology will make possible for the first time a wide range of measurements in atmospheric, planetary, and astrophysical sciences. Many molecular species of importance to stratospheric and mesospheric chemistry have rotational lines with maximum intensity at submillimeter wavelengths. The submillimeter receivers will provide the capability for continuous monitoring of those species. The results could provide significant information regarding regulation of technological activities which might affect Earth's protective ozone layer.

W78-70196

Goddard Space Flight Center, Greenbelt, Md

MULTIFUNCTION MICROWAVES FOR ENVIRONMENTAL SENSING

J L King 301-982-4949

The objective of this RTOP is to improve the performance and reliability of passive microwave systems used in sensing the earth's environment. These sensors must operate in selected bands over a frequency range from 1 GHz to about 200 GHz to measure such parameters as atmospheric water vapor profiles, temperature profiles, precipitation, sea surface temperature and wind speed, soil moisture, snow pack conditions, etc. These multifrequency and multifunction systems require advanced receiver technology development above 100 GHz and in the lower frequency range (1-10 GHz) large (10-30M) scanning beam antennas pose the major advanced development obstacle in being able to provide enough resolution and swath coverage for meaningful application experiments. This program will conduct design studies and develop breadboard subarrays for a 10 meter square 14 GHz electrically scanned microwave radiometer array. Millimeter wave low noise (100-200 GHz) subharmonic mixers with 20 GHz RF and 10 GHz IF bandwidth will be developed with solid state local oscillator sources for the 118 GHz O₂ and 183 H₂O line atmospheric profiling radiometers.

W78-70197

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

HIGHLY RELIABLE SENSOR TECHNOLOGY: PREDICTABLE LONG-LIFE

G W Lewicki 213-354-4530

(186-68-83)

The use of LSI components in NASA missions is rapidly becoming a necessity in order to meet mission goals. Existing methods for assuring reliability of these devices are not adequate. The purpose of this RTOP is to develop new methods which will provide a means for predicting LSI reliability and for assuring reliable operation in the NASA space environment. The application of these methods is important to many of NASA's near term missions where LSI will play a key role. These include (1) data systems which use the NASA standard Remote Terminal Unit (RTU), (2) synthetic Aperture Radar data processing, (3) Mars 1984 Rover, and (4) the Jupiter Orbiter Probe (JOP). Specifically, the long range goal is to provide NASA the capability of acquiring LSI components with ten operating lifetimes and safe operation in space radiation environments. The current focus is on MOS technology with primary emphasis on CMOS bulk and SOS. The approach to achieving lifetime predictions of LSI involves five steps; first, a fundamental understanding of failure mechanisms must be acquired, second, diagnostic techniques are developed to acquire information relating to basic physical parameters, including their stress time dependence. The next step is to have a vehicle for obtaining data from LSI lines - this vehicle is the test chip. The fourth step is a device model which accurately predicts device performance in terms of measured fundamental parameters. With this information, IC simulations can be performed which will provide life prediction. Thus, by determining the stress time dependence of the few key parameters, it is possible to predict the output characteristics and time-to-failure of complex LSI components. These basic developments will be done in-house, and verification will be done through

interaction with LSI lines in industry and with other government agencies

W78-70198**506-19-11**

Ames Research Center, Moffett Field, Calif

PRECISION POINTING AND CONTROL: VIDEO INERTIAL POINTING SYSTEMSK R Lorell 415-965-6530
(358-41-08)

The objective of this RTOP is to define, develop, demonstrate, and evaluate advanced pointing and control system technology with specific application to astronomical payloads and experiments. One task involves the development and demonstration of an attitude reference system for shuttle attached payloads. This system, the Video Inertial Pointing (VIP) system, will substantially improve the rapid acquisition of targets, greatly enhance the flexibility and performance of the pointing control system, and enable drift free astronomical observations without the use of multiple star trackers or on-axis guide stars. VIP is directly applicable to the Shuttle Infrared Telescope Facility (SIRTF) and utility instrument mounts such as the Annular Suspension Pointing System (ASPS). A second task involves the development and demonstration of pointing and control system concepts and hardware for use with spaceborne astronomical spatial interferometers. Problems to be solved include precise co-pointing of several telescopes, precision baseline and path length control, and stabilization of the interferometer base. Applications include a Shuttle-borne infrared (IR) interferometer to be flown in the late 1980's and a larger multi-element orbiting interferometer being considered for the 1990's.

W78-70199**506-19-13**

Langley Research Center, Langley Station, Va.

PRECISION POINTING AND CONTROL: ADVANCED SPACECRAFT/EXPERIMENT SYSTEMSW W Anderson 804-827-3049
(750-03-15)

The objective of this RTOP is to develop techniques, hardware, and software to further the long-range spacecraft guidance and control, and information system's 1990 goals of 10 times the information acquisition through precise pointing, and 1/10 the spacecraft systems life cycle costs through standardized configuration in sensitive guidance and control. To achieve these goals, new devices, concepts, and analyses are being pursued. These include (1) spacecraft, attitude control momentum devices, such as the magnetically suspended Annular Momentum Control Device (AMCD); (2) new techniques for experimental vernier pointing, such as the Annular Suspension and Pointing System (ASPS), a magnetically suspended pointing platform concept, which promises better than an order of magnitude improvement in pointing accuracy, and (3) analytical studies of optimum spacecraft maneuvering and performance and stability studies of dual spin satellites. Through these efforts, technology is being developed to permit the design and implementation of cost-effective spacecraft and experiment control concepts for earth orbital missions. System and component requirements as well as conceptual designs are being defined through the use of simulations. Effective system configurations, low-cost system integration, multipurpose operation, and component standardization will be used to reduce system and component costs while achieving required performance. Development of control software and hardware will be undertaken and critical hardware elements will be carried through laboratory evaluation to establish feasibility. This effort is being directly coordinated with GSFC, JSC, MSFC, and JPL.

W78-70200**506-19-15**

Jet Propulsion Lab., Calif Inst. of Tech., Pasadena

PRECISION POINTING AND CONTROL: TECHNOLOGY DEVELOPMENT

S Z Szirmay 213-354-4431

The long range objective of this RTOP is to develop and demonstrate precision pointing and control conceptual designs, analysis tools, and implementation approaches applicable to a wide range of NASA programs, including large structure control and pointing, experiment pointing and spacecraft control. These

missions demand systems and components with longer life, lower weight, and less power. The use of high accuracy pointing systems will facilitate the attainment of the long range goals of a tenfold increase in the acquisition of new and usable data, and 50% decrease in cost. Principal Program Targets are (1) to develop and publish a taxonomy of control concepts and potential mechanizations for the attitude & figure control of large space structures and arrays up to 5 km across with rms surface accuracies ranging from 1 meter to 0.1 mm by end of FY-78; (2) to demonstrate a breadboard extended life attitude control system (ELACS) with a 0.01 degree pointing accuracy and a lifetime potential of more than eight years by FY-79; (3) to develop for planetary application the control system technology for three axis precision pointing and tracking (PPTS) capable of one arcsecond stability while tracking at rates up to 2 degrees per second by late FY-80; (4) to provide definition of advanced control techniques for control of large, flexible spacecraft and complete initial comparison studies by FY-80; and (5) to identify advanced technologies required for control of large space structures and a plan of development implementation by FY-80.

W78-70201**506-19-16**

Goddard Space Flight Center, Greenbelt, Md

PRECISION POINTING AND CONTROL: ADVANCED COMPONENTSH E Evans 301-982-4194
(506-19-13, 506-19-14)

This task covers research, design, and evaluation of cost effective advanced components and control electronics for precision pointing applications and long duration missions. Components and control systems for both free flying spacecraft and shuttle based instruments are included. For precise pointing systems, prototype components and systems will be developed with (1) broader dynamic range control (100X), (2) greater efficiency and linearity (2X), and (3) increased reliability by elimination of life limiting elements (10X). Component technology advancements are utilized which include technical innovations in the areas of electronic commutation, magnetic suspension, and microprocessors. These concepts are utilized in cost effective precision control systems such as long life efficient rotating systems, non-contacting vibration isolators, and controlled multi-axis scanning systems. New concepts in actuators, sensors, and non-contacting power and signal transfer are incorporated. Phase-lock velocity and position control systems utilizing these components also form part of this task.

W78-70202**506-19-23**

Langley Research Center, Langley Station, Va.

ONBOARD NAVIGATION: LANDMARK TRACKERSW. E Howell 804-827-3551
(750-03-14)

This proposed landmark tracking study and experiment is designed to support the development of a landmark tracking technique for evaluation aboard an early Shuttle flight. The method is based on pointing or tracking via contrast properties of the landmark, providing pointing and tracking error signals not dependent on knowing spacecraft ephemeris and attitude to great precision, as required in present methods. This effort will allow an early assessment of instrument characteristics, software requirements, and proper flight experiment objectives. These objectives will be evaluated in simulated orbital passes over representative targets using equipment developed under earlier contracts.

W78-70203**506-19-26**

Goddard Space Flight Center, Greenbelt, Md

ONBOARD NAVIGATION: NEAR-EARTH SATELLITES

Arthur J Fuchs 301-982-6846

The primary objective of this RTOP is to develop the techniques and procedures for on-board orbit and attitude processing on near-earth satellites with the intent of improving the accuracy of satellite navigation and control, of providing the ancillary data necessary to convert raw data to user-oriented information in real-time; of providing images registered to a one-pixel accuracy directly to the user from the spacecraft and to select data for processing and transmission on-board the

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spacecraft thereby reducing the total data flow. The technology advances and companion RTOP's that make this work possible include microprocessor developments, the advent of the Global Positioning System (GPS) and precision spaceborne timing standards, the Multi-mission Modular Spacecraft on-board computer, high speed image retrieval with CCD's and work involving Landmark trackers. Under this RTOP optimal algorithms necessary to process GPS data on-board a spacecraft will be developed thereby providing for the availability of precision orbit and timing information on-board a near-earth satellite for the first time. This RTOP will also investigate the accuracy and distribution of Landmark data required on-board a spacecraft to both register the images to a one-pixel accuracy and for use in conjunction with CCD's and Landmark trackers for precision instrument pointing. The algorithms necessary for the on-board navigation will also be developed and simulated. The approach of this RTOP will be to develop a simulation laboratory where applicable on-board orbit and attitude determination and control algorithms can be developed and rigorously tested using existing minicomputers and a group of microcomputers that generate appropriate spacecraft sensor data in parallel. This will realistically simulate spacecraft conditions for the purpose of developing algorithms for autonomous navigation. Candidate algorithms for processing and estimating the orbit and attitude state from GPS and Landmark data will be programmed and evaluated. Emphasis will be to select those techniques suitable for automated processing subject to the core and speed limitations of onboard computers.

W78-70204

506-19-29

Marshall Space Flight Center, Huntsville, Ala

ONBOARD NAVIGATION: INERTIAL SENSORS

B. F. Walls 205-453-5910

The objective of this work is to continue development of a group of inertial sensors for measuring angular rate, position and attitude. This program has already produced sensors and technology that are presently being used in systems by NASA, U.S. Air Force and U.S. Navy. The work includes the design, construction, test and evaluation of new sensors for specific improvements in operational characteristics, size, weight, power, cost and reliability. Some of the items already produced with this technology are: a three-axis strapdown laser gyro navigation system, a laser rate gyro package, a high resolution laser gyro attitude sensor, and a redundant strapdown laser gyro navigation system. The proposed work for FY-78 is the continued technology development in the sensor area, the testing and evaluation of the above mentioned systems and the development of a solid state imaging detector.

W78-70205

506-19-35

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ARTIFICIAL INTELLIGENCE FOR INTEGRATED ROBOT SYSTEMS

E. Heer 213-354-3060

(506-19-21, 199-51-04; 506-20-11, 506-19-14)

This plan covers a robotics applications program to meet NASA's needs. The objectives are to develop and flight qualify specific technology. Specific objectives are: (1) automated assembly techniques for large-scale systems (LSS), (2) automated mission operations (MOS) for a variety of missions, (3) automatic image cataloging and retrieval, and (4) a system study of a completely automated spacecraft of the late 1980s. The first objective will combine laboratory assembly demonstrations using the JPL Robotics Research Program Facilities with the application of high-level assembly languages. This work will lead to development of a space-shuttle experiment with a special assembly tool. A near-term milestone relating to the second objective involves automation of the onboard TV instrument pointing function, using vision data to aim the camera. This pointing function will be ground commanded by a high-level MOS language, leading to a flight experiment. The third objective is based on the use of automated image data processing to extract important visual characteristics from TV images. A cataloging technique will be developed, and automatic retrieval based on image characteristics will be demonstrated on Viking pictures. The fourth objective is intended to combine distributed

computing and on-board data processing with the work described in this RTOP to develop an autonomous spacecraft for the 1980s. Related work is described in RTOP's 506-19-21 (Guidance and Navigation for Unmanned Planetary Vehicles); 506-20-11 (Advanced Digital Data Systems); 506-19-14 (Precision Pointing and Tracking Systems); 199-51-04 (Advanced Teleoperator Technology Development)

W78-70206

506-20-23

Langley Research Center, Langley Station, Va

ON-BOARD DATA PROCESSING

Charles Husson 804-827-3535

The objective of this work is to develop data processor technologies useful for the economic and expeditious reduction of data obtained from remote sensing vehicles. Such improvements should lead toward stand alone, small lightweight real time programmable processors which lead to a 1000-fold decrease in the density of data sent back to earth processing stations or a 1000-fold increase in the capability of earth based stations to process multispectral data. Current research efforts include the development and evaluation of a multifunction CCD processor integrated circuit and the inclusion of projected devices into a breadboard architectural hierarchy based on multivariant interactive digital analog systems processors. The results of this effort will establish system design and demonstrate the data processing capability of analog CCD data processors. The breadboard CCD processor will provide baseline performance parameters for the extrapolation of this work to larger earthbased or on-board data systems.

W78-70207

506-20-26

Goddard Space Flight Center, Greenbelt, Md.

AUTOMATED DATA HANDLING TECHNIQUES AND COMPONENTS

David H. Schaefer 301-982-5184

(506-20-14)

The focus of this RTOP is to develop hardware especially suited for very high speed analysis of data in the form of images. Such hardware is especially needed for analysis of images generated by Earth Observation and other image sensing spacecraft. The approach is to develop parallel image processing systems. In particular, this RTOP is developing digital computer systems that perform over sixteen thousand operations simultaneously. The immediate objective is to construct by 1982 a demonstration massively parallel image processing system known as the 'Massively Parallel Processor (MPP)' that will perform logical operations at an effective rate of 10 to the 11th power bits per second. Input and output rates of the MPP will be greater than 10 to the 9th power bits per second. Running at these rates, this computer will be able to perform over 5000 million additions per second and over 1000 million multiplications per second on eight bit numbers. Cross correlation of a 128 x 128 image and a 20 x 20 image, both quantized to six bits, will be computed in less than three milliseconds. The longer term goal of this RTOP is to develop low power system that will process data at 10 to the 12th power bits per second. Such systems will be suitable for use aboard spacecraft or on unmanned planetary rovers.

W78-70208

506-20-33

Langley Research Center, Langley Station, Va

SOLID STATE DEVICE TECHNOLOGY

R. A. Breckenridge 804-827-3661

(506-20-23)

The objective is to develop advanced electronic devices and components for increased capability and cost efficiency of information handling in future aerospace mission. Theoretical studies and laboratory investigations in selected areas of electronic materials, device concepts and processes will be conducted in-house. Research contracts and grants will be used to develop new and improved solid state devices and components. Those material and process technologies which have potential for yielding improved and reliable performance in cost effective electronic devices and components will be emphasized. Current efforts include the investigation of new and improved materials, device

concepts and processes for the development of data processing devices, data storage devices and data transfer devices.

W78-70209 506-20-42
Lewis Research Center, Cleveland, Ohio
HIGH SPEED DATA TRANSFER: ADVANCED MICROWAVE AMPLIFIERS
R. E. Alexovich 216-433-4000

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

W78-70210 506-20-45
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
MICROWAVE COMPONENTS AND TECHNIQUES
S. A. Butman 213-354-2759

The objective of this RTOP is to provide technology development of high speed data transfer for NASA low-cost data distribution system. Design data and techniques will be obtained to permit the distribution of processed data from future space missions to the user community via space- and/or ground-based data links in an efficient and economic manner. To meet the objective, this RTOP develops four fundamental data transfer technologies: (1) digital radio, (2) antenna systems, (3) propagation modeling, and (4) coding. The digital radio development provides technology for the next generation NASA standard transponder needed for use by the mid-80's, achieving the required performance increases while halving current cost, weight and volume. Antennas system studies provide efficient, cost effective, antenna design and test techniques, and provide technology required for precision pointing of large spacecraft antennas less than 7 inches at superhigh frequencies. A solid-state modular array feed for reflector antennas provides precision beam steering at transmitter power levels of hundreds of watts. Propagation modeling, through studies of the effects of earth and planetary atmospheres, and the interplanetary media on microwave communications, will provide data needed for more reliable communications through turbulent media. Coding development will provide 2.5 db performance improvement thus allowing near doubling of data rate to earth, while adhering to CCIR flux density limits. The accomplishment of all above technology development will make significant contributions to the OAST goals of 1000 increase in mission return with corresponding cost reduction up to 10 by 1990.

W78-70211 506-20-46
Goddard Space Flight Center, Greenbelt, Md.
HIGH SPEED DATA TRANSFER: S/KU BAND COMPONENTS AND TECHNIQUES
D. E. Santarpia 301-982-6375
(310-20-46)

The objective of the work to be accomplished under this RTOP is the advancement of Spacecraft RF Technology in Tracking and Data Transfer to satisfy the demanding communications requirements of future space flight projects. The flight programs of the 1980's are characterized by high data rates (up to 600 mb/sec.), simultaneous multilink and reliable long life operation. The accommodation of such requirements shall be achieved through technological advances in Spacecraft RF techniques and hardware.

W78-70212 506-20-55
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
HIGH CAPACITY DATA STORAGE AND DISPLAY: FIBER OPTICS DATA LINKS
Johnston A. R. 213-354-4054
(506-18-21, 180-24-51,)

The goal of the proposed effort is to apply the emerging technology of fiber optic data links to NASA needs, and to contribute to the advancement of the technology in selected areas. Development of fiber optic data transmission will support OAST goals both in terms of a great increase in mission capability and a decrease in mission costs. Two long-term objectives will be the focus of the work: development of a space data bus capability and development of high capacity data distribution capability. During FY-78, a limited digital data bus compatible with the spacecraft Unified Data System (UDS) requirements will be breadboarded. The JPL CCTV link operated in breadboard form in FY-77 will be extended into a prototype using multifiber cable. Fiber data link concepts will be developed for use in future data distribution systems. High data rate components will be investigated in connection with the data distribution system application. Applications have been sought for simple near term demonstration, and this activity will be continued in order to help set the goals for our experimental work, and to identify limiting technology. The principal benefits to be expected from the use of fiber optics are the EMI immunity of the transmission line, its small size and weight, wide bandwidth, and ultimately lower cost than copper equivalents.

W78-70213 506-20-59
Marshall Space Flight Center, Huntsville, Ala.
HIGH CAPACITY DATA STORAGE AND DISPLAY: ARCHIVAL DATA STORAGE TECHNOLOGY
G. A. Bailey 205-453-3431

The objective of this RTOP is the development of an operational optical mass memory system with storage and retrieval bit capacities of 10 to the twelfth power to 10 to the thirteenth power by 1981 and 10 to the fifteenth power by the mid-1980's. This system is intended to replace the use of magnetic tape and microfilm used in archival storage facilities of large data base centers. Although they are used almost exclusively in this application, mag tape and microfilm have few of the required characteristics for archival storage. The storage material for instance must provide low cost per bit, can be recalled efficiently and accurately, can be duplicated easily, requires no maintenance, must be compatible with existing systems, and must be certifiably archival, i.e., a material that satisfies the NBS standards for archival storage media. Data will be provided to users on conventional mag tape compatible with their respective tape readers. The key features of this system will include very high information packing densities (about 50-100 Mb/sq in.), very low bit error rates smaller than 10 to the minus ninth power, high recording and readout rates (on the order of 20 Mb/sec), very low cost per bit (about .03 cents/kbit), negligible maintenance requirements and full archival reliability. The technology basis will be direct digital recording (optical spot recording) on a certifiable archival recording medium, e.g. bismuth thin films on polyester. There are several primary milestones necessary to achieve a cost effective and operationally successful system. A breadboard system is completed and will be demonstrated in June 1977. This system will be used to delineate and characterize critical components needed for the design of the breadboard.

W78-70214 506-20-69
Marshall Space Flight Center, Huntsville, Ala.
HIGH-DENSITY CIRCUIT TECHNOLOGY: COMPUTER-AIDED DESIGN AND TESTING
J. M. Gould 205-453-3431

The underlying goal is the reduction of the cost of electronic subsystems through enhancement of high density circuit technology. The principal subsystem cost factors are packaging, parts fabrication and the screening and reliability testing of parts. To have a significant effect upon packaging cost, it is essential to dramatically reduce parts count by increasing the degree of integration of monolithic arrays while maintaining low parts fabrication and screening cost. Such high density arrays must consist both of off-the-shelf parts such as microprocessors and memories and of custom designer arrays for collecting random interface and control logic. This effort will provide the technology, techniques, equipments, and sources to insure that high density arrays can be produced with assured reliability in an economical and consistent manner. This will be accomplished through the

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development of: automated design, process and test hardware and software; high density large scale integrated circuit technologies, and improved methods and techniques to assess and assure reliability

W78-70215

506-21-19

Marshall Space Flight Center, Huntsville, Ala

ADVANCED REUSABLE HIGH DENSITY AND DUAL-FUEL ENGINE TECHNOLOGY

D. H. Blount 205-453-3431

(910-03-10)

Advanced reusable vehicle design studies show payload advantages and reductions in vehicle volume through use of dual-fuel engines and altitude compensating nozzles. Tests are planned utilizing existing and modified 40K test chambers to establish the feasibility of LOX/high density fuel and LOX/H₂ used as dual-fuel propellants and to experimentally determine heat transfer, combustion efficiencies, and combustion stability of LOX/high density fuel at high chamber pressure. The dual throat, concentric chamber engine provides altitude compensation by providing two nozzle area ratios. Analysis is planned to predict the aerodynamic and heat transfer effects of the two concentric exhaust streams from the two throats and to provide design information on the relative throat sizing and axial positioning. Tests are planned to verify and augment the analysis in the areas of aerodynamic behavior, heat transfer, and performance. Two inner chambers will be tested. One with hydrogen cooling and one with LOX cooling to evaluate the feasibility and merits of LOX cooling. The 40K hardware referred to herein consists of SSME subscale devices that are to be declared residual in the SSME program. The testing is to be conducted in a facility at MSFC commonly known as the 40K facility, which was used to test the reference SSME subscale hardware.

W78-70216

506-21-25

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

LONG LIFE ADVANCED PROPULSION SYSTEMS FOR PLANETARY SPACECRAFT

D. L. Young 213-354-3217

(525-71-01; 506-21-43)

The objective of this RTOP is to provide the research and technology demonstration for key liquid feed assembly components, and of the rocket engine assembly, for advanced liquid propulsion systems for use on planetary missions. The first portion of this effort will be devoted to the support of an on-going effort to develop a durable fluorine/hydrazine engine. The work will involve both an on-going in-house effort and continued contractual effort in design and fabrication of preprototype and prototype engines. The three-phase contract, started in FY-76, will continue through FY-78. This effort will support on-going liquid-fluorine components work, specifically continuation of long-term materials compatibility testing, procurement and testing of preprototype relief valve assemblies, isolation valve, and helium regulator. Space shuttle safety-related action items identified by OSF will be addressed and necessary research and technology identified.

W78-70217

506-21-33

Langley Research Center, Langley Station, Va.

ANALYSIS OF ENVIRONMENTAL IMPACT OF LAUNCH VEHICLE EFFLUENTS

The objective of this research is to develop a basic understanding of the chemistry of exhaust clouds from rocket vehicles and the interactions of the exhaust clouds with the atmosphere including precipitation, and to determine the probable effectiveness and atmospheric perturbations of proposed chemical agents and delivery systems for neutralizing the acidic effluents emitted in the troposphere. The initial composition of the rocket exhaust known at the SRM exit plane, is only a starting point in determining the ultimate chemical and physical distribution of these products in the atmosphere, or on the ground. The chemical composition of the exhaust cloud changes continually, rapidly at first as a result of high-temperature reactions with atmospheric species and nucleation of condensable species and then more slowly as a result of both thermal and photochemical gas and

species condensed-phase reactions, turbulent and molecular diffusion, droplet growth and evaporation, and various other microphysical and microchemical phenomena. Thus, a complete chemical characterization of the resulting cloud as a function of propellant, atmospheric conditions, and time is needed to properly assess the environmental impact of the exhaust products. This research will also attempt to assess whether or not (1) the hydrogen chloride emitted in the troposphere can be effectively neutralized by proposed low-cost systems, and (2) the potential toxic hazards due to HCl can be removed and the possibility of an acid rain can be eliminated without significant exacerbation of weather modification and other environmental effects. This research is part of the technology base required by NASA to develop and substantiate the environmental impact statements for future NASA rocket launches.

W78-70218

506-21-35

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ADVANCED SOLID PROPULSION AND PYROTECHNIC CONCEPTS

W. Gin 213-354-3790

(506-21-45)

NASA in the period from 1980 to 2000 will need enabling technology in solid propellant rocketry and pyrotechnics in order to effectively accomplish its missions. The objective of this work is to create the needed new technology. This work will provide reductions in costs or increases in performance, reliability and flexibility of solid propellant motors and pyrotechnics, as well as the creation of new concepts. The technology will be able to be applied to NASA launch vehicles, and NASA spacecraft for orbit, landing, and take-off propulsive maneuvers at other planetary bodies. Attention will also be given to frequently-encountered design problems such as solid rocket combustion instability and long-life pyrotechnic squibs. The specific tasks are: (1) Advanced upper stage motor technology; this activity is focused on completion of the rocket motor which incorporates several new motor components. (2) Advanced earth-to-orbit propulsion concept; a feasibility design study will be conducted. (3) Heat sterilizable propellants; this will consist of preparing candidate propellants and subjecting samples to the sterilization thermal environment. (4) Space storage of propellants; this effort will support the LDEF experiment. (5) Advanced propellant concepts; propellant formulations will be prepared, tested, and evaluated using different oxidizers as well as mixed oxidizers in order to obtain a wider range of ballistic parameters. The innovative low-cost synthesis of perchlorate by biochemical methods will be further investigated. (6) Planetary atmospheric propulsion; this effort is changing from investigating detonation propulsion for dense atmospheres to devices which can also utilize the buoyant or aerodynamic properties of the atmosphere. Feasibility studies will be conducted to define requirements. (7) Combustion and pyrotechnic problems; this effort will be focused on solving pyrotechnic problems such as lowering the cost of pyrotechnic squibs and increasing their storage life to 20 years and on understanding the steady state and dynamic combustion processes of composite propellants.

W78-70219

506-21-45

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

CHEMICAL PROPULSION RESEARCH AND DEVELOPMENT

J. Moacanin 213-354-3178

(506-21-25; 506-21-35)

The objective of this RTOP is to establish scientific bases for the chemical formulation and mechanical design, of solid propellants for rocket motors, and to quantify liquid rocket performance by modeling of experimental results. Theoretical and experimental investigations will be performed in rheology, chemistry, and combustion to: (1) obtain a better understanding of propellant mechanical properties, processing and environmental stability characteristics to permit the formulation of techniques for the control thereof, and to reduce costs of motor development, (2) derive information which will enable the design of motors as structurally integrated units with a minimum of costly empirical study and to predict their useful lifetimes on the basis of expected environmental duty cycles, (3) develop computer programs for

analysis of complex flow fields amenable for theoretical-performance studies of liquid rocket engines of unconventional design and improve experimental analyses of combustion in sprays, (4) promote standardization of monopropellant testing methodology and evaluate new hydrazine catalysts as available; and (5) determine plume/spacecraft interaction effects leading to guidelines for the minimization of exhaust plume envelopes

W78-70220**506-21-49**

Marshall Space Flight Center, Huntsville, Ala

JANNAF SUPPORT - PLUME TECHNOLOGY WORKING GROUP

T F. Greenwood 205-453-3285

The JANNAF Plume Technology Working Group (PTWG) has been funding the development of a Plume Handbook for the past three years. This handbook is to be a compilation of existing plume technology methodology. Chapters on the Basic Flow Structure (Chapter 2), Plume, Electromagnetic Interactions (Chapter 4), and IR Radiation (Chapter 3) are either already finished or being completed. Chapter 6, which concerns vehicle base flow and base heating, is to be developed next. NASA (MSFC) is responsible for Chapter 6. In addition to the Handbook, JANNAF (PTWG) plans to sponsor the development of a state-of-the-art low altitude plume computer program that will be used as a standard for NASA, DOD, and contractors. This program will include viscous effects, finite rate chemistry, internal shock structure calculations, and coupled two-phase effects

W78-70221**506-22-12**

Lewis Research Center, Cleveland, Ohio

AUXILIARY ION THRUSTER SYSTEM TECHNOLOGY

R C Finke 216-433-4000

(506-22-32, 506-23-42, 506-22-22, 750-03-09)

The objective is to define and develop the technology for auxiliary electric propulsion systems, including thrusters and power processors, for application to stationkeeping and attitude control of geocentric spacecraft and future large space systems. The integration with geocentric spacecraft of mercury bombardment thrusters with thrust levels between half and two millipounds will be defined by study. Auxiliary propulsion systems, possibly with propellants other than mercury, suitable for attitude control and station keeping of large space systems will be defined by study. The lifetime of the 8-cm mercury bombardment thruster will be verified by extended testing of critical elements and a complete thrust subsystem including power processor, thruster, gimbal, and propellant storage systems. The definition of requirements and the development of a technology plan will be initiated for the application of auxiliary propulsion to large space systems. The work will be performed both by in-house and contracted efforts.

W78-70222**506-22-16**

Goddard Space Flight Center, Greenbelt, Md

AUXILIARY ION PROPULSION FOR MMS APPLICATION

R A Callens 301-982-4205

Ion engine propulsion has reached sufficient maturity that work needs to be done to find if and how it should be applied to improve the cost effectiveness of free flyers in the Shuttle era. The approach is to identify the role of the ion propulsion for the Shuttle deployed Multimission Modular Spacecraft (MMS) through the next two decades. Lewis Research Center is cooperating in implementing this RTOP and will supply ion engine cost and performance data.

W78-70223**506-22-22**

Lewis Research Center, Cleveland, Ohio.

PRIMARY ELECTRIC PROPULSION SYSTEMS

Robert R Lovell 216-433-4000

The overall program goal is to identify and develop the required technology to demonstrate technology readiness status for primary propulsion ion thrust systems for proposed missions. Development and testing of thrusters, power processors, and system elements will be done to optimize element performance, lifetime, and reliability and characterize the critical system interfaces and requirements. The program will result in a baseline technology and design criteria for application to anticipate electric propulsion

spacecraft. The approach is to define requirements, develop to engineering model status, and verify by test and multiple thruster operation, primary propulsion thrusters which satisfy the range of requirements of foreseeable missions. Power processors will be designed and developed to functional model status, integrated with thrusters, and verified by system level tests. Other critical system elements such as gimbals, propellant storage and distribution system, and thrust subsystem-spacecraft interface hardware and software will be investigated to the extent necessary to define critical interfaces and system requirements and reduce risk in future applications. The program will be carried out via both in-house and contracted programs.

W78-70224**506-22-25**

Jet Propulsion Lab, Calif Inst of Tech, Pasadena

ION DRIVE (SEP)/SPACECRAFT AND SCIENCE INTERACTIONS

E V. Pawlik 213-354-3455

In the long history of ion drive, the extent-of the interaction between the Ion Propulsion Module (IPM) and the science and mission modules has been a question mark to the science and spacecraft design communities. These interactions were investigated in a preliminary sense during the Advanced System Technology Program and several areas, including telecommunications, EMI, and plume deposition and contamination were identified as phenomena which would constrain spacecraft design. With the possibility of a near term application of ion drive to a high energy mission, the need for a program has developed to build confidence in the science and spacecraft design communities that these interactions either are understood, or are being examined in greater detail. This work, which is not presently being conducted at any other NASA center, would provide a degree of understanding to these areas which would apply not only to a specific mission such as Halley's Comet, but to other planetary and earth orbital missions. The effort at JPL involves the participation of scientists/technologists in areas where the interactions are of most concern. This effort is directed toward understanding the spacecraft and science interactions with the ion propulsion module and then determining the additional constraints that they place on the module. Ways of minimizing these interactions will be determined. This effort includes participating in LeRC design team efforts and key tests, and insures that the interfaces between the TSS and the rest of the spacecraft are well defined and workable.

W78-70225**506-22-29**

Marshall Space Flight Center, Huntsville, Ala

SOLAR ARRAY TECHNOLOGY AND ENVIRONMENTAL IMPACT FOR SOLAR ELECTRIC PROPULSION (SEP)

L E Young 205-453-2110

The objective of this RTOP is to insure the availability of solar array and environmental impact technology which meets solar electric propulsion requirements. The approach is to perform preliminary design and analysis activities to identify the technology required to support solar electric propulsion. This technology will be compared with the state of the art to identify areas where demonstration or further development of technology is needed. These areas will be worked as specific tasks with results being fed back into the design effort. To accomplish the objective, the following tasks will be performed: (Task 1 was completed in Dec 1974). (1) Task 1: preliminary design for identification of required technology (>66 W/Kgm), (2) Task 2: materials demonstration, (3) Task 3: thermo-compression bonding of solar cells to electrical interconnects, (4) Task 4: solar cell selection and characterization, (5) Task 5: solar cell module thermal cycling, (6) Task 6: nondestructive inspection and tests, (7) Task 7: full-scale solar array wing fabrication and tests, (8) Task 8: extended performance SEP solar array study (>200 W/Kgm), and (9) Task 9: environmental effects assessment.

W78-70226**506-22-32**

Lewis Research Center, Cleveland, Ohio.

ELECTRIC PROPULSION RESEARCH AND ADVANCED CONCEPTS

R C Finke 216-433-4000

The objectives of this RTOP are (1) to perform the

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fundamental and applied research required to understand the physical processes inherent to electric propulsion systems, (2) to develop models of the phenomena in order to establish design guidelines, understand controlling processes, define interface criteria; (3) to investigate alternative electric propulsion concepts and predict performance, life, and interface criteria. [Examples of systems in an early development stage requiring further investigation are the inert gas bombardment ion thruster system, and the synchronous linear accelerator (mass driver)]. (4) to identify, evaluate, develop, and transfer to the user community nonpropulsive applications of ion thruster technology, and (5) to develop new or improved materials and processes that are enabled by the application of ion beam technology will be explored

W78-70227

506-22-35

Jet Propulsion Lab, Calif Inst of Tech, Pasadena
MPD THRUSTER SYSTEM TECHNOLOGY
E V Pawlik 213-354-3455
(506-24-25)

The objective of this effort is threefold (1) to evaluate the technology associated with generating a quasi-steady state magnetoplasmadynamic (MPD) thruster with an inductive storage energy transfer device, (2) to define the potential performance, efficiency and lifetime of the MPD thruster, and (3) to conduct a preliminary conceptual study of how a MPD thruster system might be incorporated into either a Solar Electric Propulsion (SEP) or a Nuclear Electric Propulsion (NEP) vehicle. Periodically the charging current is interrupted and the energy stored in the magnetic field of the inductor is utilized for a short duration thrust pulse. Both analytical and experimental studies of this concept are required in order to determine overall feasibility

W78-70228

506-23-12

Lewis Research Center, Cleveland, Ohio
SOLAR CELL TECHNOLOGY
D T. Bernatowicz 216-433-4000

The objective of this RTOP is to develop the technology for low-cost solar cells and blankets with high end-of-life efficiency. Research and technology programs will be continued in the following areas (1) Research will proceed into the basic loss mechanisms and radiation damage in photovoltaic devices (2) Cells will be developed with improved end-of-life efficiency. Such cells may include some or all of the following features: epitaxially-grown junction, ion implanted junction, back surface field, heavily doped base, thin base wraparound contact, textured front surface and tailored dopant profile (3) Processes for fabricating cells at low cost, will be investigated including thick film processes for contacts, interconnects, and coatings, and nongaseous diffusion sources (4) Exploratory development of new concepts for covering and encapsulating solar cell modules will be continued.

W78-70229

506-23-15

Jet Propulsion Lab, Calif Inst of Tech., Pasadena
PLANETARY SOLAR CELL AND BLANKET RESEARCH AND TECHNOLOGY
W A Hasbach 213-354-2817

The RTOPs for photovoltaic energy conversion are to improve conversion efficiency, reduce mass, reduce cost, and increase the operating life of photovoltaic converters and blankets. The following tasks are in support of the above specific objectives and those targets, of the FY-78 PASO, which JPL is chartered to support: (1) demonstrate pilot production of thin (<75 micron) silicon solar cells at efficiencies >12% by FY-79, (2) reduce solar array total blanket mass to <3 kilograms/kilowatt by FY-79; (3) test and evaluation of solar cells to develop an improved understanding of solar cell performance in space, includes characterization of new type cells and evaluation of space radiation effects; (4) demonstrate automated low-cost (<\$10 per watt) array module fabrication by FY-80; and (5) develop solar array fabrication materials/adhesive/welded interconnect technology for high temperature operation with or without concentrators

W78-70230

506-23-16

Goddard Space Flight Center, Greenbelt, Md

ATS-6 SOLAR CELL RADIATION DAMAGE EXPERIMENT L W Slifer 301-982-4841

The objective of this RTOP is to extend the collection, analysis, and reporting of data from the ATS-6 Solar Cell Radiation Damage Experiment

W78-70231

506-23-22

Lewis Research Center, Cleveland, Ohio
ELECTROCHEMICAL RESEARCH AND TECHNOLOGY
Stuart J Fordyce 216-433-4000

The object of this program is to attain long life, high energy densities and high reliability, at low cost, for electrochemical energy conversion and storage devices. The emphasis is on alkaline batteries and separators, electronic techniques for improving performance and life. H₂-O₂ fuel cells to operate at higher efficiency and exploratory studies on higher energy density systems. During FY 1978, the performance matrix for the long-life, secondary silver-zinc cell will be completed, and its applicability for planetary probes established. The tests of the single cell protector technology will be completed and pulse charging techniques to prolong life of alkaline cells will be defined. Work continues on the silver hydrogen cell. A 50 AH, 40-watt hr/lb cell capable of > 500 cycles in a synchronous orbit regime will be designed. The lightweight (25 watt hr/lb) nickel-cadmium program will be supported via lightweight electrodes, introducing inorganic-organic separators and exploring deep discharge reconditioning. Alkaline battery separators will continue to evolve, the inorganic concepts aimed at low cost, reproducible, uniform materials and fabrication methods and exploration of new polymers and modifications. Multi-kilowatt hour storage technologies will be examined for feasibility, particularly the novel > 100 AH torodial nickel-cadmium concept. H₂-O₂ fuel cell technology aimed at long maintainable fuel cell electrolyzer missions (energy storage) as well as orbital transfer vehicle applications will be advanced. Exploration of 100 C sodium-sulfur cell concept for 150-watt hr/lb continues. The NASA Battery Test Facility at NWSC, Crane, Indiana, will be maintained

W78-70232

506-23-25

Jet Propulsion Lab, Calif Inst. of Tech., Pasadena
ADVANCED NICKEL-CADMIUM AND PROBE BATTERIES
A A Uchiyama 213-354-4039

This RTOP is directed toward providing the battery technology basis for future space power systems needed to develop near-earth space and to continue exploration of the solar system. The objectives are to achieve improved performance, energy density, and life, as well as extend operational capability and reduce cost of space batteries. The objectives are to be met by advancing the technology of battery components, operating and storage techniques, and test and evaluation procedures. Specific objectives are: (1) advance the state of the art of nickel-cadmium technology by developing a battery capable of a 10-year life and an energy density greater than 26 Wh/kg through innovative design technology, and by establishing nickel-cadmium design and accelerated/predictive test techniques based on all available empirical data and by improved operational techniques; and (2) demonstrate a 330 Wh/Kg (10-yr storage life) primary lithium battery by FY-82, and a >220 Wh/Kg secondary battery by FY-82

W78-70233

506-23-35

Jet Propulsion Lab, Calif Inst of Tech., Pasadena
THERMOELECTRIC THERMIONIC ENERGY CONVERSION
W. E Bachman 213-354-4420

Continued exploration of the outer planets will in many cases require the use of improved and advanced power systems. Three separate tasks (O1, O2, and O3) are contained within this RTOP which is responsive to the level IV element of the OAST Space R&T Program. The work to be done is described in three technological areas. Task O1 involves thermoelectric systems. The broad objectives of this task are to perform technology investigations that will identify new thermoelectric conversion material which can significantly improve RTG performance and provide a data base to allow NASA to make appropriate selection of the thermoelectric material concept for a given application. To achieve these objectives, three areas are being pursued (1)

develop techniques for decreasing the RTG/spacecraft integration cost; (2) evaluate candidate thermoelectric materials which are considered for power systems; and (3) develop new, high efficiency thermoelectric materials. Task 02 involves thermionic systems technology. The objective of this task is to demonstrate technology readiness for the system development effort in the areas of heat pipes, high temperature insulators, and thermionic converter surfaces. The approach taken is to conduct systems work to assure identification of key technologies and to evaluate higher system operating temperatures (1800 K). Task 03 involves thermionic converter research. The objective of the thermionic converter technology task is to demonstrate a nominal converter output power density of 4 W/sq cm and a barrier index of 1.75 eV with a corresponding conversion efficiency of approximately 17%. Tentative candidate to achieve such an objective is a molybdenum, hybrid thermionic converter which would operate at emitter and collector temperatures of 1650 K and 850 K respectively.

W78-70234**506-23-42**

Lewis Research Center, Cleveland, Ohio.

SPACECRAFT CHARGING AND HIGH VOLTAGE PLASMA EFFECTS

R C Finke 216-433-4000

The environmental interactions considered in this RTOP involve all interactions between the charged particle environment of space and spacecraft surfaces that can impact the operation or life of spacecraft systems. Investigations of the interactions between the geomagnetic substorm environment and spacecraft surfaces (spacecraft charging phenomena), and interactions between higher voltage spacecraft surfaces and the space plasma environment will be conducted. The broad objective of these investigations is to provide design guidelines for control of the interactions. The approach used to attain this objective is to conduct a comprehensive analytical and experimental technology program to identify the environmental fluxes and the interactions of concern, to evaluate these interactions, to develop the design guidelines, and to transfer this technology to designers of operational systems.

W78-70235**506-23-52**

Lewis Research Center, Cleveland, Ohio.

MULTI-KW LOW COST POWER SYSTEMS MANAGEMENT

Fred Ieren 216-433-4000

The objective is to provide the technology base of multi-kW space power systems including electrical components, power processing and distribution systems needed for low cost semi-permanent low earth and geosynchronous power systems in the mid-1980's. The proposed work will define and develop the technology necessary to both extend Shuttle based capabilities and establish semi-permanent central utility power capabilities essential to the habitation and development of near earth space. Contractor and in-house analysis and experimentation will be used to define, develop and test components, subsystems and systems needed for low cost semi-permanent earth orbital electrical power systems. In-house and contractor studies will be conducted to determine performance requirements, identify system constraints, and estimate cost, weight and size of potential space power systems, identify technology needs, and determine benefit/cost ratio of proposed technology programs. A strong activity will be maintained to coordinate with and support work at other NASA centers aimed at meeting future earth orbital power needs.

W78-70236**506-23-55**

Jet Propulsion Lab, Calif Inst of Tech, Pasadena

ECONOMICAL EARTH ORBITAL POWER SYSTEM

D. L. Ross 213-354-4049

The objective of this RTOP is to ascertain the feasibility, assess the risk, determine the approach to and define the realistic costs and performance associated with a multi-kw, economical earth orbital power system (ECOP) that would extend orbital power plant capabilities for a variety of applications. Terrestrial and aeronautical power components, methods and systems will be evaluated for low cost application. A program plan will be prepared for implementation of hardware. This activity also

includes inter-center coordination including JSC for acquiring additional information pertaining to the space shuttle. This objective supports the NASA program and space objective for Space Energy Systems to 'evaluate and implement low cost terrestrial and aeronautical methods and systems for applicability to space energy systems' and the corresponding target to 'evaluate and demonstrate the application of terrestrial and aircraft power components and methods to economical orbital power (ECOP) systems by FY-80'.

W78-70237**506-23-59**

Marshall Space Flight Center, Huntsville, Ala.

MULTI-KW LOW COST EARTH ORBITAL SYSTEMS

J L Miller 205-453-2113

The objectives of this RTOP are to provide the technologies required to develop multi-kW low cost space power systems needed for future NASA missions such as Space Station, Space Construction Base and Power Module. The RTOP will be a combination of in-house and contracted efforts and will consist of the following tasks: (1) Task 81 (Power Distribution System Simulator) will establish and demonstrate technology readiness for high voltage distribution systems, (2) Task 82 (Investigation of Concentrating Photovoltaic Power Generation) will establish and evaluate an approach for developing concentrating solar array power generation, (3) Task 83 (Advanced Solar Power Generation) will evaluate advanced power generation approaches which offer significant performance improvements.

W78-70238**506-23-62**

Lewis Research Center, Cleveland, Ohio

BRAYTON ISOTOPE POWER SYSTEM (BIPS)

L. Shure 216-433-4000

The objective of this RTOP is to provide a technology base for high-efficiency, long-life, low-cost, thermo-mechanical space power conversion systems applicable to near-term NASA and DOD missions (early 80's). This joint NASA-ERDA program will include a demonstration of the Brayton power conversion process in the fractional-to-2 kilowatt power level. NASA missions in the early 80's appear to require power levels in the neighborhood of 1 kilowatt. Several of these missions, especially deep space probes, cannot use solar arrays. In addition, certain DOD missions in this time period require compact power systems in the range of 1 kilowatt with long life. To fulfill these needs and provide confidence for mission selection, a flight prototypical Brayton system will be assembled by ERDA using components furnished by NASA. This system will be performance and endurance tested to validate long life for mission durations of 5-7 years.

W78-70239**506-23-65**

Jet Propulsion Lab, Calif Inst of Tech, Pasadena

HIGH-PERFORMANCE POWER SYSTEMS

W. E. Bachman 213-354-4420

Four separate tasks (1, 2, 3, 4) are contained within this RTOP with objectives generally as follows: (1) The objective of this task is to develop a capability referred to herein as Automated Power Systems Management (APSM). APSM is defined to be the capability of a spacecraft power system to automatically perform monitoring, computational, command, and control functions without the need for ground intervention. (2) The objective of this task is to identify a lightweight power source capable of surviving the intense Mercury thermal environment. It is the intent of this task to ascertain the feasibility of the solar thermoelectric generator (STG) for a low altitude Mercury Spacecraft application by testing in a 10 to 16 Sun simulation. (3) The objective of this task is to develop and demonstrate advanced power processing and distribution and related system configuration and integration technology to meet the requirements of future planetary spacecraft. The intent of this work is to develop designs that not only can accommodate technical needs but which can also be built and incorporated into the spacecraft power system for minimum cost. (4) The objective of this task is to provide the detailed design technology basis for lightweight, high power solar arrays, capable of long-life unattended performance in the hostile environment spanning near-sun and deep space operation.

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

W78-70240

Langley Research Center, Langley Station, Va
PLASMA CORE REACTOR RESEARCH
F Hohl 804-827-3781
(506-25-33)

The objective is to establish the scientific knowledge required for the future development of gaseous-core and plasma-core nuclear reactors. Emphasis in this basic research is on determining the characteristics of the radiant energy from gaseous nuclear fuel heated by fission and other means, and the transport of this radiation and its conversion to other forms of energy. A major effort of the research is directed toward the study of materials for use with high-temperature UF₆ and uranium, argon/UF₆ injection, separation, and recirculation system design and testing. Analytical investigations of the prospective applications and performance potential of gaseous core reactors for space and terrestrial applications will be performed. UF₆ handling, separator design and testing, and part of the radiation research will be conducted under contract under LaRC direction. Other supplementary radiation research is conducted under the LaRC 506-25-33 RTOP. Nuclear reactor experiments will be conducted under a separate NASA Headquarters RTOP.

W78-70241

Ames Research Center, Moffett Field, Calif
CRYOGENIC TECHNOLOGY FOR COOLING DETECTORS BELOW 10 KELVIN
J W Vorreiter 415-965-6525
(790-40-19, 188-78-51, 188-41-55, 188-41-54)

The objective of this effort is to provide space compatible technology for photon and gravity wave detectors requiring operating temperatures between 10 and 0.02 Kelvin. Efforts in three general areas will be to: (1) maintain cognizance and coordination with all related cryogenic activities within NASA, DoD, NBS, and ERDA to minimize possible duplication of effort, make maximum use of already existing technical talent and knowledge, and identify future NASA technology needs as well as recognize and evaluate possible new applications in this area; (2) develop space compatible cooling technology and related components for various science detectors and detector packages; and (3) develop methods to protect cold optics from contamination. Both in-house and contractual efforts will be applied as well as subauthorizations to other NASA Centers to make maximum use of technical talent in this discipline.

W78-70242

Jet Propulsion Lab, Calif Inst of Tech, Pasadena
APPLIED MATHEMATICS
F B Estabrook 213-354-3247

The objectives of this research are (1) to develop new methods of applied mathematics for nonlinear systems, and (2) to apply these methods to current problems where the importance of solitons and nonlinear wave processes has been suggested. Solitons are fundamental excitations of nonlinear physical systems. A newly developed geometric method of analysis based on Cartan's calculus of exterior differential forms is used to find invariance transformations, general similarity solutions, and conservation theorems. Baecklund transformations (analytical operations that create and destroy solitons in nonlinear systems) are systematically derived with this new method. A hierarchy of potentials (satisfying linear equations) is found for each of the nonlinear soliton equations by the technique of prolongation structures, developed under this task. This has now become a subject of active research at many other institutions, in several countries. In cooperation with nonlinear controls theorists at Harvard and the Ames Research Center, prolongation structures have been shown to be related to mathematical entities from differential geometry known as connections. The use of connection-theoretic results to extend soliton theory to three spatial dimensions is under active investigation. The relation of prolongation structures to Baecklund transformations and variational principles is being sought; both new analytic techniques and computational algorithms can then be derived. The importance of intrinsically nonlinear phenomena, such as solitons and wave interactions, for understanding the dynamics of a great variety of physical systems has been demonstrated in recent years, and new

applications are continually being recognized. These effects are seen in fluid dynamics, laser media, magnetic domains, lattice dynamics, and nonlinear controls, among others. A major current effort in this task is the application of the mathematical techniques, described above, to develop a theory of soliton charge carriers in quasi-one-dimensional conductors. The basic model has been defined and its physical implications are being investigated. A new application effort in FY-78 will be to explore nonlinear surface wave processes which can be important, for example, in liquid drop dynamics and freak ocean waves.

W78-70243

Marshall Space Flight Center, Huntsville, Ala
MAGNETICS AND CRYOPHYSICS
P. N. Peters 205-453-5134
(188-41-54)

Existing facilities for thin film deposition and microfabrication are being utilized to investigate and develop advanced superconducting instrumentation compatible with flight experiments requiring cryogenically cooled surfaces. Superconducting, thin film Josephson junctions, individually and in arrays, are being investigated and developed for magnetometry and radiation detector applications in space, and a design for a step-up dc superconducting transformer is being investigated as a possible coupling device. Investigations into solving coupling problems with the junction devices, the properties of superradiant array structures, and detector response to photon energies greater than the superconducting energy gap are being pursued.

W78-70244

Ames Research Center, Moffett Field, Calif
RADIANT ENERGY CONVERSION
K W Billman 415-965-5233
(506-25-41)

The objective is to conduct basic research on the interactions of photons with matter for major advances in the generation, transmission, and utilization of energy with emphasis on light amplification by stimulated emission of radiation and the excitation of molecules, atoms and ions by coherent and incoherent radiation. To this end, investigations will be made in the following areas: (1) theoretical modeling and experimental development of discharge excited excimer lasers; (2) theoretical calculation of molecular potential surfaces, collision and photoionization cross sections; (3) theoretical and experimental investigation of the influence of intense electromagnetic fields on interacting molecular systems; (4) development of laser techniques to remotely probe gasdynamic flows; and (5) examination of novel concepts in space-related conversion of solar radiation such as solar-pumped lasers, technology advances for SSPS and SOLARES, and similar concepts.

W78-70245

Lewis Research Center, Cleveland, Ohio
ION CYCLOTRON GAS EXCITATION
James W. Blue 216-433-4000

A general objective of this work is to study problems related to advanced power and propulsion concepts which can be conducted in the laboratory-like environment of the LeRC cyclotron. Specific objectives of the study are: (1) determination of power density of a plasma achieved with cyclotron particles; (2) measurement of the optical and X-ray photon yields from this plasma; and (3) determination of the effects of radiation on relevant materials. One approach to these objectives is a pending study of the effect of particle bombardment in properties of superconductors. Another objective is to evaluate the feasibility of the gamma ray laser. Major problem areas are level broadening due to electric and magnetic fields and the achievement of the directionality of photon emission required to make a laser cavity. Two approaches are being studied to achieve directionality, one is to use critical angle reflection from very small capillaries and the other is to make use of internal fields to establish a directional radiative pattern.

W78-70246

Langley Research Center, Langley Station, Va
PHOTON-MATTER INTERACTIONS
F Hohl 804-827-3781

Research will be performed to characterize fissioning uranium plasmas and to obtain efficient high-power conversion of nuclear energy directly into electromagnetic radiation laser power, or work. The interaction of fission fragments with uranium hexafluoride and with other gases will be determined. Radiation-induced plasma will be studied to determine possible population inversion, nonequilibrium emission, and ionization and excitation cross sections. A new type of plasma focus will be used as an intense X-ray and neutron source in radiation-induced plasma research. The potential of the recently achieved nuclear-pumped lasers (Ne, Ar, Kr, Xe, Cl, and F) for increased power output will be investigated. Also, the possibility of new lasers in the ultraviolet and visible region with greatly increased power output will be studied. Studies for the selection of the most promising lasing medium and transitions will be performed using nonnuclear excitation. Actual tests will be performed using the U.S. Army Pulse Radiation Facility at Aberdeen, Maryland. Efficient methods of converting broad-band light directly to electricity and storable hydrogen and oxygen by photochemical conversion, will be developed. New concepts, such as double electrode cells and protection of corrodible electrodes by inactive films or by passive electrolytes, will be investigated.

W78-70247 **506-25-41**
Ames Research Center, Moffett Field, Calif
HIGH-POWER LASER SYSTEMS TECHNOLOGY
K. W. Billman 415-965-5233
(506-25-31)

The objective is to conduct research and technical investigations of high power laser systems to extend performance for potential use in space and to determine in what manner and to what extent the emerging field of high power lasers can contribute to or enhance the capabilities and return of future NASA space missions. To this end, investigations will be made in the following areas: (1) The pursuit of capability to convert laser radiation to useful work with high efficiency will continue by utilizing TELEC, MOM optical diodes, laser driven engines and other novel means. Engine development will include an investigation of isentropic engine processes and the development of a one horsepower engine with conversion efficiency exceeding 50%. (2) harmonic conversion of high average power laser radiation in gaseous media will be examined experimentally; (3) research on means to obtain high repetition rate excimer lasers and high efficiency COEDS lasers for space power transmission will continue, and (4) molecular dissociation and laser-enhanced chemistry will be explored for potential NASA application.

W78-70248 **506-25-43**
Langley Research Center, Langley Station, Va.
HIGH POWER LASER SYSTEMS TECHNOLOGY
R. V. Hess 804-827-2818
(506-25-33; 506-18-13)

The objectives are to develop new approaches for optical pumping with single and multifrequency high power density laser radiation to obtain CW/pulsed new laser transitions and increased tuning range and pressures and to provide more efficient frequency upconversion techniques, to evaluate application of multifrequency laser operation to remote sensing of the earth's environment and the solar system (photon missions), and other NASA missions, and to evaluate optical pumping with broadband sources in space. CO₂ lasers operating simultaneously on many lines will be used to efficiently excite molecules to high vibrational levels, which laser directly or transfer their vibrational energy to other molecules lasing at higher frequencies. Various gas mixtures will be studied to enhance the efficiency and tuning range of these lasers. Design studies will be performed of multifrequency lasers for remote sensing and other NASA missions. Broadband optical pumping of various gases with radiation from solar concentrators and future radiation sources and conditions for lasing, will be evaluated.

W78-70249 **506-25-45**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
HIGH-POWER LASER SYSTEMS TECHNOLOGY
G. R. Russell 213-354-3547
(506-25-35)

The objective is to develop the necessary technology required to construct multikilowatt copper halide lasers for potential use in space. The approach will be to determine the scaling laws governing the operation of subsonic copper halide lasers by constructing and testing a 300 watt prototype copper chloride laser. The program is based on the conclusion that high power visible lasers will be utilized in future NASA missions in the 1990 time period.

W78-70250 **506-26-11**
Ames Research Center, Moffett Field, Calif
COMPUTATIONAL AND EXPERIMENTAL AEROTHERMODYNAMICS
J. G. Marvin 415-965-5390

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. Turbulence models (used in these computer codes) will be developed from building block numerical and physical experiments. New instrumentation techniques will be developed for the measurement of turbulence quantities in three dimensional flow fields.

W78-70251 **506-26-13**
Langley Research Center, Langley Station, Va.
SPACE VEHICLE AEROTHERMODYNAMICS AND CONFIGURATION TECHNOLOGY
B. Z. Henry 804-827-3911

The objective of this study is to develop configuration design concepts and the associated aerothermodynamic technology data base which will allow the achievement of space transportation vehicles operational in the 1990's and beyond which offer significant improvement in operational efficiency, economy, and safety. The intent is to study, both analytically and experimentally, configuration concepts utilizing technologies advanced beyond the base being established by the space shuttle. Specific studies will be directed toward solution of the aerothermodynamic problems associated with these concepts in such areas as aerodynamic performance, viscous-interaction and real-gas effects, vortex interactions, heat transfer, basic configuration shaping, and optimization. Computational flow-field methods will be developed with emphasis on realistic configurations, and techniques for integrated configuration design, analysis, and optimization will be developed and continuously improved. Feasibility studies of the use of the Space Shuttle Orbiter to obtain fundamental aerothermodynamic data applicable to future vehicle design will be pursued. Various perfect gas and real-gas facilities will be utilized in experimental investigations to provide design data over a broad range of parameters.

W78-70252 **506-26-21**
Ames Research Center, Moffett Field, Calif
PLANETARY PROBE AEROTHERMODYNAMIC TECHNOLOGY
H. K. Larson 415-965-5369
(506-16-41)

This effort is directed at providing the aerothermodynamic technology base in high speed aerothermodynamics required for the design, development and verification of probes entering planetary atmospheres and to provide computational and experimental support, in a timely manner, for the specific development of planned and approved missions, in accord with the following targets: (1) to provide a complete understanding and prediction of the shock-layer and ablation product radiative gasdynamics for planetary entry vehicles, (2) to provide coupled flow-field/ablation solutions for the outer planet probes; (3) to provide systematically coupled performance analysis, and (4) to support the aerodynamic development of planetary probe configurations, and to provide the flight mechanics data in support of atmospheric reconstruction experiments. The coupled nature of outer planet probe aerothermodynamics requires a highly integrated computational and experimental program. The

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theoretical and experimental efforts in the area of shock-layer radiation must be coupled with similar efforts in ablation product radiation and absorption. These efforts in turn must be coupled with research associated with shock layer flow which is highly blown by ablation products. In addition, the flight mechanics of the probe, both static and dynamic, are significantly affected by the ablation mass loss and shape change. Finally, all these theoretical efforts and experimental validations must be systematically coupled computationally to provide the required aerothermodynamic input to outer planet probe development.

W78-70253 506-26-23
Langley Research Center, Langley Station, Va.
PLANETARY MISSION SUPPORT
G. D. Walberg 804-827-3031

The objectives are: (1) to provide computational and experimental support as required for aerothermodynamic design, development, and verification of planetary mission vehicle configurations with special emphasis on the Jupiter Orbiter/Probe mission; (2) to develop a technology base that can be used to minimize planetary mission costs, maximize science return, and insure a high probability of mission success; and (3) to support atmospheric reconstruction experiments through ground-based aerodynamic tests and analyses, and through development of trajectory reconstruction analyses that allow deduction of vehicle aerodynamic characteristics and planetary atmospheric characteristics from entry data. These objectives will be pursued using analytical and experimental methods and will be conducted primarily in-house with contract support as justified. This work will encompass the following topics: (1) refinement of benchmark flow field solution techniques for Venusian and Jovian entries; (2) use of benchmark solutions to predict entry environments for Pioneer/Venus and Jupiter Probe Missions; (3) development of engineering flow field solution techniques for Jovian entry; (4) experimental measurement of radiative properties of ablation products; (5) determination of planetary probe aerodynamic characteristics from ground tests and analysis of flight data from Viking and Pioneer/Venus; and (6) studies of effects of mass loss, shape change and real gas aerodynamics on atmospheric reconstruction experiments.

W78-70254 506-26-31
Ames Research Center, Moffett Field, Calif.
SPACE SHUTTLE: CONFIGURATIONS AND AEROTHERMODYNAMICS
J. G. Marvin 415-956-5390

The objective is to provide the analytical and experimental support to the Shuttle Program Office as required for aerothermodynamic design, development, and verification of the shuttle orbiter, launch and ferry configurations and subsystems. The necessary expertise and facilities will be provided to support in-house and program-generated action items as required during the design, development and verification of the space shuttle. A single flow-field computer code will be developed to simulate the hypersonic nonequilibrium flow over the windward surfaces of the Space Shuttle Orbiter.

W78-70255 506-26-33
Langley Research Center, Langley Station, Va.
SPACE SHUTTLE DEVELOPMENT SUPPORT
B. Z. Henry 804-827-3911
(506-26-30)

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

NASA centers and the Phase C/D contractor through appropriate Program Office Engineering Coordination Panels at JSC.

Space Systems Studies

W78-70256 790-40-13
Langley Research Center, Langley Station, Va.
STUDY OF ADVANCED GLOBAL INFORMATION SERVICE SYSTEMS
W. R. Hook 804-827-3666
(790-40-23)

The study of advanced space service systems has been undertaken in order to provide timely information for planning of the agency's advanced research and technology programs. Based on current studies, an advanced Geosynchronous Information Service Platform (GISP) with a supporting Large Aperture Microwave imaging system Platform (LAMP) in low Earth orbit have been selected for more detailed study. The objectives of this further work are: (1) to develop a new concept for global services to the public sector; (2) to assess the feasibility of developing, constructing and flying the GISP and LAMP; (3) to make enabling technology forecasts in the disciplines of propulsion, power, materials, structures and electronics; and (4) to identify associated flight experiments. The technology forecast will be based on independent study and access to classified company proprietary and foreign technology programs. Resulting information will be important to both Center and Headquarters management to support research and technology development planning.

W78-70257 790-40-15
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ADVANCED AUTOMATION NEEDS ANALYSIS
E. Heer 213-354-3060

The objectives are to: (1) broaden communication among NASA Centers and universities and other research organizations currently engaged in machine intelligence research; (2) identify opportunities for the application of machine intelligence in NASA missions and systems; (3) estimate the benefits of successful adoption of machine intelligence techniques such as cost savings, improved performance, and mission enablement; and to prepare forecasts of the growth in capability of these techniques; and (4) recommend a program of research, advanced development, and implementation of machine intelligence technology for use in OAST planning. The approach will be to: (a) establish a board consisting of members of NASA Centers, NASA Headquarters, and the machine (artificial) intelligence community; (b) identify potential applications of advanced autonomy and machine intelligence techniques; (c) hold a series of workshops at which the state-of-the-art in machine intelligence may be addressed in the context of the applications; and (d) following the workshops, prepare recommendations to OAST on promising approaches and potential candidates for further development.

W78-70258 790-40-17
Lyndon B. Johnson Space Center, Houston, Tex.
NONTERRESTRIAL RESOURCES IN SPACE CONSTRUCTION
R. O. Piland 713-483-4071

The primary objective of this RTOP is to compare the relative merits of constructing space solar satellites with materials from the moon and from earth. The primary consideration will be to compare the two approaches utilizing a common set of methodologies and assumptions as regard to costing, technology and other factors. This study will involve a comparative analysis of the two approaches in order to define under what conditions which approach might be preferable.

W78-70259 790-40-19
Marshall Space Flight Center, Huntsville, Ala.
ASSESSMENT OF ENABLING TECHNOLOGY FOR FUTURE MISSIONS
J. D. Capps 205-453-0134

The objectives of this RTOP are to: (1) estimate the complexity and magnitude of software for future NASA payloads, (2) identify software limitations to desired payload performance and areas of software application with a large impact on program or user cost and/or flexibility, (3) survey and assess the current state of art in software technology and determine its applicability to future software, (4) identify opportunities for the advancement of software technology that offer substantial payload benefits, and (5) define programmatic requirements for the advancement of software technology beneficial to payloads. The study approach is structured to capitalize on the experience and data developed in three years of SPDA studies of STS payloads, and takes full advantage of available payload software studies. Future payload software requirements will be identified, defined, and then reviewed with appropriate NASA payload working groups. The software development load will be estimated in terms of number and size of application programs. Extraordinary processing requirements will be identified and evaluated for applicability to software technology advancement. Software cost reduction alternatives will be identified and correlated with the payload requirements. The current state of art in software technology will be assessed and applicability to payloads evaluated. Software advanced technology opportunities will be identified and defined and their programmatic requirements established to allow timely NASA decisions and implementation.

W78-70260 **790-40-23**
Langley Research Center, Langley Station, Va.
TECHNOLOGY READINESS FOR GLOBAL SERVICE MISSIONS
W R Hook 804-827-3666

This effort will identify and evaluate technology alternatives for planned agency flight programs in global services. Specific results will identify OAST programs which can substantially improve performance or reduce cost. Technology assessments will be made for critical systems and economic data will be supplied to program benefit/cost analyses. Secondly, the work will identify areas where previous and on-going technology programs have been instrumental in enabling the proposed space flight system. The results will provide insight as to ways in which technology can be more rapidly utilized in new systems to improve performance and/or to reduce cost. The bulk of the effort will be carried out in-house by a small multidisciplinary team of systems analysts. Small additions to existing contracted planning studies will be made to examine alternate technology impact on system design and cost.

W78-70261 **790-40-25**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
VOIR/SEASAT FOLLOW-ON TECHNOLOGY READINESS
J. L. West 213-354-5719
(790-40-18, 790-40-19)

The objective of this RTOP is to evaluate a group of spacecraft advanced technology candidates in the context of the VOIR (Venus Orbiter Imaging Radar) and SEASAT follow-on missions to identify the candidates' potential benefits to these missions and readiness for mission support based on the current NASA advanced development (AD) program. The study will rank each candidate by relative merit in the context of complete conceptual spacecraft designs for these missions and provide recommendations for AD program changes necessary to assure the readiness of each candidate for project commitment. The study will examine technologies for all engineering subsystems with emphasis on technologies affecting power, telecommunications, and data processing. In addition while the study will not examine, in general, advanced technology science subsystems/instruments, it will assess the benefit of advanced engineering subsystem technologies for the support of several alternative implementations of the synthetic aperture radar (SAR), as developed in this study, which could be based on excursions from existing technology. The approach of the RTOP will be to apply the methodology developed in the Technology Readiness Study performed in FY-76 under RTOP 790-40-Q3. Specifically, existing mission/spacecraft studies will be used to synthesize reference mission and spacecraft designs. A list of candidate advanced technologies will then be assembled, with emphasis on technologies being

developed under JPL cognizance but to include any technologies proposed by NASA. This list will include many of the technologies previously evaluated in the context of the 1985 Jupiter Orbiter mission. A team of evaluators will identify the benefits and development status of each candidate and provide recommendations for changes to the AD program which will assure that the technologies are at an acceptable state of development for project commitment.

W78-70262 **790-40-33**
Langley Research Center, Langley Station, Va.
ADVANCED MISSION CONCEPTS - TECHNOLOGY REQUIREMENTS OF INTEGRATED EARTH-TO-GEOSYNCHRONOUS SPACE TRANSPORTATION SYSTEMS
B. Z. Henry 804-827-3911

The objective of this study is to identify and evaluate the technology required for the design and operation of advanced systems capable of meeting the goals of economical transportation within the Earth-Moon sphere of influence in the post-shuttle timeframe. The intent is to analyze potentially attractive concepts which build upon the technology base developed for the Space Shuttle Program utilizing projected advances in the areas of materials, structural design, propulsion, aerothermodynamics, design interaction and others. Definition of approaches to advanced system design and a detailed examination of the relative impact of assumptions as to achievable levels of various technologies offer a suitable means of identifying those technologies which are crucial as well as those most cost effective; this identification will be a primary output of the effort. An inherent characteristic of any such advanced system is that it offers clear and significant cost/capability advantages relative to current systems. Programs to provide solutions to key technology issues will be designed based on the results of these studies. The activity will be pursued through a series of contractual system studies, technology-planning, methodology-development studies, and selected in-house analyses as required.

W78-70263 **790-40-35**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
SPACEBORNE ANTENNA AND MICROWAVE SYSTEMS TECHNOLOGY STUDY
R. E. Edelson 213-354-3394
(358-41-07; 645-25-02, 650-40-11)

The goal of this study is to develop a preliminary system specification and programmatic recommendations, including appropriate system demonstrations, based upon the FY-77 conceptual design approach for a large spaceborne antenna, operating in the frequency range of 20-300 GHz. Antennas of 200-300 meter aperture at geosynchronous orbit will be investigated. Emphasis will be given to the identification of critical technologies. The Earth's atmosphere blights reception over much of this frequency range, and large apertures of sufficient surface accuracy are difficult to achieve in a gravitational field. For this reason, such instruments would have at least three users: (1) the Search for Extraterrestrial Intelligence (SETI); (2) radio astronomy, and (3) the Deep Space Network. The first two will use this capability to observe signals invisible from the surface of the Earth. The third user will take advantage of the improved communications link performance possible at these frequencies. All users would benefit from diminution of Earth environment sources of RF interference and noise. In particular isolation from the noise induced by re-radiation in the Earth's atmosphere which sharply increases with decreasing wavelength. The study will (a) state the system's functional requirements; (b) provide a preliminary system specification; (c) determine critical systems, their detailed requirements, preliminary design considerations, and requirements for technological development, and (d) recommend a programmatic plan (with an emphasis on critical technology developments) including schedule and estimated costs for several launch dates.

W78-70264 **790-40-39**
Marshall Space Flight Center, Huntsville, Ala.
NON-TERRESTRIAL MATERIALS UTILIZATION FOR SATELLITE POWER SYSTEMS
Georg F. Von Tiesenhausen 205-354-2789

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

This system analysis study will analyze the utilization of nonterrestrial materials in the construction of satellite power systems (SPS) and assess economic, resource, environmental and other consequences. The study product will be a comparative assessment of SPS construction from terrestrial and non terrestrial materials.

Space Systems Technology Programs

W78-70265

520-71-03

Langley Research Center, Langley Station, Va.

SOLID STATE DATA RECORDER

R L Stermer 804-827-3535

(323-40-13)

The overall objective of this project is to provide, by FY-1978, a 10 to the 8th power bit solid state data storage system suitable for replacing tape recorders in many aerospace vehicle applications. In addition to the basic tape recorder operations, the solid state data recorder is to provide a flexible operational command structure for advanced aerospace data systems. Specific intermediate objectives are: design a 10 to the 8th power bit data recorder using bubble technology; develop and demonstrate a basic recorder in a breadboard configuration; develop and fabricate a prototype 10 to the 8th power bit recorder. A two-phase developmental contract is being used to provide the data storage system. This contract is being supplemented by in-house analytical studies and laboratory investigations in critical areas of the recorder magnetic and electronic systems. These studies will be directed toward providing improved operational characteristics, longer useful life, and reduced costs.

W78-70266

520-72-03

Langley Research Center, Langley Station, Va.

MULTIPURPOSE - USER ORIENTED SOFTWARE (MUST)

E C Foudriat 804-827-2077

(506-19-13)

The objective is to define and develop software support tools and technology which will provide for the effective utilization of digital electronics in avionics and space flight systems. To be effective, the user (e.g. research, flight test engineer) must be involved in all stages of the program development and checkout in order to maintain visibility and continuity with his flight test objective. The software support system seeks to develop flexible software language systems, validation, and test procedures which can effectively be targeted to a variety of flight type computers. The tool system concept must also keep pace with the rapidly advancing and changing computer hardware technology. These software techniques will be developed and tested by application to NASA flight test programs and will be available to NASA, other government agencies, universities, and industry.

W78-70267

524-70-03

Langley Research Center, Langley Station, Va.

SYSTEMS TECHNOLOGY STUDIES

A. Guastaferrro 804-827-4606

Technical studies will be conducted by the line organizations of the Langley Research Center and their contractors to determine technology requirements for large area space systems, to develop and evaluate preliminary technology concepts, analyses and design methods, applications of composites and other advanced materials, and pointing and surface control techniques, and to define future ground based and space flight experiments needed to evaluate key technology developments.

W78-70268

524-70-05

Jet Propulsion Lab., Calif Inst of Tech., Pasadena

LARGE DEPLOYABLE ANTENNA TECHNOLOGY DEVELOPMENT

E. Heer 213-354-3060

(524-70-01; 645-25-02; 506-19-15)

The long range objective of this RTOP is to develop the base technology for a variety of large deployable antennas for

identified space applications such as mobile communications, satellite VLBI for radio astronomy, Earth looking radiometry/precision radar, submillimeter radio astronomy and atmospheric limb sounding. The technology for large deployable, precision deployable and hybrid deployable antennas will be developed through (1) analysis, (2) hardware evaluation and tests, and (3) shuttle based experiments. The FY-78 activity will provide the early technology developments required to formulate and provide a refined definition for the specific tasks. FY-78 objectives are: (1) to complete the preliminary definition of a large deployable antenna shuttle experiment, (2) to initiate the development of a spaceborne surface accuracy sensing system with the capability of automated mapping of large area antennas for the purpose of design verification, RF performance prediction and for active control of critical antenna surfaces, (3) to initiate development of a flightworthy active surface control system for the purpose of improving RF performance through variable positioning of the antenna feed system and adjustment of large area reflective surfaces, (4) to determine the performance characteristics of advanced concepts for large deployable antennas by (a) design evaluation, (b) assessment of analytically determined performance and (c) demonstration of fundamental concepts by simple hardware models, and (5) to determine the performance characteristics of advanced concepts for precision deployable antennas by (a) evaluation of mechanical designs, (b) assessment of analytically predicted performance and (c) demonstration of the fundamental mechanical concepts by hardware models of critical mechanical components.

W78-70269

524-71-03

Langley Research Center, Langley Station, Va.

CASTS- COMPOSITE FOR ADVANCED SPACE TRANSPORTATION SYSTEMS

J G Davis, Jr. 804-827-2125

(505-01-33, 505-02-33, 743-01-03)

The broad objective is to increase the maximum operating temperature of resin-matrix composite materials for structural applications to 600 F to meet requirements for advanced space transportation systems and payloads. This objective will be achieved through a joint in-house and aerospace industry contract effort which will include: (1) development and characterization of currently available polyimide resins and adhesives and new resin systems; (2) development of manufacturing and quality control procedures; (3) development of thermal structural design methods; (4) design, fabrication and ground tests of small-scale components and fullscale space structure demonstration components.

W78-70270

525-71-05

Jet Propulsion Lab., Calif Inst of Tech., Pasadena

LONG LIFE SPACE STORABLE PROPULSION SYSTEMS TECHNOLOGY

D L Young 213-354-3217

(506-21-25, 506-21-45)

The overall objective of this effort is to demonstrate technology readiness of a complete flight weight fluorine/hydrazine F2/N2H4 propulsion subsystem for planetary spacecraft application by the end of FY-80, using both past and ongoing individual component and system related developments. The demonstration will consist of a hot fire test of the complete subsystem to a preselected duty cycle that will simulate a typical application. This system level effort was initiated in FY-77. Detailed planning has been completed and an implementation plan was published. Future missions' propulsion requirements will be examined, and subsystem performance, interface, and overall test requirements established. Flow testing of components to system requirements will continue, as well as firing tests of pre-prototype injectors and rocket engines. Proposed thermal control and structural techniques will be tested and subsystem test planning will be completed this year. The preliminary design review for the subsystem will be held during the first quarter of FY-78 and final subsystem structure, thermal control, and feed module designs will be completed by the critical design review in early FY-79. The feed assembly components and rocket engine assembly to be used in this demonstration subsystem are being designed and fabricated.

Space Experimental Programs

W78-70271 750-01-22
Lewis Research Center, Cleveland, Ohio.
SHUTTLE PAYLOAD DEFINITION; SPACE FLIGHT TECHNOLOGY EXPERIMENTS
Robert R. Lovell 216-433-4000
(750-03-21)

This effort is to conduct definition studies for potential shuttle/Spacelab experiments which support, complement or proceed from OAST research and technology programs specifically to determine the technical and programmatic requirements for the experiment effort. Definition studies will be carried out on a Spacelab two phase heat transfer facility and experiments

W78-70272 750-01-23
Langley Research Center, Langley Station, Va
SHUTTLE PAYLOAD EXPERIMENTS DEFINITION
W E Sivertson 804-827-3666
(750-03-03)

The objective of this RTOP effort is to identify and obtain technical information and data required to proposed new experiments for development and orbiter/Spacelab flight, and to define technical and programmatic requirements for experiments that complement OAST-sponsored space research and technology efforts. In-house studies, grants, and contract effort will be used to define flight and ground tests relative to selected experiments that are deemed promising candidates for flight on a future shuttle payload. Concept, feasibility, error, system and programmatic analyses will be performed. Technology evaluation and tradeoff studies will be made. Laboratory testing and computer simulations will be utilized when needed to provide input study data. Shuttle experiments will be defined relative to: solar effects on GaAs solar cells, in-flight gain system, shuttle instrument panels, plus the STS technology experiments integration and interface support effort

W78-70273 750-01-52
Lewis Research Center, Cleveland, Ohio.
SHUTTLE PAYLOAD DEFINITION: PHYSICS AND CHEMISTRY EXPERIMENTS IN SPACE
Robert R. Lovell 216-433-4000
(506-21-42, 506-21-12)

This effort is to conduct definition studies for potential Spacelab experiments which support, complement, or proceed from OAST research and technology programs, specifically to determine the technical and programmatic requirements for the experiment effort. Definition studies will be carried out in fluid physics on critical point thermophysical phenomena, fluid surface dynamics and capillarity, convection phenomena, and isothermal multiphase mixtures. In combustion studies will be pursued in premixed gaseous combustion, gas jet combustion, droplet and particle combustion, large surface liquid and solid combustion, combustion of porous arrays, ignition and autoignition, extinguishment, and gravitational scaling

W78-70274 750-01-53
Langley Research Center, Langley Station, Va
DEFINITION OF PHYSICS AND CHEMISTRY EXPERIMENTS IN SPACE
E. J. Conway 804-827-3127

This RTOP is composed of two aspects of the total PACE program: (1) management of the PACE Working Group, and (2) definition of Molecular Beam Apparatus (MBA) experiments. PACE develops uniform procedures for the phased development of basic and applied in-space science experiments, fosters both new general areas for experiments and definition of specific experiments, and it recommends mature in-space experiments for flight status. These specific, mature experiments are used to justify flight facilities. Definition studies of scientific experiments which use the high purity atomic oxygen available in space are in progress. These studies cover the technical areas of surface oxidation kinetics, high-temperature corrosion, catalysis and scattering. To support these definition studies, theoretical analyses of the Molecular Beam Apparatus (MBA) define instrumentation

characteristics such as purity of the atomic oxygen beam, beam energy distribution, and beam spreading

W78-70275 750-01-59
Marshall Space Flight Center, Huntsville, Ala.
DEFINITION OF PHYSICS AND CHEMISTRY EXPERIMENTS (PACE) IN SPACE
George H. Fichtl 205-453-0875

The objective of this RTOP is the conduct of scientific and feasibility studies of candidate experiments, in the area of the physics and chemistry of fluids which require and utilize the unique zero or low gravity environment of Earth orbit. The candidate experiments (tasks listed below) are motivated by the need to resolve fundamental scientific problems and issues which are of significant importance in the areas of pure and applied physics and which relate to national needs. The approach for this effort will be based on the PACE Committee phasing of effort. The total effort involves five tasks. Two tasks that will enter phase II in FY-78 are as follows: Task 01 - Zero-Gravity Aerosol Behavior, Task 02 - Zero-Gravity Two-Phase Turbulence. The remaining three tasks that follow will enter phase I study: Task 03 - Zero-Gravity Diffusiophoresis and Thermophoresis, Task 04 - Mesophase Liquid Behavior, Task 05 - G-Jitter Effects in Fluid

W78-70276 750-02-03
Langley Research Center, Langley Station, Va
LONG DURATION EXPOSURE FACILITY PROJECT
W. H. Kinard 804-827-3704

The broad LDEF Project objectives are the following: (1) To develop LDEF, a simple, low-cost, free-flying facility for performing long duration technology and other experiments in the space environment using the STS; to develop a first set of experiments for the facility and, by the performance of these experiments, obtain valuable technological data and demonstrate the unique shuttle/LDEF capabilities and features; (2) to broaden the STS user community by providing a simple low cost approach to integrate and operate a large number of OAST and other unmanned long duration experiments via the STS; and (3) the LDEF is a reusable, unmanned, low-cost, free-flying structure on which many different experiments can be mounted. The facility will be delivered to Earth orbit by the shuttle. After an extended period in orbit, the facility will be retrieved on a subsequent shuttle flight and returned to Earth for experiment analysis. Many of the experiments being considered for the LDEF are completely passive with the active data measurements being made in the laboratory after the experiments are returned

W78-70277 750-03-01
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
DEVELOPMENT OF A SHUTTLE FLIGHT EXPERIMENT: DROP DYNAMICS MODULE
D. H. Swenson 213-354-5110

The principal objective of this RTOP is to design, fabricate, and test an acoustic positioning and manipulation module for Spacelab and to utilize it to perform an initial set of experiments as part of the NASA Physics and Chemistry in Space Program on an early Shuttle/Spacelab flight. The module is scheduled to be ready for the ESA-NASA joint Spacelab mission, and will be available for Spacelab flights thereafter. 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 dynamics experiments that are impossible to perform in a gravitational field. Examples are: (1) study experimentally the problems first proposed by Newton, and never satisfactorily studied, of equilibrium figures and the bifurcation processes of a rotating spheroid, and (2) understand the fission and fusion processes in drops that are also applicable to meteorology and nuclear physics. The scope of this work is threefold. First, to determine the maximum capability of this facility within the constraints of money and schedule, through consultation with the scientific community and investigators. Second, to fabricate a flight unit, and Third, to perform an initial set of experiments (Drop Dynamics), as part of the NASA Physics and Chemistry in Space Program. The scientific community will be invited to participate in experiments informally through international

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symposia and colloquia. Some scientists will participate with JPL as science associates and consultants. Others will presumably submit experiments in response to NASA AFO's

W78-70278 750-03-02

Marshall Space Flight Center, Huntsville, Ala.

DEVELOPMENT OF AN INDUCED ENVIRONMENT CONTAMINATION MONITOR (IECM)

Edgar R. Miller 205-453-0108

The broad objectives of the Induced Environment Contamination Monitor are to conduct an indepth survey of potential contamination to experiments from the induced environment in and around the STS on early flights. A set of contamination measuring instruments will be developed and built. These instruments will be integrated into a self-contained flight package to verify the specified requirements, to identify contamination sources, and to detect and monitor environment contamination during all mission phases, including delivery, deployment, retrieval, and landing a free-flying payload.

W78-70279 750-03-03

Langley Research Center, Langley Station, Va

LASER HETERODYNE SPECTROMETER FOR SPACELAB

R J Duckett 804-827-4571

(506-18-13)

To flight test an LHS instrument on Spacelab to demonstrate its capability as a multi-pollutant remote sensor with high specificity, high sensitivity, and vertical resolution for detecting stratospheric trace constituents important in the photochemical processes of O₃ depletion. For an early Spacelab flight, a specific mission is proposed: solar occultation with a minimum of four gases will be measured including ozone, nitric acid, Freon 11, and Freon 12. An LHS instrument will be designed, developed, and fabricated for this specific mission; anticipated flight time is 7 days. Software algorithms will be developed to reduce the data stream in a format suitable for utilization in global models of stratospheric pollution. The flight test data will be compared with existing computer models of the stratosphere. These data will also provide an evaluation of instrument performance. Subsequent measurements with the LHS instrument will be extended to other stratospheric species including ClO, NO_x's, CO, and SO₂.

W78-70280 750-03-04

Marshall Space Flight Center, Huntsville, Ala.

SHUTTLE OPERATIONAL FLIGHT TEST OF THE SOLAR ELECTRIC PROPULSION SOLAR ARRAY

L. E. Young 205-453-2121

(506-22-29)

The objective of this RTOP is to provide overall demonstration of the availability of advanced Solar Array Technology by flight testing the Solar Electric Propulsion (SEP) solar array as an experiment on shuttle. Demonstrating that the array will deploy and retract in a space environment and establishing its dynamic characteristics, are objectives which are particularly important. The approach consists of four basic steps as follows. (1) define, through study and analysis, the requirements, criteria and conceptual design for the Solar Array System Experiment; (2) perform a detailed design, build, and test the flight array experiment; (3) install and fly the solar array experiment on shuttle, and (4) evaluate flight results after return to earth.

W78-70281 750-03-07

Goddard Space Flight Center, Greenbelt, Md.

THERMAL CANISTER EXPERIMENT

S Ollendorf 301-982-5228

The broad projects objective for the Thermal Canister Experiment is to demonstrate the performance in space of an Experimental Thermal Control Canister using Heat Pipes. The specific objectives of the Thermal Canister Experiment are to design, fabricate, and test a Thermal canister 1m x 1m x 3m weighing 160 kg, which, when flown aboard Space Shuttle on an OFT mission will verify the ability of a system of heat pipes to provide thermal control, within certain limits.

W78-70282

Lewis Research Center, Cleveland, Ohio

EIGHT-CM ION THRUSTER EXPERIMENT

Robert R Lovell 216-433-4000

(506-22-12)

The objective is to conduct in-situ tests of a one millipound mercury-ion thruster auxiliary propulsion system over a representative duty cycle and time period, to acquire engineering design information by which to determine the systems compatibility with host spacecraft, and to demonstrate to potential users the technology readiness of mercury-ion thruster systems for auxiliary propulsion applications aboard operational spacecraft; to fly the experiment as part of the USAF/Space Test Project P80-1 (Teal Ruby) spacecraft on an OFT flight (free flyer).

W78-70283

Langley Research Center, Langley Station, Va

MICROWAVE RADIOMETER

C T Swift 804-827-3631

The objective is to conduct a Space Shuttle Technology Experiment for the development and evaluation of multi-spectral microwave radiometer techniques required for all-weather earth, ocean, and atmospheric observations. Radiometer receivers, which will operate in three microwave spectral regions, will be fabricated into an integrated package, including the necessary scanning antennas and control system. The system will be configured for testing on a pallet only experiment. This approach will be taken in order to reduce re-fabrication costs for future applications missions on free-flyers.

W78-70284

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PROPULSION CONTAMINATION EFFECTS MODULE - PCEM - SPACECRAFT EXPERIMENT

D. L. Young 213-354-3217

The PCEM test facility will be designed and fabricated for Space Shuttle Orbiter spaceflight testing of various types of rocket propulsion systems. The tests will measure rocket engine plume characteristics such as, exhaust plume backflow, core flow efflux (mass and constituents), electrical charge buildup, forces, torques, and heating rates. The Payload Category III-IV PCEM will be available for flight on 'Missions of Opportunity'.

W78-70285

Langley Research Center, Langley Station, Va

LANDMARK TRACKING AND IDENTIFICATION

W E Howell 804-827-3551

(506-19-23)

A landmark classification experiment to classify, in real time, the scene content of earth viewing systems is proposed for evaluation aboard an early Shuttle flight. The instrument, as proposed, will classify scene content into vegetation, bare earth, water, or clouds. This classification is based on ratios of spectral signature in the 0.65 and 0.85 micron bands. The results will not only provide an instrument to use in the classification of scene content in future missions, but will also provide data for the further development of a landmark tracker for tracking the boundaries of these interfaces.

W78-70286

Langley Research Center, Langley Station, Va

ANNULAR SUSPENSION AND POINTING SYSTEM (ASPS) FLIGHT VERIFICATION

C R Keckler 804-827-3917

(506-19-13)

The objectives of this RTOP are to provide a flight verification of the technology encompassed in the Annular Suspension and Pointing System (ASPS) as well as a flight qualification of this pointing system for future Shuttle/Spacelab use. To achieve these goals, an ASPS flight prototype will be integrated by making use of the developments established under the R&T base. This integrated system will consist of the ASPS coarse and vernier system, ASPS electronics, and control and information system, control computer and associated software, sensors and associated electronics, and interfacing structure. The ASPS flight prototype will be flown on an early Shuttle OFT mission to verify its

750-03-09

750-03-10

750-03-12

750-03-14

750-03-15

undesirable interactions and interference with other users. Without excluding others, the primary emphasis will be placed on the Broadcast Satellite and the Earth Exploration Satellite Service in the frequency bands that they share with other users. The information gained will be incorporated in reports suitable for use at World Administrative Radio Conferences (e.g. 1979 WARC) and Regional Planning Conferences (e.g. 1982 BCSAT) where the international agreements necessary to a workable design must be negotiated. This effort will be closely coordinated with NASA, OTP, FCC DoS and other agencies as appropriate. In addition, under this RTOP, active participation will be provided in the CCIR, in the WARC's, and other national and international organizations, as applicable.

W78-70301**643-10-01**

Lewis Research Center, Cleveland, Ohio
TECHNICAL CONSULTATION SERVICES
 R E Alexovich 216-433-4000

The objectives are to (1) provide technical consultation services support in the areas of high powered broadcast satellite technology and fixed service communications satellite technology in preparation for the 1979 WARC; and (2) conduct studies, technical assessments, and where necessary, measurements in the area of high powered broadcast satellite technology, culminating in technical papers required for CCIR SG/s on frequency utilization and broadcasting (sound/television). Following an assessment of the more important issues to be considered in the 1979 WARC, perform in-house studies, and contract studies where necessary, to establish possible United States positions and to determine the trade-offs associated with each position. Principal emphasis will be given to keeping available a range of options for broadcasting satellite implementation.

W78-70302**643-10-02**

Goddard Space Flight Center, Greenbelt, Md
COMMUNICATIONS SATELLITE APPLICATIONS SYSTEMS STUDIES
 E A Wolff 301-982-2265
 (643-10-01, 682-10-08, 682-10-13)

The objective is to promote the growth of Public Service Communications Satellite (PSCS) Applications. The ATS-1, -3, -6 and CTS satellites will be used to facilitate the growth of service where appropriate. Reports required in response to OTP Circular 11 (frequency use plans; technical and functional requirements, and system description) will be prepared and submitted to assure required frequency support. Sharing studies will be performed to assure that the PSCS is compatible with existing and planned terrestrial and space services. Public policy issues will be studied to define the alternatives, options and implications for policy makers. The necessary FCC and IFRB filings will be prepared and submitted. Studies will be undertaken of future applications to provide the information required for the implementation of future experiments and applications transfer and demonstration programs. Frequency allocation policies and supportive positions, filing criteria and authorization requirements for PSCS demonstrations/experiments/operations will be specified. PSCS user policy issues, ramifications and alternatives will be solidified from which demonstrative type evaluation programs will be implemented to evolve low-cost user service.

Shuttle Payloads Definition and Preliminary Design

W78-70303**645-25-02**

Jet Propulsion Lab, Calif Inst. of Tech, Pasadena
LARGE DEPLOYABLE ANTENNA SHUTTLE EXPERIMENT
 A G. Brejcha 213-354-3080
 (506-20-45; 524-70-02, 650-10-15)

The long range prime objectives of the Large Deployable Antenna Shuttle Experiment (LDASE) are: (1) to measure the mechanical and RF performance of a large deployable antenna in space, and (2) to demonstrate the utility of a large antenna in space using the Shuttle Orbiter. The FY-78 major objectives

are: (1) finalize the experiment definition, (2) complete all pre-project activities for an FY-79 new start, and (3) identify, and establish a plan for developing, the technologies required for a mid FY-82 experiment. From FY-74 through FY-77, antenna requirements for future space missions have been assessed using both outside surveys and in-house advanced studies. The results of these studies have shown a definite need for large deployable antenna technology within the next eight to ten years. Over the past several years, it has been established that very large deployable antennas are technically feasible. However, technology has almost come to a complete standstill for antennas larger than 10 meters because of one major hurdle, i.e., verification of functional performance. Very large space antennas cannot be tested in a lg field. The only practical approach to evaluating the functional performance is in a space environment. It is believed that LDASE will revitalize the technology for large deployable space antennas. The activities to be performed during FY-78 are: (1) develop and finalize the mechanical and RF test approaches, (2) assess the proposed antenna demonstrations and their impact on cost, complexity, and risk, (3) finalization of test and demonstration procedures and sequences, (5) identification of necessary supporting technologies such as surface quality measurements and multiple-beam feeds for possible demonstration, (6) formation of a multi-discipline project team to carry the LDASE through its expected six years duration.

W78-70304**645-25-41**

Goddard Space Flight Center, Greenbelt, Md
COMMUNICATIONS AND NAVIGATION EXPERIMENT DEFINITION
 J J Woodruff 301-982-5908

The objective is to define and develop pioneering communications and navigation experiments which match NASA capabilities to user needs and utilize Spacelab. Through consultation with users, active groups, committees and Headquarters, experiments will be prioritized and high priority experiments defined. The RTOP supports the following major problems: (1) antenna system calibration, (2) shortage of available frequencies, and (3) atmospheric effects. These in turn support the following end objectives: (a) understand RF interference environment, (b) maximized use of frequencies, (c) atmospheric effect data base, and (d) spaceborne calibration system. Definition of selected experiments, identification and development of instrumentation, and plans to meet given launch dates.

Advanced Communications Research

W78-70305**650-10-13**

National Space Technology Labs, Bay Saint Louis, Miss
DATA COLLECTION SYSTEM DEVELOPMENT
 W L Hopkins 601-688-2125
 (650-10-14)

The objective of this RTOP is to establish a project to provide technical assistance, development, test, and evaluation to support and advise Data Collection System (DCS) users in three principal functional areas: (1) user application assistance to provide overall support in the establishment and utilization of Data Collection Systems; (2) user-oriented DCS utility enhancements to design, develop, and test improvements and modifications to system components, and (3) component development for specific user needs to address specialized system requirements. The approach to meeting these objectives is to use NASA/NSTL's background and experience in DCS technology to establish specific projects which address identified user needs. Thirteen activities have been selected as base-line tasks to provide support to and/or cooperation with the following agencies: U.S. Army Corps of Engineers, U.S. Geological Survey, NOAA/NESS, Tennessee Valley Authority, Louisiana State University, and the Southern Regional Medical Consortium. These activities have been reviewed by members of the Satellite Data Collection Interagency Working Group.

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W78-70306

650-10-14

Goddard Space Flight Center, Greenbelt, Md

DATA COLLECTION SYSTEMS AND APPLICATIONS

E. P. Mercanti 301-982-5580

The objective is to define a satellite-aided system for collecting and relaying data from in-situ monitoring sites that will meet national needs for the 1980-2000 time frame based on stipulated user requirements. The approach will be to: (1) prepare a detailed user requirements definition and definitize a strawman follow-on DCS concept in conjunction with NOAA, NESS, USDA, DOI-USGS, DOD-COE, EPA, and ERDA for use in modifying and replacing current systems, and (2) conduct interagency analyses and develop DCS components as appropriate. The RTOP supports the following major problems: (1) increasing demand for low-cost high-capacity systems, (2) real time global coverage; (3) standardization among multitude of users. These in turn support the end objectives of improved environmental monitoring, earth resources, and weather and climate. The expected results include: Satellite Data Collection Interagency Working Group approval of strawman DCS concept for 1980-2000 time period implementation. Development of lower-cost DCP's; development of improved standards programmable DCP; and development of DCP's for several new applications.

W78-70307

650-10-15

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

EFFICIENT SPECTRUM UTILIZATION

J. G. Smith 213-354-3828

(506-20-22; 643-10-01, 645-25-01)

The long range objective of this RTOP is to develop and promote the application of specific technologies which permit better utilization of spectrum. These are grouped here as: (1) modulation technology, and (2) antenna technology. These encompass the generic technologies of signal, polarization, and spatial multiplexing. Basically, the modulation effort permits sending more data in less bandwidth than the presently employed methods; while the antenna effort permits re-use of spectrum. Spectrally efficient modulation uses simultaneous digital modulation of multiple signal parameters, while the antenna techniques utilize dual polarized shaped beams. The dramatic spectral congestion in all microwave bands requires that new technologies be developed in these areas to alleviate the spectral inefficiencies produced by present methods and techniques. Development of the technologies requires continued research and demonstrations within these individual areas, while promotion of the applications requires both individual system studies and demonstrations of synergistic couplings of these and other spectrum conserving techniques. Immediate objectives of the modulation effort include: (1) determination of the system benefits and costs of applying advanced spectrally efficient digital modulation techniques to future space communications requirements, and (2) continued design and analysis of communication systems which use these methods. Similarly, immediate objectives of the antenna effort include: (1) development of synthesis and analysis techniques and software required for validating the methods for obtaining optimum performance from reflector antennas for generating contoured patterns and multiple beams, (2) assessment of the potential of lens systems, and (3) assessment of feed array requirements and limitations. The approach taken will continue to include combinations of surveys, system studies, analyses, simulations, laboratory breadboards, experiments, and demonstrations. In addition, work in comparable technical areas by other NASA Centers, U.S. governmental agencies, industry and foreign investigators will be reviewed and documented in executive summary form in order to provide NASA with the knowledge required to advise appropriate government agencies in matters pertaining to efficient use of the spectrum.

W78-70308

650-10-16

Ames Research Center, Moffett Field, Calif

SYSTEMS ENGINEERING AND DEMONSTRATION OF AN AUTOMATED FIRE WEATHER DATA SYSTEM

K. Nishioka 415-965-5897

This study has as its objectives to: (1) conduct a systems engineering study to delineate overall system and detailed component costs, component specifications and availability, (2)

conduct with the California Department of Forestry (CDF) a demonstration test using approximately 23 automated fire weather stations in concert with existing manual fire weather stations for a selected test region to evaluate and demonstrate the effectiveness and cost-benefit potential of an automated fire weather data system, (3) provide detailed documentation of the results from this study to provide a basis to help others design and implement a similar system, (4) provide CDF with the necessary information to justify to the California State Legislature future requests for funding this type of system on a statewide basis, and (5) perform a potential application survey of this concept for other states. Approach to this project will be to utilize our past experience fully in the tasks starting with the weather station component procurement and assembly. This will be followed by field installation, system engineering, and system demonstration testing. Results will then be evaluated and documented.

W78-70309

650-10-17

Goddard Space Flight Center, Greenbelt, Md

CIVILIAN APPLICATIONS OF GLOBAL POSITIONING SYSTEM (GPS)

S. H. Durrani 301-982-4384

(650-10-14, 682-10-08)

The objectives are to identify potential civilian applications of GPS for position location (navigation) and position monitoring (surveillance) of mobile user terminals, and to develop, test, and evaluate low-cost user terminals for such applications. Potential civilian users of GPS will be contacted and their requirements analyzed. Special emphasis will be placed on maritime mobile and land mobile applications. Duplication with ongoing efforts sponsored by the NASA Low Cost Systems Office and by other government agencies will be avoided. The RTOP supports efforts in the following major areas: (1) analysis of civilian user requirements of GPS; and (2) design, development and test of user terminals for selected applications, with emphasis on low cost. The end objectives are to enable navigation and surveillance of mobile user terminals at low cost, using the GPS signals which are available free of cost. The results are expected to provide an estimate of the potential civilian user market for GPS, and a low-cost user terminal of proven performance capability.

W78-70310

650-20-01

Lewis Research Center, Cleveland, Ohio

COMMUNICATIONS TECHNOLOGY PLANNING

J. J. Ward 216-433-4000

This is a continuing effort with the objectives of identifying advanced technology users, their needs, and potentially cost-effective technology innovations which would meet these needs; assessing and stimulating advanced techniques with potential application to these needs; providing program plans for and demonstration of selected technology items and techniques, and developing joint NASA/industry programs for implementing the technology and techniques. Key elements of the program are: (1) interaction with other government agencies, industry, and the ultimate consumers of communication services to establish and understand their needs and requirements, (2) continual assessment and stimulation of advanced communication techniques aimed at new and/or improved services with application to user needs, (3) identification of potential technology innovations and synthesis of total system concepts which employ these innovations and meet users' needs and requirements; (4) evaluation of innovations using cost benefit analysis, (5) development of plans for the demonstration of selected technology items, and (6) establishment of joint NASA/industry programs to implement the technology.

W78-70311

650-60-10

Ames Research Center, Moffett Field, Calif

ADVANCED VIDEO SYSTEMS

S. Knauer 415-965-6525

A hardware video compression coder/decoder, capable of transmitting conference quality monochrome television will be constructed from breadboarded hardware designs based on previous research. It will use a 2-D transform and a novel

conditional replenishment algorithm, and will operate at different compression ratios. The picture quality will be evaluated as a function of compression. Basic color video research will be continued and applied to the design of hardware modifications to the monochrome units for conversion to color. Hadamard and other transforms, such as Cosine and Slant, will be compared to determine the tradeoff in efficiency and hardware complexity. The application of new techniques, such as optical processing, analog domain transforms and analog bandwidth compression, will be investigated. The study of system optimization for a compressed digital TV link will be continued, investigating the tradeoffs in compression, modulation, channel coding as a function of power, bandwidth, cost and system complexity. This study will be aided by computer simulations and experimentation using the CTS satellite.

W78-70312 650-60-11
Goddard Space Flight Center, Greenbelt, Md
ADVANCED COMMUNICATIONS RESEARCH
J L King 301-982-4949
(643-10-01; 506-18-36)

The objective is to study and develop advanced system concepts and component technology for future needs and new applications in satellite communications. This RTOP will use in-house personnel, industrial contract and university grants to develop (1) 4 db noise figure low cost K/U-band ground terminals for receive-only TV video/audio operation with direct broadcast satellites working into standard TV receivers; (2) mobile communications systems multibeam array technology consistent with the Public Service Communications System (PSCS) definition; (3) new device applications development of surface acoustic wave oscillators, microwave integrated circuits, and stripline low profile antennas for mobile communications systems; (4) millimeter wave technology development in the 100-1000 GHz range including IMPATT and Gunn diode oscillators up to 200 GHz, wideband mixers, antennas, maser oscillators, and channel loss characterization; and (5) multiple beam lens antenna technology development. The expected results include: 12 and 183 GHz receiver systems; multibeam array and lens antenna breadboards, and a very stable SAW oscillator.

W78-70313 650-60-14
Lewis Research Center, Cleveland, Ohio
HIGH POWER TRANSMITTER TECHNOLOGY
R E Alexovich 216-433-4000
(506-20-04, 643-60-01; 043-10-01)

The objectives are (1) to provide increased knowledge and capability for high power space transmitter systems to meet general satellite communications needs of the future, and (2) to identify and define prospective applications of this high power communications technology. To achieve these objectives, studies and investigations of space-Earth propagation and high power RF component and systems technology will be conducted for space communications applications in new high frequency bands. Possible space experiments in these frequency bands will be studied and developed.

W78-70314 650-60-99
Goddard Space Flight Center, Greenbelt, Md
DESIGN OF SOFTWARE COMMUNICATIONS COMPONENTS
W K Allen 301-982-6963

The objective of this RTOP is to reduce the cost of communications equipment by standardizing design procedures and components. The objective will be met by applying microprocessor and software techniques to the design of communication equipment. The approach is based on replacement of present analog designs of communications components with digital designs consisting of software residing within standardized microcomputer configurations. A study of microprocessors and software techniques for processing communications signals will be performed. The impact of likely hardware and software improvements in the next few years on this approach will also be considered. This RTOP supports low-cost communications system development. The results of this effort will demonstrate the feasibility of designing, testing and producing communication

system functions by the use of microcomputer based software. This will lead to cost reductions due to the avoidance of the high initial costs of monolithic LSI development.

Communications Advanced Studies

W78-70315 682-10-05
Lewis Research Center, Cleveland, Ohio
DISASTER COMMUNICATIONS SATELLITE
J J Ward 216-433-4000

This plan is directed toward identifying and implementing those analytical and experimental activities necessary for the definition of an operational Global Disaster Relief Communications Satellite System. Specific activities will include (1) coordination through the Agency for International Development (AID) and the United Nations Disaster Relief Office (UNDRO) to establish system operational requirements, (2) conduction of experiments utilizing NASA and commercial satellites to establish system technical and operational requirements; (3) development of system conceptual designs, and (4) development of a project plan for the implementation of the system through the service phase.

W78-70316 682-10-08
Goddard Space Flight Center, Greenbelt, Md
LAND MOBILE COMMUNICATIONS SATELLITE SYSTEM DESIGN
James P. Brown 301-982-6720
(643-10-02; 650-60-15)

The objectives are to obtain the technical and operational data required for the design of a satellite-aided land mobile communication system. This data can then be used with the results of on-going studies in this and other RTOP's (e.g. 682-10-13 Public Service Communications Satellite and 506-17-1 Advanced Large Space Structures), to design a second generation satellite system (spacecraft, terminals, etc.) which is capable of providing two-way voice and data communications between remotely located land mobile vehicles and their respective base stations. The approach will be: to complete the on-going feasibility study of satellite-aided land mobile communications in the UHF and L-Band spectral regions, to continue interfacing with potential users, to determine their needs, and to continue the UHF and L-Band verification tests being conducted with ATS-6. The expected results will provide experimental data to verify PSCS mobile design concept preliminary system design of future land mobile communication system.

W78-70317 682-10-11
Goddard Space Flight Center, Greenbelt, Md
SATELLITE-AIDED 200-MILE FISHERIES COASTAL ZONE
J E Painter 301-982-2823

The objective is to conduct an advanced mission study for a space-based system to detect, identify and locate surface vessels operating within the 200 nautical mile U S Coastal Zone. Ships to be monitored will include oil tankers, foreign fishing vessels and certain bulk carriers. Requirements for marine vessel monitoring established by recent and pending legislation will be studied in conjunction with the U S Coast Guard, NOAA, MARAD, and other agencies. A satellite system concept will be developed and compared with non-satellite techniques for performance and cost effectiveness. This RTOP supports solutions to major problems in: (1) marine vessel monitoring, and (2) marine traffic control. These in turn support end objectives in oil spill prevention and fisheries conservation. Sufficient systems descriptions will be developed and evaluated to permit fundamental decisions on satellite coastal zone monitoring to be made.

W78-70318 682-10-13
Goddard Space Flight Center, Greenbelt, Md
PUBLIC SERVICE COMMUNICATIONS SATELLITE (PSCS)
E A. Wolff 301-982-2265
(643-10-02; 682-10-08)

The objectives are to provide experimental satellite communications for public services to users who do not have such

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services and to develop new communications satellite techniques and technology to advance to the state of the art. Effort will consist of user requirements and economic studies, conceptual system design, initiation of technology development for future applications, identification of public policy issues, and preparation of project plan. User requirements studies will include user demonstrations on existing satellites, translation of applications into communications system requirements, and identification of applications ready for economic analysis and system implementation. Economic studies will consider costs and benefits and anticipated satellite service use. System concept studies will define methods for implementing the applications, alternatives, and required R&D. R&D studies will determine needed technical development. User applications and associated system requirements will be solidified to enable the rendering of appropriate public services via satellite in a low-cost effective manner commensurate with technological development.

W78-70319

682-10-15

Goddard Space Flight Center, Greenbelt, Md
ELECTRONIC MAIL STUDY
J W Kiebler 301-982-6092

The objective is to conduct a controlled experiment of electronic mail transmission using available equipment. The long range objective is development of electronic mail services using the PSCS. Previous work performed in this country and abroad on electronic mail systems will be reviewed. Conceptual designs will then be developed to handle the mail requirements of three users with significantly different volumes of mail: (1) internal to NASA and its major contractors, (2) internal to the U.S. Government and (3) the U.S. Postal Service. Verification tests will be designed and conducted using the Shuttle leased communications satellite circuit or the ATS-6 and/or CTS satellites. In coordination with the U.S.P.S., prototype electronics mail systems will be proposed. The RTOP supports the following major problems: (1) information; (2) information distribution within the Federal Government; (3) effects of electronic mail on the U.S.P.S. These in turn permit nationwide transmission of electronic mail via communications satellites. Designs will be defined for electronics mail systems for various levels of user volume and complexity. System requirements and design parameters will be developed. User acceptability and system performance will be assessed through demonstrations and tests.

Data Management

W78-70320

656-12-01

Goddard Space Flight Center, Greenbelt, Md
DATA MANAGEMENT SYSTEMS ENGINEERING AND ANALYSIS FOR CLIMATE
Patrick J. Gary 301-982-6079
(656-44-02, 175-40-40)

The objectives are specifically to: (1) identify and consolidate the format characteristics of the data required for the NASA Climate Research Program, (2) specify the processing and intercomparison analyses that will be performed on individually derived spacecraft/sensor data and on ancillary data to prepare working data sets for climate research, and (3) define any initial standard products which need be prepared for distribution. The approach will be to: (1) identify and document the sources, types, characteristics, formats and coverage of all satellite derived data and other ancillary information needed for climate research, (2) review with climate researchers and report on the intended usage of the data including the requirements for interfacing the data with appropriate applications models, and (3) define the functional requirements of a baseline data management support system to assist in the perusal, access and distribution of data to research investigators. Implementation will be funded by the Climate Program. The results are expected to produce a detailed study report containing a complete definition of the required data format characteristics, a requirements analysis of intended data usage, an estimate of the climate data management workload, and a functional specification and a feasibility review of an initial

climate data management support system. This report will be used as a baseline from which to plan specific follow on implementation efforts.

W78-70321

656-12-01

Marshall Space Flight Center, Huntsville, Ala
SYSTEMS ENGINEERING AND ANALYSIS
H. Golden 205-453-0093
(656-21-02; 656-50-01)

The objective is to ascertain through analysis if long-term (1985 and beyond) OA objectives are feasible with known or projected data-related technologies and capabilities. OA management will be informed of any deficiencies revealed by analyses, and alternate approaches to overcome these deficiencies will be developed and recommended. The recommendations may include suggestions to modify the planned objective. The approach being taken is to analyze selected, data-intensive OA objectives (e.g., Global Crop Production Forecasting) and their resultant data and information requirements, to determine (from the data related viewpoints) the feasibility of achieving the objectives. Initial overview analyses will be made of all selected objectives deemed likely to present data related problems (for example, specific problems due to high data volumes), and then logical combinations of these objectives will be selected for more thorough subsequent analyses so that the most likely data-related problem areas will be identified and solutions to these problems suggested to NASA management. Trade studies may be conducted to determine the relative merits of viable alternative approaches to satisfy the long-term objectives in which problems are identified. Consideration will be given to each objective separately, and collectively as an ensemble.

W78-70322

656-12-01

Lyndon B. Johnson Space Center, Houston, Tex.
SYSTEMS ENGINEERING AND ANALYSIS
W. E. Rice 713-483-2789

The objective of this task is to complete the planning and analysis for an earth resources data management system to support agricultural inventory, microwave and selected miscellaneous tasks during the next decade (1980-1990). This design will be directed toward a system that will promote user oriented applications development in a systematic, cost effective manner. The approach will be to: (1) select alternative hardware and software data management configurations to support a food and fiber inventory, research test and evaluation in the 1980's; (2) select alternatives for preprocessing LANDSAT D and other sensor configurations in support of designated tasks; (3) expand the overall data management system design to include ancillary subsystems such as cartographic and data status processing; (4) improve the microwave and aircraft program requirements base in order to obtain better estimates of system design scope and capability; (5) construct candidate systems configurations based on the above studies and perform design and cost trade-offs based on overall system requirements, and (6) select and recommend the configuration that best fits the user applications development and technology transfer goals of the JSC Earth Resources Program during the 1980-1990 time frame.

W78-70323

656-21-02

Marshall Space Flight Center, Huntsville, Ala
DATA TECHNOLOGY ASSESSMENT
D. G. Aichele 205-453-0321
(656-12-01, 656-50-01)

The objectives of this RTOP are to support the analysis task of RTOP 656-12-01 and to assist in directing data related SRT to develop new technology which may be needed to accomplish long-term OA Goals. The sub-objectives of this RTOP are seen specifically as: assessing technology in various data system functional areas, surveying institutional data processing capabilities, evaluating selected techniques for image data processing, and establishing and supporting a Data Base Management Systems (DBMS) Panel. The DBMS activity is submitted as over guideline. The approach being taken is to receive from RTOP 656-12-01 the data system characteristics and requirements generated by the analysis of OA objectives and carry out the technology assessments and analyses needed.

to determine the feasibility of achieving these objectives. Functional areas such as image analysis, onboard/ground data handling and processing, data storage, data base management systems, and information dissemination are among the candidates for assessments and analysis.

W78-70324**656-44-01**

Ames Research Center, Moffett Field, Calif

INTERACTIVE DATA LINK EVALUATION STUDY AND EXPERIMENT

D Rasmussen 415-965-5897

The objectives of the Interactive Data Link Evaluation Study and Experiment will include: (1) verification of the concept of remote interactive use, with a representative set of users, of a regional earth resources analysis facility (for example, the Image Display and Analysis System for the PNW Project), (2) development of efficient data transfer strategies that exploit the available telecommunications media, such as satellites, and terminal processing techniques such as data compression. The approach to meet these objectives will be focused on the following activities: (1) evaluate user access requirements including data quantity, frequency of access, and user display terminal characteristics; (2) study and selection of communication alternatives; (3) develop software packages for pretransmission processing including data compression coding and decoding; (4) design and implement communication experiment for use with the PNW Project, such as a CTS-based communication experiment; and (5) evaluate the effectiveness and potential for growth to an operational system.

W78-70325**656-44-02**

Goddard Space Flight Center, Greenbelt, Md

SYSTEMS ENGINEERING ANALYSIS AND DATA/ INFORMATION TECHNOLOGY FOR OA DISCIPLINES

John J Quann 301-982-4834

(175-40-41; 175-30-40; 175-10-50)

The objectives of this RTOP are: (1) the definition, evaluation, and analysis of the long term data management requirements associated with the Weather & Climate Program and the determination of development activity necessary to meet these requirements; (2) the survey, analysis and assessment of data compression and image coding schemes, and (3) the survey, analysis and assessment of data base management systems and applications software. Future data and information management requirements will be defined, analyzed and validated with respect to Severe Storm and Local Weather research involving localized areas and ranging in duration from a few minutes to a few days, Global Weather research involving large scale phenomena having a period from several days to weeks, and Climate research incorporating long term characteristics of the atmosphere, ocean, and land. All work performed will be directly related to the needs of the Weather & Climate program and will be coordinated with the Discipline Center for Data Management at MSFC in support of their function for the Office of Applications. Active participation will be established and maintained on the NASA Image Coding Panel and on the Data Base Management Systems (DBMS) Technology and Applications Software Panel. The expected results will include an assessment of the data management and data technology related aspects of the long range objectives of the Weather & Climate Program.

W78-70326**656-44-03**

Jet Propulsion Lab, Calif Inst of Tech, Pasadena

END-TO-END DATA SYSTEM CONCEPTS STUDY

T. H. Bird 213-354-6958

The primary objective of this RTOP is to provide detailed evaluation of the major problem area identified during the FY-77 End-to-End Data System Concepts Study. That study was directed towards providing a conceptual design for an end-to-end information system for mid 1980's operational Seasat program. Inputs from the FY-77 study were directed to assisting Marshall Space Flight Center personnel in evaluating selected data system objectives in the context of an overall program assessing the data implications for various Office of Applications objectives. Analysis of the conceptual end-to-end information system for an operational Seasat has revealed that the major options possible

for the ground data processing configuration were also major factors influencing the cost effectiveness of the overall system. In order to establish the specific advantages and disadvantages of various components of the ground processing system, relative to operational Seasat assumptions, a detailed analysis effort will be undertaken. This detailed analysis will evaluate centralized processing vs. a distributed or regional processing concept, including description of related hardware requirements and information distribution network requirements for the assumed operational Seasat concept for the mid 1980's. In addition, general support to MSFC regarding data system and management tasks will be provided as is consistent with allocated resources.

W78-70327**656-44-04**

Jet Propulsion Lab, Calif, Inst of Tech, Pasadena

REAL-TIME ELECTRONIC SYNTHETIC APERTURE RADAR (SAR) PROCESSOR

R. Piereson 213-354-3322

The long range goals for imaging radar information systems are as follows: (1) to increase the information throughput rate by a factor of 100, (2) to reduce the volume of transmitted data by a factor of 100, and (3) to reduce the cost per image by a factor of 100. This RTOP contributes to these goals by providing for development of a stand-alone real-time, electronic SAR data processor which produces radar images from the radar echo data. The development will comprise the following steps: (1) Develop a stand-alone laboratory SAR data processor which can process SEASAT-A data to produce real-time, four-look, 25 meter resolution imagery covering a 20 km swath. Demonstrate processing of SEASAT-A data at the real-time rate during 1979. (2) Develop an experimental Spacelab SAR data processor able to produce real-time, four-look, 25 meter imagery covering a 100 km swath. Also, perform on-board processing of SAR data on a Spacelab flight during 1981. (3) Perform preliminary design of on-board SAR processor for an earth observation mission (SEASAT) and a planetary mission (VOIR) based upon the technology previously developed. These design activities will be performed during 1980 and 1981.

W78-70328**656-44-05**

Jet Propulsion Lab, Calif Inst of Tech, Pasadena

EVALUATION/MODIFICATION OF CLUSTER COMPRESSION FOR THE LANDSAT D THEMATIC MAPPER

E Hilbert 213-354-2853

The larger volume of data to be generated by the thematic mapper of LANDSAT D creates a need to use lower-cost data management techniques. The assumption that present techniques are used to reduce 10 percent of LANDSAT D images, results in cost estimates in the range of \$2.5M/yr for tape procurement, and 228M/yr for thematic classification. These large costs demonstrate the need to use techniques for LANDSAT D which lower the costs of data storage and data interpretation. Previous efforts under OA RTOP's 177-25-51 and 656-11-03 have resulted in the formulation of a Multispectral Cluster Compression Algorithm (HM1). This algorithm uses clustering to compress and preprocess multispectral data into a form which is anticipated to reduce storage, retrieval, and thematic classification costs by a factor of 5 to 50. A very conservative estimate is that use of this technology would reduce the large data storage and interpretation costs by at least a factor of five. Such a reduction would similarly benefit data distribution and timeliness. The work proposed in this RTOP is to cooperate with MSFC on a concurrent evaluation and refinement of the cluster compression technique for a specific ground application to LANDSAT D. If this evaluation is favorable, a breadboard effort will be proposed in FY-79. The LANDSAT D system and data user constraints will be incorporated into this evaluation by coordinating with the Data Management Program at MSFC, and with other activities involved in simulating thematic mapper data and studying its user applications. The specific objectives in FY-78 are: (1) interface with MSFC, the Image Compression Panel, and with activities for thematic mapper simulation and user application studies; (2) evaluate and quantify the data management benefits and the impact on data users resulting from the application of cluster compression to LANDSAT D; (3) evaluate costs, performance, and schedule for ground implementations suited

OFFICE OF APPLICATIONS

to LANDSAT D; (4) provide pertinent modifications of cluster compression in response to the above evaluations; and, (5) prepare, review and report documentation for disseminating the results

W78-70329

656-44-08

Langley Research Center, Langley Station, Va.
**SYSTEMS ENGINEERING ANALYSIS AND DATA/
INFORMATION TECHNOLOGY FOR ENVIRONMENTAL
QUALITY**

John P. Mugler, Jr. 804-827-2717
(656-12-01)

The objectives of this RTOP are (1) to conduct surveys and technology assessments relative to the management of air and water pollution monitoring data, (2) to provide consultation to the Discipline Center for Data Management (MSFC) in formulating OA plans for solving data-related problems, and (3) to participate as members on NASA-wide data management panels in support of the Environmental Quality Discipline, complete and augment existing studies to define data management concepts for retrieving validated pollution monitoring data from satellite and airborne platforms. Participate as members on NASA-wide data management panels to integrate the results of these studies into far-term OA data management plans.

W78-70330

656-50-01

Marshall Space Flight Center, Huntsville, Ala
DISCIPLINE CENTER FOR DATA MANAGEMENT
W. T. Carey 205-453-3424

The objective of this RTOP is to provide the Discipline Center Leadership and Management to the Data Management Program. Emphasis will be placed on program leadership, review and assessment of the program, accomplishment of select lead management functions; and evaluation and assessment of data management and data management related problems. Efforts will be directed toward acquiring knowledge and developing an overview of NASA programs with respect to data and information related needs so that recommendations to the OA Data Management Program can be made and NASA projects and programs can benefit. An understanding of data related technology and problems will be sustained in order to support all data management related reviews, evaluations and assessments. The approach taken in this RTOP is to provide discipline center leadership and management, evaluate the overall program and make recommendations; organize, host and lead data management symposia; and to carry out reviews, evaluations, assessments and consultations.

OFFICE OF SPACE SCIENCES

Solar Terrestrial

W78-70331

170-36-55

Ames Research Center, Moffett Field, Calif
**MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLES/
FIELD INTERACTION**
A. Barnes 415-965-5506
(384-47-67, 385-36-01)

The objective is to improve understanding of the dynamics, origin, and termination of the solar wind, turbulence in the solar wind, and to investigate possible effects of solar and interplanetary phenomena on terrestrial weather and climate. 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. These studies include investigation

of existing data for evidence of sun-weather effects, and search for mechanisms that can produce such effects

W78-70332

170-36-55

Goddard Space Flight Center, Greenbelt, Md
PARTICLES AND PARTICLE/FIELD INTERACTIONS
Keith W. Ogilvie 301-982-5904

The object of this research is to increase the knowledge and understanding of non-thermal plasmas occurring in the interplanetary medium and the magnetosphere, and also to improve the theoretical description of their properties. This requires continuous improvement in measurement techniques, and interpretation of the results of appropriate space experiments. The interpretation requires corresponding improvements in theory, in numerical techniques, and in methods of data display.

W78-70333

170-36-55

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
**MAGNETOSPHERIC PHYSICS: PARTICLES AND PARTICLE/
FIELD INTERACTIONS**
M. M. Neugebauer 213-354-4110

The vector helium magnetometer is being developed for use on future missions, especially to the outer solar system where extremely weak interplanetary or interstellar fields will be measured and where intense planetary fields may also be encountered. JPL scientists and engineers carry out test and experiments to establish the fundamental principles of the magnetometer operation and design. Improved components are developed, the design is changed to yield improved performance, and new modes of operation are investigated. When appropriate, mission opportunities are announced, the scientific requirements are established, and a scientific proposal submitted. The basic objective is to provide continuing theoretical support for JPL's and NASA's observational space plasma programs. A theoretical study of the variation of solar wind properties with distance from the sun will be continued and improved with more realistic modeling of heat conduction. Work will also continue on theoretical models of heavy ions in Jupiter's magnetosphere. New efforts include: (1) a study of the similarities between stellar X-ray bursts and magnetospheric substorms, and (2) an investigation of the interaction between the solar wind and the Martian magnetosphere-ionosphere system to determine the implications for studying Martian interior electrical conductivity by magnetic sounding techniques.

W78-70334

170-36-55

Marshall Space Flight Center, Huntsville, Ala
PARTICLE & PARTICLE FIELD INTERACTIONS
Charles R. Chappell 205-453-3036
(385-36-01)

The objectives of this RTOP are to develop space plasma instrumentation for automated spacecraft and sounding rocket payloads. To accomplish these objectives, the following tasks will be performed: (1) joint instrument development activities will be continued with the Lockheed Palo Alto Research Laboratory. This includes the development of electronics for the central electronics box and the sensor heads for a multiheaded light ion mass spectrometer for the DOD SCATHA spacecraft on which Dr. Chappell is the Principal Investigator. (2) The in-house design, development and fabrication of three analyzer heads for the light ion mass spectrometer to be flown on the DOD SCATHA satellite will be continued, including the testing and calibration of these analyzers. (3) The development of a differential ion flux probe to be used for the measurement of multiply directed, low energy ion streams will be continued. This technique has been applied in laboratory plasma wind tunnel studies and will be upgraded for applications to sounding rockets, automated satellites and Spacelab.

W78-70335

170-36-56

Ames Research Center, Moffett Field, Calif
**MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/
PHOTON INTERACTIONS (AERONOMY)**
R. C. Whitten 415-965-5498
(185-47-67, 385-36-01)

The objective is to perform comparative studies of the physics

of the ionosphere of Earth, Venus, Mars, Jupiter, Titan, and Io and the interactive sampling of these regions with the solar wind. The theoretical approach invokes modeling of the thermal, charged-particle composition, concentration and temperature performed by means of numerical solutions of continuity, momentum, and energy balance equations. Data from fly-by and orbiting spacecraft will be used to establish boundary conditions and to assess the significance of various physical processes. In addition, feasibility studies of various spacecraft experiments will be made to assure that experimental techniques will be available for exploitation on future NASA missions.

W78-70336**170-36-56**

Goddard Space Flight Center, Greenbelt, Md

PARTICLE AND PARTICLE/PHOTON INTERACTIONS (ATOMOSPHERIC-MAGNETOSPHERIC COUPLING)

James P. Heppner 301-982-4797

The objective is to develop experimental and theoretical approaches for study and understanding the complex 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 sub-objectives 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 the primary forces, electric fields and neutral winds, and the associated transport and energization of particles. Related phenomena include electric current systems and associated surface magnetic field disturbances, atmospheric chemical composition anomalies, the transformation of atmospheric ions to trapped radiation, auroral excitation, instabilities producing ionospheric irregularities, and gravity waves. New instrumentation is being designed and developed for observations of tracer chemicals and for measurements of low energy particles. Properties of double probes in low density plasmas are to be studied with the SCATHA satellite. Models for the diffusion of tracer particles are to be developed for planning future experiments.

W78-70337**170-38-51**

Goddard Space Flight Center, Greenbelt, Md.

DEVELOPMENT OF SOLAR SPACELAB EXPERIMENT AND HARDWARE

J. C. Brandt 301-982-4701

The objective of this RTOP is to develop payloads which contribute toward the solution of well defined solar research problems. These payload activities will proceed with the ultimate objective of flying on the shuttle Spacelab. In such problem-oriented Spacelab missions, a payload of instruments is assembled which, by simultaneous observations of a phenomenon, such as a solar flare or the outflow of the solar wind at the base of the corona, provides in complete detail the physical data needed for a cogent model of the phenomenon. An example of such a mission is SMM for solar flare research. This spacecraft will be retrieved by the shuttle and flown again with refurbished instrumentation. Additional research problems will form bases for series of missions using the shuttle. One of these will be a study of coronal structures contributing to the solar wind and the interplanetary plasma. A second will be a study of the sources of high energy particles on the sun, emphasizing instrumentation that could not be accommodated and may be supplementary to the SMM instruments. Missions emphasizing the phenomenon of coronal heating and mass and energy balance in the chromosphere are also contemplated. In each case a number of different instruments covering a wide range of wavelengths is required. They will be selected on the basis of making comprehensive measurements in their specific wavelength regions in a format which is coordinated with and complementary to the other instruments in the payload. For example, all instruments will operate with the same temporal and spatial resolution to the maximum possible extent. The instruments considered for these payloads are the helioscope and the UV, EUV, X-ray, and Gamma-ray spectrometers.

W78-70338**170-38-51**

National Aeronautics and Space Administration, Washington D. C.

DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH

Adrenne F. Timothy 202-755-8490

The objective of this area is to develop experiments and instrumentation for space observations or laboratory applications directly related to solar physics research. Additional objectives are the development of critical technology items which are needed for new or significantly improved solar observations. Activities in this program include the following: (1) new or existing techniques and light sources will be developed to accurately calibrate ultra-violet (UV) and extreme ultra-violet (XUV) solar experiments intended for operation in space. Existing calibration standards and facilities frequently are insufficient to obtain maximum information return from new and some existing instrumentation. Improved, lightweight, mobile and accurately reproducible transfer standards are much in demand by the experimental community. (2) The preliminary design of instruments will be continued to meet observational requirements for the shuttle era, such as improved spatial, spectral and time resolution. The spectral range of interest extends from the standard lamp, synchrotron calibration, grazing incidence optics; photoheliograph, spectrometer; spectrograph, coronagraph, and diffraction gratings.

W78-70339**170-38-52**

Goddard Space Flight Center, Greenbelt, Md

GROUND BASED OBSERVATIONS OF THE SUN

Robert W. Hobbs 301-982-2591

The major objective is the measurement of solar radiation at those wavelengths accessible from the ground (primarily 3000 to 11000 Å) with resolution (spatial, spectral, temporal, velocity) suitable for supporting investigations of solar phenomena (flares, active regions, wave motions) carried out in the EUV, X-rays, and gamma rays by Orbiting Solar Observatories, SMM and other flight missions in the NASA Solar Physics Program and for basic research on the sun. Other objectives are: (1) the observation and spectral analysis of high temperature laboratory plasmas in order to interpret solar spectral analysis of high temperature laboratory plasmas in order to interpret solar spectra in the range 10 to 800 Å for the purpose of understanding physical processes in the solar corona, (2) the analysis of comet-tail photographs to determine the velocity field of the solar wind; and (3) high resolution radio observations of the sun. Two observatory facilities and several laboratory programs are maintained for this purpose. The dedicated vacuum solar telescope and multichannel spectrometer now operated by the Laboratory for Solar Physics and Astrophysics at the Sacramento Peak Observatory are used to obtain photometric data, spectroheliographs and line profiles.

W78-70340**170-38-52**

National Aeronautics and Space Administration, Washington D. C.

GROUND-BASED OBSERVATIONS

Adrenne F. Timothy 202-755-8490

Ground-based observations of the sun in wavelengths for which the terrestrial atmosphere is transparent are carried out at a number of suitable observatories and ground stations throughout the United States. The purpose of these ground-based observations is to obtain information on the solar atmosphere from the photosphere and sun spots, to the chromosphere, and the corona, and on the fine and gross structure of the solar atmosphere, and activity in it. This information is then used in conjunction with observations from sounding rockets, OSOs, ATM and other spacecraft to determine the physical conditions in the objects studied and to understand the physical mechanisms at work in them. Of particular importance in the coming year will be the continuation of a series of coordinated ground based observing programs planned in collaboration with the OSO-8 mission. Steps will also be taken to define an appropriate ground based observing system (visible and radio wavelengths) to support the Solar Maximum Mission.

W78-70341**170-38-52**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GROUND-BASED OBSERVATIONS OF THE SUN

M M Neugebauer 213-354-4110

The JPL-Table Mountain 8-mm interferometer will be suitably modified for solar observations and the system will be used to study solar flares. The frequency, baseline, sensitivity, time resolution, and availability of this instrument are particularly well suited for the study of the important observable processes occurring in a solar flare, and the interferometer can fill an existing gap in present capabilities for research on this subject. At 8-mm the Solar emission originates deep in the chromosphere, and the preflare and flare radiation which is measured refers to central and early processes in the overall flare event. The interferometer may be adapted and made available for extensive solar monitoring with negligible impact on the ongoing planetary studies, and with a cost small compared to the initial investment in the instrument. The principal personnel to obtain, analyze, and interpret the data will be provided through our collaboration with Dr. Harold Zirin of Caltec.

W78-70342

170-38-53

Goddard Space Flight Center, Greenbelt, Md

EXPERIMENT DEVELOPMENT - LABORATORY AND THEORETICAL SOLAR PHYSICS

J C Brandt 301-982-4701

The objective is to develop fundamental techniques which support the laboratory's ongoing programs. These techniques ultimately are both experimental (applicable in the areas of design of flight instruments) and theoretical (analysis of returned data). However, at the initial level of investigation, fundamental physical processes must be investigated and defined before development of solar models based on these processes can be proposed and executed. Likewise, fundamental understanding of spectra observed on the sun is confirmed if not originally suggested by laboratory and theoretical work. Among such work is the identification of spectral lines in high energy spark discharges, the calculation of the transition probabilities of atomic transitions, and the development of techniques for the analysis of spacecraft observations. Each of these areas is investigated in the context of ultimate application to instruments or theoretical modeling of the solar atmosphere carried out by members of the laboratory.

W78-70343

170-38-53

National Aeronautics and Space Administration, Washington D C

LABORATORY AND THEORETICAL SOLAR PHYSICS

Adrienne F Timothy 202-755-8490

Laboratory and theoretical studies are performed on problems in solar astronomy, solar physics, and in important and relevant areas of atomic and molecular physics. These investigations contribute basic information which is necessary for the analysis, interpretation, and understanding of data about the sun which is obtained from space and from the ground. Theoretical studies of the sun include the following types of activity: (1) the analysis of ground-based and space data to produce models of the solar atmosphere and to understand the underlying physical conditions and mechanisms; (2) prediction of future events on the sun, such as predications of coronal structures from features observable on the disk, of the development of future active regions from magnetic and H-alpha features, and the occurrence of flares from magnetic field complexity and configuration; (3) theoretical studies of the production of magnetic fields in astrophysical bodies, and the study of radiative transfer and mechanical transport phenomena to understand the chromosphere and transition region of the sun.

Cometary Science

W78-70344

173-45-51

Goddard Space Flight Center, Greenbelt, Md

COMETS AND INTERSTELLAR MATTER

B D. Donn 301-982-5014

This RTOP includes several programs to study comets and

interstellar matter. The primary objective is laboratory experimentation relevant to the physicochemical behavior of matter in space. Theoretical analysis of astronomical and space problems using experimental and theoretical results is a second aim. A third aspect involves ground based telescopic observations. The last phase uses observations from spacecraft to obtain otherwise unavailable data. The laboratory investigations make use of several new techniques: (1) resonance fluorescence flash photolysis, (2) unable laser spectroscopy from ultraviolet to infrared, and (3) infrared heterodyne spectroscopy. These are used to study the production and reactions of atoms and radicals from planetary, cometary and interstellar molecules. Molecular beams and equilibrium condensation techniques are used to study condensation phenomena relating to the formation of interstellar and primordial planetary grains. Theoretical research examines the origin of comets and interstellar molecules and relationships between them. Irradiation of condensed gas mixtures by van de Graaf proton beams is used to determine the effects of cosmic rays on comets in the Oort cloud. Ground based observation of comets continues with emphasis on image intensifier studies of faint comets. A search for newly formed highly rotationally excited CN radicals is underway using high dispersion spectra of bright comets. With the forthcoming launch of IUE in December, 1977, investigations of the far ultraviolet spectra of comets and interstellar molecules will be carried out.

W78-70345

173-45-55

Jet Propulsion Lab., Calif Inst of Tech., Pasadena

COMETARY STUDIES

R S Saunders 213-354-3815

The objective of this RTOP is to conduct laboratory and theoretical work towards a quantitative understanding of the physical and chemical processes occurring in comets. The laboratory work is directed towards an understanding of ionization processes in comets and the formation of both the neutral and ionic species observed in the halo and tail. Kinetic modeling studies will be conducted using these data, working back from observed species through the appropriate chemistry in order to provide constraints on the possible parent species evaporated from the nucleus. The cometary dynamics work is directed towards the inclusion of non-gravitational perturbations in orbit determinations for comets with periods greater than 70 years. The objectives of the dynamics work are to successfully model the non-gravitational forces, determine accurate orbits and infer the nature of cometary ices for the five long period comets, Halley, Olbers, Pons-Brooks, Brorsen-Metcalf and Westphal. The ground-based spectroscopy tasks are focussed to the acquisition of ultraviolet cometary spectra with high spatial and spectral resolution. These spectra provide data on scale lengths, lifetimes, new species, and excitation/de-excitation mechanisms.

W78-70346

173-45-56

Jet Propulsion Lab., Calif Inst of Tech., Pasadena

COMETARY INSTRUMENTATION

R S Saunders 213-354-3815

This RTOP proposes the continuation of two instrument development efforts geared towards the demonstration of technology readiness for a mission to the Comet Hale. It is proposed to complete the feasibility studies and development of a spectrometer capable of obtaining both the mass/charge and three dimensional velocity distributions of ions in the coma and tail of a comet on either a rendezvous or a flyby mission. No presently existing energetic ion mass spectrometer has resolution sufficient to separate species which differ by a single mass unit near 40 or 50 AMU/charge. It is believed such resolution can be achieved with a new type of spectrometer which combines electrostatic analysis by modulated grids and magnetic analysis by a sector magnet. It is also proposed to perform more thorough analyses and experimental tests of this new concept. The resolution and angular response will be determined experimentally and compared with theoretical predictions. The high-voltage subsystem will be breadboarded and tested. The design of a breadboard magnet will be started. The cometary environment problem will be addressed. This task is designed to complete functional testing of a breadboard mass spectrometer using electro-optical ion detection (EOID) to vastly improve its sensitivity.

over existing mass spectrometers. This increased sensitivity will greatly enhance the chances for observing parent neutral molecules in the very tenuous cometary atmosphere. Emphasis will be placed on proving feasibility of the MS/EQID concept through careful design and testing of the MS/EQID interface, comparative evaluation of photo diode arrays vs charge coupled devices as photon detectors, and the breadboarding of the MS/EQID sensor at the University of Minnesota under the direction of prof A O C Nier

W78-70347**173-45-60**

Marshall Space Flight Center, Huntsville, Ala
COMETARY OBSERVATION AND THEORY
 C R O'Dell 205-453-3033

The objective of this RTOP is to obtain cometary spectra with intermediate spectral resolution between 350 to 820 nm, with emphasis on the higher wavelength, and to analyze rovibronic structure of the observed comets and spectra of comets in terms of a corrected resonance-fluorescence mechanism. An echelle spectrometer employing a S-20 fiber optics image tube with an F/2 Schmidt camera will allow a spectral resolution of ≈ 0.5 Angstroms to be obtained on photographic plates. Standard data reduction by densitometry will be employed. A review of laboratory and cometary spectra will provide the initial suggestions to correcting the resonance-fluorescence mechanism (e.g., NH_2)

W78-70348**173-46-60**

Marshall Space Flight Center, Huntsville, Ala
COMETARY PHYSICS
 Kenneth S Clifton 205-453-2305

The effort to study the problems related to the composition and physical properties of comets and cometary debris will be continued. This effort will be accomplished primarily by means of an observational program to determine the spectral and photometric characteristics of shower meteors and of faint or distant comets. Observations will be conducted with the use of low-light-level TV systems equipped with fast optics or intermediate sized telescopes and low dispersion spectrographic systems. In addition, these observations may be augmented by photographic and/or photometric observations. The resulting data from the TV observations will be analyzed with automated systems employing both digital and analog reduction schemes. Efforts will continually be made to improve these systems for the most efficient and accurate analysis possible. Analysis efforts will be aided through consultation with leading specialists in the field of interplanetary material.

Planetary Exploration SR&T - Science

W78-70349**185-47-51**

Goddard Space Flight Center, Greenbelt, Md
ABSOLUTE PRESSURE MOLECULAR AND ATOMIC BEAM CALIBRATION TECHNIQUES FOR MASS SPECTROMETERS
 H B Niemann 301-982-4706

The objective of this work is to develop new laboratory techniques and to construct facilities for testing and calibration of instruments to measure the neutral particle composition and temperature of planetary atmospheres. The different atmospheric environments encountered in the various planetary and interplanetary missions as well as the different scientific goals set for the study of the planets require an extensive instrument and test facility development program which leads to a satisfactory laboratory capability for evaluation and calibration of flight instrument concepts and subsequently flight instruments. The different chemical properties of the various atmospheric constituents. The different chemical properties of the various atmospheric constituents and the various gas dynamic conditions expected in a planetary entry or cometary encounter make it necessary to develop several separate systems each with a limited range of flexibility which together satisfy the test requirements. Static pressure calibration systems have been developed for calibration of mass spectrometers with nonreactive gases in the pressure

range suitable for mass spectrometer operation, i.e., less than or equal to 0.01 mb. This technique will be expanded to include pressure regions up to 100 bar, where instruments with extended dynamic ranges of greater than or equal to 10 to the 9th power can be calibrated for detection of minor constituents and the precise determination of isotope ratios. High speed computer compatible data recording is planned to improve measurement accuracy and data handling efficiency.

W78-70350**185-47-52**

Goddard Space Flight Center, Greenbelt, Md
INSTRUMENT DEVELOPMENT FOR NEUTRAL GAS COMPOSITION AND DENSITY MEASUREMENTS IN PLANETARY ATMOSPHERES
 H B Niemann 301-982-4706

This research plan is concerned with the overall improvement of neutral gas composition measurements planned for the atmospheres of earth, the planets, and comets. In general, improvements are sought in two basic areas: sensor concept and application, and optimization of basic instrument parameters in anticipation of restrictive mission constraints. In the first area, sensor development will be directed toward (1) the improvement of ambient gas sampling techniques for high velocity probes into high density atmospheres (e.g., outer planets entry probes), the design of more efficient ion sources of both the open type which provides side-energy focussing, and the closed type which increases the thermalization of the gas being measured, and development of a neutral particle retarding potential analyzer for high velocity probes. In the second area, neutral mass spectrometer system development will be directed toward optimizing existing techniques in view of rigorous requirements anticipated in forthcoming planetary and cometary flight opportunities. This work will concentrate on (1) development of smaller, lighter, higher resolution, less expensive mass analyzers, (2) improvement of ion current detectors applicable to digital systems, emphasizing accuracy, sensitivity, and stability, and (3) development of improved digital logic and on-board data processing sub-systems.

W78-70351**185-47-53**

Goddard Space Flight Center, Greenbelt, Md
ADVANCED TECHNIQUES FOR THE MEASUREMENT OF ION COMPOSITION AND DRIFT
 H A Taylor, Jr. 301-982-6610

The RTOP objective is to improve ion composition measurement techniques in anticipation of flight exploration of cometary and planetary ionospheres. Instrument refinements are prompted by direct measurement difficulties identified in the analysis of earth satellite data obtained under conditions of rapidly changing ion drifts, and high velocity passage through the relatively dense lower atmosphere. Drift irregularities result in fluctuating ion velocities (and equivalent energies). High velocity entry can result in impact ionization and secondary emission from sensor surfaces. Development of the Bennett RF ion mass spectrometer will be concentrated upon accommodation of dynamic effects influencing ion detection, and determination of absolute ion concentrations. Emphasis will be given to (1) refining servo-controlled ion peak detector response to variable ion drifts, and (2) evaluation of electrostatic ion-deflection techniques required for off-ram axis detection of ambient ions in a dense, high velocity neutral gas beam. Improved measurement performance will be verified by high velocity ion-beam stimulation of modified sensor designs, coupled with breadboard models of improved detector-logic circuitry.

W78-70352**185-47-54**

Goddard Space Flight Center, Greenbelt, Md
DEVELOPMENT OF MEASUREMENT TECHNIQUES FOR GAS AND CLOUD PARTICLE COMPOSITION IN HIGH PRESSURE ATMOSPHERES
 H B Niemann 301-982-4706

The objective of this work is to develop measurement techniques for the determination of the composition of the gas and the cloud particles in the lower atmospheres of the planets. The method of mass spectrometry for the composition determination of solid materials and condensibles will be adopted for spaceflight application. Several different atmosphere sampling

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techniques will be developed and studied for optimum efficiency in the specific application of the various principle atmospheres. Sampling techniques employed in the high temperature CO₂ environment in the lower atmosphere of Venus differ significantly from those employed in the relatively cool H₂/He environment in the lower atmospheres of the outer planets. Chemical enrichment techniques will be developed with goals to obtain enrichment by a factor of 10 to the 7th power for trace constituent analysis and isotope ratio measurements. The analysis of solid particles deserves special attention as it requires a much higher degree of instrument complexity than required for atmospheric gas analysis. Laboratory proven techniques will be adopted for flight application when practical and new sampling concepts will be developed when required.

W78-70353

185-47-55

Goddard Space Flight Center, Greenbelt, Md

SPECTROSCOPY AND PHOTOCHEMISTRY OF PLANETARY AND COMETARY MOLECULES

L. J. Stief 301-982-2529

The objectives of this research are to measure the optical and chemical properties of atoms, free radicals and molecules which are important in understanding the composition of planetary atmospheres and comets. Emphasis is placed on those problems which are of immediate concern for interpreting the results of rocket and satellite observations. The flash photolysis-resonance fluorescence apparatus is equipped with a variable temperature cell and the experiment is linked to a computer for real-time data reduction and analysis. The apparatus is being used to measure absolute rate constants as a function of temperature for atom-molecule reactions such as H+PH₃ and H+C₂H₄. A discharge-flow system which variable temperature capability has been constructed and this apparatus combined with a tunable CW dye laser will be used to measure absolute rate constants for reactions of free radicals such as NH₂ or CH. Several types of spectroscopic measurements are made. In one, photoabsorption and photoionization cross sections are measured. Cross sections are also determined for producing fragments in excited electronic states. Branching ratios are measured for excited states which cascade into lower level excited states via photon emission. Electron impact excitation cross sections are determined. Ultra-high resolution infrared absorption spectra are measured using tuneable semiconductor diode lasers.

W78-70354

185-47-57

Goddard Space Flight Center, Greenbelt, Md

DYNAMICS OF PLANETARY ATMOSPHERES

J. A. Pirraglia 301-982-6088

Planetary missions supplemented by ground based and airborne instruments have greatly increased our knowledge of the atmospheres of Jupiter, Venus, and Mars, and planned missions promise more detailed information on Jupiter, Saturn, and their satellites. The planets and their satellites present contrasts in mass, rotation rates, radiative time constants, heat deposition, and topographic influence of the atmosphere. For a better understanding of these disparate atmospheres, it is necessary to develop a general approach to theoretical atmospheric dynamics based upon the existing data obtained from the planetary missions. The widely differing conditions permit the isolation of specific phenomena and allow comparisons of different regions of the parameter space associated with a particular phenomenon. This fortunate occurrence of a varied set of atmospheres is essentially the atmospheric dynamists laboratory, and the increased knowledge of them, when augmented by analytical models, will lead to a greater understanding of the nature of our own atmosphere.

W78-70355

185-47-58

Goddard Space Flight Center, Greenbelt, Md

MINIATURE VACUUM PUMP DEVELOPMENT FOR NOBLE GAS AND HYDROGEN PUMPING ON ATMOSPHERIC ENTRY PROBES ON OUTER PLANET MISSIONS

H. B. Niemann 301-982-4706

The objective of this work is to develop efficient, low weight vacuum pumps for flight application with mass spectrometer experiments on atmospheric entry probes for outer planet

exploration. The most abundant gases on the planets presently under consideration for direct probing are hydrogen and helium. While hydrogen can be pumped chemically to a pressure level suitable for mass spectrometer operation, the difficulties encountered in pumping helium effectively and reliably has become a major obstacle in the development of instruments for mass spectrometric composition measurements from atmospheric entry probes. Getter pumps or sputter ion pumps conventionally employed in flight mass spectrometers have no or very limited pumping capability for helium. Moreover when exposed to hydrogen, hydrocarbons are synthesized in the pump normally at higher concentration levels than similar compounds expected to be found in the planetary atmosphere. It is proposed to do development work in three areas: (1) developing a low weight getter baffled sputter ion pump with high specific pumping efficiency for helium, and minimum hydrocarbon synthesis; (2) develop a miniature turbomolecular pump suitable for flight application which has no specific discrimination for noble gases, and (3) development of a nonevaporable getter pump having a large pumping capacity for hydrogen and other reactive gases.

W78-70356

185-47-66

Ames Research Center, Moffett Field, Calif

ATMOSPHERIC CHEMICAL PHYSICS - PROCESSES IN PLANETARY ATMOSPHERES, COMETS, AND INTERSTELLAR SPACE

E. C. Y. Inn 415-965-5500

The objectives are to determine products, rates, and yields of energy transfer reactions in planetary atmospheres, comets, and interstellar space. Solar and galactic radiations interact with the atmospheric constituents to produce excited and ionized species and free radicals, which then react to form other ionized and excited species, and/or neutral unexcited species, and/or reradiate spectral energy. Insight into the nature of planetary atmospheres, comets, and interstellar matter can be obtained from studies of these processes under controlled laboratory conditions. Investigations in the photochemistry and other atmospheric processes involving optical emission and absorption will be conducted under controlled laboratory conditions. When considered necessary, this study may be carried out under conditions simulating the natural atmospheric environment. This study will consider also the effectiveness of minor constituents such as Cl, S, and OH in catalyzing or participating in important reactions. Photolysis of CH₄, NH₃, H₂, and H₂O will be investigated and the quantum yields and fluorescence cross sections determined. These studies will contribute to our understanding of the photochemistry of reduced atmospheres (e.g., Jupiter) and will provide scientific support for future planetary exploration.

W78-70357

185-47-67

Ames Research Center, Moffett Field, Calif

STRUCTURE OF PLANETARY ATMOSPHERES

J. B. Pollack 415-965-5530

The abundances and distributions of ions, electrons, and minor constituents on Mars, Venus, the outer planets, and the moons of Jupiter and Saturn are being studied theoretically, using data from observations and laboratory measurements. For example, in the case of Titan, the complete set of coupled mass, momentum, and energy conservation equations for electrons, ions, and neutral particles was solved. A one-dimensional model of Martian atmosphere photochemistry has been constructed to investigate the behavior of high latitude ozone, a simple two-dimensional model will be constructed for the same purpose. A one-dimensional model of the Earth's stratospheric sulfate aerosol model will be adapted for application to the Venus clouds. Thermal structure models have been constructed to understand the operation of the greenhouse effect on Titan. In order to understand the dynamics of Venus' atmosphere, calculations are being carried out to examine the effects of rotation, apparent solar motion, and the energy deposition profile on the circulation of the atmosphere. The Mintz-Arakawa model of the Earth's atmosphere is being adapted to the conditions on Mars to permit a calculation of the general circulation of the Martian atmosphere. The MIT spectral model of atmospheric dynamics will be adapted to the Jovian atmosphere in collaboration with

MIT scientists, the model will be programmed for Illiac IV. Estimates of the particle size in the rings of Saturn are obtained from analysis of IR and microwave measurements.

W78-70358**185-47-68**

Ames Research Center, Moffett Field, Calif.

PLANETARY ATMOSPHERES-STRUCTURE AND COMPOSITIONA. Seiff 415-965-5685
(185-47-67)

The ongoing OSS program to explore the planets includes missions in which properties of planetary atmospheres are measured during entry and descent by instruments carried by entry probes. The Viking landers carried such an experiment and it greatly advanced our knowledge of Mars' atmosphere. Similar measurements are a primary part of the Pioneer Venus Mission and the proposed Jupiter Orbiter Probe Mission. The atmosphere structure measurements on Viking and Pioneer Venus have been advanced and developed in recent years under this RTOP. Broadly stated, the RTOP objective is to support laboratory studies, analyses, and field tests required for maximum return from atmosphere structure experiments at the planets. These studies lead to quantitative and more accurate interpretations of the planetary data, and further develop the experiment capabilities. Objectives in FY-78 include the accurate determination of Pioneer Venus probe aerodynamics, to permit the structure of Venus' atmosphere to be accurately derived, the study of low Reynolds number aerodynamics of Viking, Pioneer Venus, and JOP probes to extend the altitude threshold of the experiments, the development of analytical approaches for extracting wind data from the Venus multiprobe data, and further study by drop tests in the Earth's atmosphere of buffeting forces on probe geometries in low speed descent to permit turbulence measurements at the planets.

W78-70359**185-47-71**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ATMOSPHERIC EXPERIMENT DEVELOPMENT

W. T. Huntress 213-354-3238

This work defines, develops and evaluates new or improved science experiments for the exploration and study of the atmospheres of solar system bodies from spacecraft. The approach is through research in the following categories: (1) development and application of practical radiative transfer theory applicable to remote sensing experiments; (2) interpretation and critical analysis of existing data from planetary missions and Earth-based observations; (3) laboratory and theoretical studies of physical and spectral properties of atmospheric gas and cloud constituents relevant to specific experiment goals, and (4) participation in planning mission science by evaluating feasibility of key objectives using realistic technology within a framework of spacecraft and mission constraints. Instruments and techniques are developed via detailed numerical studies and error analyses and laboratory, ground based or airborne experiments as appropriate. Atmospheric models are developed and continually refined to maximize the realism and relevance of numerical work. Experimental techniques developed under this task are being implemented on Viking, MJS and Pioneer Venus. New and continuing work for FY-78 centers on (1) development of simultaneous wind and temperature experiments for the Mars '84 and VOIR '83 missions, (2) further development of new techniques for high vertical resolution temperature sounding, with initial application to the terrestrial troposphere and advanced application to the atmosphere of Jupiter, (3) new methods for studying planetary atmospheric dynamics using temperature sounding data, with initial application to Venus, (4) further laboratory, theoretical and observational studies of the spectral and radiative transfer properties of the outer planet atmospheres, with application to remote sensing from MJS, JOP and future missions to the outer solar system, (5) preliminary work on development of radiometric/spectrometric experiments for the comet Halley '86 mission, (6) further theoretical development of methods for interpreting remote observations of scattering atmospheres with application to temperature sounding of the cloudy Venus and dusty Martian atmospheres.

W78-70360**185-47-72**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

THEORETICAL STUDIES - PLANETARY ATMOSPHERES

W. T. Huntress 213-354-3238

A broad program of applied and theoretical studies pertaining to planetary atmospheres will be conducted with the following primary objectives: (1) understanding the properties and determination of the parameters of planetary atmospheres; (2) application of experimental data (laboratory astronomical and spacecraft) to the understanding and interpretation of spectral features and mechanisms for complex planetary atmospheres; (3) applying these findings toward design of ground based spacecraft experiments; (4) interpretation of experimental data to aid in the evolution of valid dynamic planetary atmospheric models. The studies to be conducted in FY-78 pertain to planetary atmospheric modeling, radiative transport theory, atmospheric circulation, determination of millimeter and submillimeter spectra and theoretical spectroscopic development for the understanding of planetary atmospheres.

W78-70361**185-47-74**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

IONIZATION AND RATE PROCESSES IN PLANETARY ATMOSPHERES

W. T. Huntress 213-354-3238

Laboratory measurements will be made to determine the rate constants and products for ion-molecule reactions of importance in the atmospheres of the outer planets. These data are required for support of future orbiter/entry missions to the outer planets and their satellites. The laboratory work is specifically directed towards the origin of organic species in the atmospheres of the outer planets and their satellites. Theoretical studies of atmospheric chemistry are also conducted at JPL in association with the modeling efforts at Ames Research Center. The laboratory data and theoretical work at JPL is used to continually update the chemistry in these models. Using a calibration procedure developed in our laboratory, absolute differential elastic and inelastic cross sections of electron-molecule (atom) collision processes which occur in planetary ionospheres and atmospheres are measured. Electron-impact spectroscopy is used to identify low-lying, optically-forbidden transitions in polyatomic systems. Extension of the electron-impact techniques to (1) excited species, (2) molecular clusters, (3) positive ions, and (4) coincidence measurements will be initiated. The high resolution (0.02 nm) photoionization mass spectrometer (PIMS) will be used to study photoionization processes and charge-transfer reactions in planetary ionospheres. A new technique for measuring threshold photoelectron spectra (threshold photoelectron spectroscopy by electron attachment, or TPEA) will be used to study the electronic structure of atomic, molecular and radical ions present in planetary atmospheres, and to identify important UV photoionization processes in planetary atmospheres.

W78-70362**185-50-61**

Ames Research Center, Moffett Field, Calif.

THEORETICAL STUDIES OF PLANETARY BODIES

J. B. Pollack 415-965-5530

The objective 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 by means of theoretical investigations employing the results of spacecraft and ground-based experiments. Theoretical knowledge, physical insight, and mathematical modeling techniques are used, together with astronomical and geological data, to construct self-consistent mathematical descriptions of planetary processes and structure. Analysis and interpretation of the results of these model calculations are applied to such topics as the evolution of Jupiter, wind-blown surface features on Mars, and the calculation of conditions within the early solar system.

W78-70363**185-50-72**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

JPL PLANETOLOGY

R. S. Saunders 213-354-3815

The Volatile Evolution task continues to be a comparative

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study of the present occurrence of volatiles in planetary atmospheres, on surfaces of planetary objects, and in meteorites. The objective is to decipher the history of solar system volatiles in terms of: (1) the manner of their initial incorporation into solid solar system material and planetary objects; (2) the mechanism of release from the interiors of these objects, and (3) the subsequent chemical evolution of volatiles condensed on planetary surfaces, chemically recombined in regolith material, or present in planetary atmospheres. This year the objectives include definition of the role of regolith volatiles in Mars climate change, Mars channel production, and the evolution of the Galilean satellites. In the Planetary Frost task, the infrared reflection spectra (1 - 5 Micron) from optically flat surfaces of CH₄, NH₃ and other ices will be measured. The reflection spectra of the frosts of these ices as well as hydrated minerals will also be measured. These results will be used to determine their reflective and scattering properties for the interpretation of the spectra of planetary atmospheres, comets, and the surfaces of asteroids and satellites. Objectives of the Phobos/Mars task include (1) determining the optical oblateness of Mars as well as the density and distribution of atmospheric particulates and clouds; and (2) improving the existing globe of Phobos in its geodetic and topographic representation of Phobos.

W78-70364

185-50-73

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
JPL PLANETOLOGY INSTRUMENT DEVELOPMENT
R. S. Saunders 213-354-3815

The objective of the alpha/X-ray task is to develop a combined alpha-scattering/X-ray analysis instrument that would provide valuable in-situ geochemical information on Mars. The instrumentation is sufficiently flexible to be used in penetrators or on a roving vehicle. The effort at JPL is carried out in support of the University of Chicago. It has included studies on X-ray analysis using alpha-particle excitation, development of a Joule-Thomson cooled X-ray detector, and study of room temperature X-ray detectors. Future work will include further development of the X-ray mode, concentrating on room temperature detectors, and support of testing of the Micro-Alpha instrument using the Caltech tandem Van De Graaff accelerator. Support will also be given in the design of the neutron mode for the detection of H (water). The penetrator/water detector task will be directed toward completing the definition of several water measurement sensors and related electronics for a Mars penetrator in order to develop an instrument for the measurement of water. After conceptual design, fabrication of a breadboard of the soil sampler and processor system will be initiated, built and tested. JPL will assist ARC in integrating the free-water measurement, soil sampler and processor instrument designs into the penetrator design. The objective of the X-ray spectroscopy/Galilean satellite task is to demonstrate by experiment and analysis the feasibility of designing an X-ray spectroscopy instrument to determine the surface chemistry of the Galilean satellites while immersed in the Jovian magnetospheric particle fluxes. The latter, which produces both satellite fluorescence and background interference, makes a new hardware design mandatory. The ultimate goal is for understanding the origin and evolution of the Galilean satellites by understanding their chemistry, which in turn will help to model the origin and evolution of the entire solar system.

W78-70365

186-68-54

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
GUIDANCE AND CONTROL TECHNOLOGY FOR PLANETARY MISSIONS
J. M. McLaughlin 213-354-6631
(506-19-15)

The objective of this work is to make available a planetary star tracker suitable for interplanetary spacecraft applications. This work will also provide the technology base for a standardized low cost star tracker for broad application to anticipated NASA missions from 1980 on. This star tracker has been designated by the acronym STELLAR for Star Tracker for Economical Long Life Attitude Reference. The STELLAR makes significant improvements in reliability by utilizing an all solid state image sensor thereby completely eliminating high voltage circuitry and vacuum tubes as used in current star trackers and in addition

provides significant reductions in cost, size and weight. The STELLAR concept is keyed directly to the new technology of charge coupled device (CCD's) photodetectors and microprocessors. The objective of the STELLAR development effort is to achieve the improvements in reliability (10 year lifetime vs 3 years), performance and cost (over 50% reduction in sensor costs) and to demonstrate these improvements in an engineering model STELLAR.

W78-70366

186-68-62

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
PROPELLANT COMPATIBILITY WITH MATERIALS FOR LONG DURATION MISSIONS
D. L. Young 213-354-3217

The objective of this work is to provide the technology for propellant/material compatibility that will be used on future planetary missions. Current objectives include work to determine which materials are acceptably inert for use in the construction of propulsion subsystem components in contact with earth storable liquid propellants for long duration missions. The test program involves continuing actual specimen storage tests in a controlled environment using the compatibility test facility at the JPL Edwards Test Station. Detailed chemical and physical analyses of specimens and propellants will be performed after specific storage periods and a rating assigned for design purposes.

W78-70367

186-68-87

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ORBITER MISSION COMMONALITY STUDIES
P. W. Riggie 213-354-3618

This RTOP describes a total study effort which is jointly funded by the 1865 program and the LCSO. Its objectives are to establish commonalities at each level for orbiter missions and systems, to identify alternate ways of implementing these commonalities, and to describe in some detail and evaluate the promising commonality alternatives. Orbiter Commonality Studies beginning in the FY-76 Transition Period and continuing through FY-77 and FY-78 were initiated last year. Two phases of study effort are involved. A Phase 1 effort devoted to establishing commonalities at each level of the orbiter missions and systems and identifying alternative ways of implementing these commonalities within the planetary exploration program; and a Phase 2 effort which undertakes to describe the promising alternatives to sufficient design depth to allow programmatic evaluation in terms of performance and capability, schedule, resource requirements, and risk. Phase 1 is currently underway and will be completed during FY-77. This RTOP describes the Phase 2 effort planned for FY-78.

Physics and Astronomy

W78-70368

188-41-51

Ames Research Center, Moffett Field, Calif.
THEORETICAL ASTROPHYSICS
D. C. Black 415-965-5527
(188-41-55)

The objective of this work is to conduct theoretical studies on important fundamental problems in astrophysics and astronomy and to provide theoretical support for the center program in observational infrared astronomy. Although a wide range of astrophysical phenomena are under investigation, research effort are primarily directed towards infrared astronomy and computational astrophysics. Theoretical work in infrared astronomy includes modelling of circumstellar shells in Be stars, studies of fragmentation of interstellar clouds and subsequent collapse to the main sequence, investigation of the structure of molecular clouds, modelling of dusty HII regions, as well as data analysis and interpretation of airborne infrared observations. The computational astrophysics underway treats a broad spectrum of gas dynamic and hydrodynamic problems in astrophysics, including pre- and post-main sequence evolution, accretion, the evolution of spiral galaxies, and the dynamics of gas acceleration near QSO's. A variety of other astrophysical problems are studied.

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at existing observatories. Part of the mm spectrum and most of the sub-mm spectrum is obscured.

W78-70375

188-41-52

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GROUND-BASED RADIO ASTRONOMY

R. W. Davies 213-354-4156

The main emphasis of this RTOP is the study of neutral interstellar gases by observations of their millimeter rotational transitions. The interaction between dense clouds and imbedded or adjacent heat sources is investigated via the excitation of various molecules. Relative abundance measurements are also used to test theories of astrochemistry. Analysis of the line shapes yields information about the kinematics of dense clouds. Previous observations were conducted primarily as guests of the NRAO facility at Kitt Peak, although the past fiscal year has seen use of the Kuiper Airborne Observatory. In FY-78, a full program is anticipated from the KAO, as well as the first use of the new 10-m telescope at Owens Valley Radio Observatory. To take full advantage of these and other facilities suited to very high frequencies, it is proposed to revive the Engineering Support task (188-41-52-14-55) to construct a portable, state-of-the-art receiving system based on technology being developed under RTOP 506-18-19. The receiver would operate initially between 330 and 400 GHz, and be adapted to higher frequencies in future years. This task would also support RTOP 196-41-73, and would be available to support cometary observations. During FY-77, the Laboratory Program has begun to build a computer-based catalog of rotational transitions of molecules of interest to astronomy. 25 molecules, including isotopic species for a total of 62 sets of transitions, have been catalogued so far. In FY-78, user software will be developed, and additional molecules will be added to this catalogue. It is planned to continue our study of ionized gas using the facilities of the DSN. In collaboration with Spanish scientists, an investigation of extended, diffuse H II regions will be continued. Further studies will be conducted of ionized gas in cold clouds. During FY-77, the interferometer between DSS-62 and DSS-63 will be completed and an observing program using this facility will begin in collaboration with Australian scientists. Monitoring of selected pulsars will also be continued.

W78-70376

188-41-54

National Aeronautics and Space Administration, Washington, D. C.

RELATIVITY

Roman N. G. 202-755-3649

The primary objective is to make experimental tests of the theory of relativity and thereby elucidate the interrelationship among space, time, and gravity. In particular, the test of Einstein's General Theory of Relativity is paramount. This formulation is fundamental and of high scientific interest. Experimental verification is difficult but the ability to orbit large, complex, and extremely precise apparatus, shielded from deleterious perturbations should obviate them. In addition to the scientific goals, improvements and innovations in the technological areas of cryogenics, gyroscope design, and precision clocks are expected. Specific objectives include the development and operation of a flight qualified cryogenic gyroscope, complete gyroscope system error analysis, and the consideration of various theoretical formulations of relativity and their subsequent experimental implications. Possible future benefits apart from the scientific ones include improved timing for navigation, communication and geodesy as well as cryogenic systems capable of extended operation in space.

W78-70377

188-41-54

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

RELATIVITY

R. W. Davies 213-354-4156

The possibility of missing matter in the universe is being studied by computer integration of evolutionary models of the intergalactic medium. This research will support interpretation of data on intergalactic matter, its composition, excitation and ionization history, which will result from far ultraviolet quasar spectra taken with the forthcoming IUE satellite. The solution of

Einstein's equations for selected anisotropic cosmological models has been investigated. Consequences for observational cosmology were considered. This research supported a study and proposal for measurement of large scale anisotropy of the cosmic microwave background radiation to be made from an Explorer satellite. A study will be made of a similar experiment on board the shuttle. Advances in techniques of nonlinear applied mathematics are being applied to selected problems of relativistic gravity, in particular to the calculation of fields of axisymmetric spinning sources, and to gravity waves. Research is being performed on the interaction of gravitational radiation with Doppler spacecraft tracking measurements, and on various possible detection methods of gravitational radiation. Feasibility studies are being made on precision tracking experiments utilizing the unique experimental capabilities of the Deep Space Net.

W78-70378

188-41-54

Marshall Space Flight Center, Huntsville, Ala

RELATIVITY AND CELESTIAL MECHANICS

Richard A. Potter 205-453-3431

The objective of this activity is to develop, through a coordinated program, the technology and research required to support the flight of the gyro-relativity experiment. This experiment will be a fundamental and unique test of the general theory of relativity. The feasibility of this experiment centers around the development of a cryogenic gyroscope several orders of magnitude more precise than any existing, and the ability to maintain these gyroscopes and record their precessions, while in earth orbit, over a period of three months or more. The work, requiring advancement in several disciplines, is being accomplished by complementary efforts at MSFC, Stanford University and the University of Alabama in Huntsville. This work is a well coordinated, theoretical, experimental and engineering program oriented toward a satellite flight that will establish the validity of the General Theory of Relativity.

W78-70379

188-41-55

Ames Research Center, Moffett Field, Calif.

INFRARED EMISSION LINE POLARIZATION ASTRONOMY

P. Dyal 415-965-5523

(188-41-51)

The objectives are to study the line polarization properties of infrared astronomical sources and to interpret the results in terms of the astrophysical mechanisms and compositions associated with these observed objects. The approach is to observe the polarization of forbidden lines in H II regions and the galactic center and from these observations determine properties of the electron distribution and the magnetic field. A Fabry-Perot interferometer and polarimeter will be used at a ground-based observatory to measure the strength, line shape, and polarization of the collisionally excited Ne II forbidden line. A map of the polarized line intensity will then be used to determine a magnetic field geometry to compare with that obtained from aligned silicate grains. This will be valuable in determining the dust to ionized gas spatial distribution.

W78-70380

188-41-55

Goddard Space Flight Center, Greenbelt, Md

FAR INFRARED ASTRONOMY

M. G. Hauser 301-982-4679

The scientific objective of this program is to observe stellar, interstellar, and extragalactic sources of far infrared (10-1000 micron) radiation in order to study many astrophysical problems, such as early and late phases of stellar evolution, composition, and dynamics of the interstellar medium, the energetics of high luminosity galactic and extragalactic sources, and the structure and history of the universe. Since atmospheric opacity and emissivity prohibit or severely limit ground-based observations, high altitude observational platforms, such as balloons and satellites must be developed to permit sensitive astronomical measurements in this spectral range. High detectivity composite bolometers will be developed to take maximal advantage of the low background conditions achievable at these altitudes.

W78-70381

188-41-55

National Aeronautics and Space Administration, Washington, D. C.

W78-70369**188-41-51**

Goddard Space Flight Center, Greenbelt, Md.

UV AND OPTICAL ASTRONOMY

A. Boggess 301-982-5103

The objective is to pursue a long range program in astronomical research with emphasis on optical observations, theoretical astrophysics, and other specific topics of special interest to NASA. The effort includes operation of ground telescopes, development of new instrumentation for ground and rocket use, data interpretation, and theoretical studies. Spectroscopic and photometric data are obtained from ground telescopes in order to analyze the properties of stellar atmospheres, nebulae, and the interstellar medium. Nonequilibrium model atmospheres are being investigated to interpret spectral observations from space and ground observatories. Theoretical investigations are carried out on the evolution of stellar interiors, variable stars, novae, and planetary nebulae.

W78-70370**188-41-51**

National Aeronautics and Space Administration,

Washington D C

ULTRAVIOLET (UV) OPTICAL ASTRONOMY

J D. Rosendhal 202-755-3687

The objective is the advancement of stellar and galactic astronomy through observations and interpretations of data secured in the ultraviolet and visible electromagnetic portions of the spectrum. The emphasis is on research in direct support of on-going flight programs or in anticipation and preparation for future ones. The four elements supported are laboratory astrophysical studies, theoretical astrophysics, instrumentation development, and direct observational programs. A balanced program involving all those elements is required in order to insure full utilization and healthy development of the space science order to insure full utilization and healthy development of the space science program with the goal of the advancement of our understanding of the universe. The approach will be to develop theoretical models, perform theoretical studies, and determine basic atomic and molecular parameters. Interpretation of data, especially that obtained in the relatively unexplored UV spectral region, requires the additional information provided by these efforts. A broad and sound theoretical framework allows new observation to be interpreted and new directions to be instituted. In addition to atomic and molecular physics, specific areas of study include stellar atmospheres, stellar systems, and cosmology.

W78-70371**188-41-51**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

UV AND OPTICAL ASTRONOMY

R W. Davies 213-792-4156

Laboratory work will be conducted to measure the products and rate constants for ion-molecule reactions leading to the synthesis of molecules and ionic species in interstellar clouds. The laboratory data will be applied to the construction of theoretical chemical models for the formation of molecular species in interstellar clouds. These results are compared with observed molecular abundances in order to unravel the chemistry occurring in interstellar clouds, and to understand the mechanisms leading to the formation and destruction of interstellar molecules. This work is SR&T supportive of observational work on interstellar molecules, to both explain and predict abundances of interstellar molecules and to describe molecular evolution in astrophysical environments. Electron-molecule interactions (elastic, rotational, vibrational and electronic excitation), dissociative attachment and photon emission processes which play an important part in interstellar chemistry will be studied. Measurements of absolute cross sections for scattering of electrons with energies 0-100 eV by interstellar H₂O and CO will be studied. High resolution (0.02 nm) UV photoionization studies will be carried out on interstellar gases. A new technique for measuring threshold photoelectron spectra will be used to study electronic structure of atomic, molecular and radical ions produced by UV radiation from hot stars, and measure absolute threshold photoionization cross sections for states of atomic, molecular and radical species important in ionization equilibrium models.

W78-70372**188-41-51**

Lyndon B Johnson Space Center, Houston, Tex

ULTRAVIOLET STELLAR SPECTROMETER DEVELOPMENT FOR SPACE SHUTTLE

Y. Kondo 713-483-6467

The objective is to develop astronomical space-UV instrumentation for use in shuttle sortie mission, which will demonstrate state-of-the-art detector and tracking performance, flexibility of interfacing instrumentation with a general purpose telescope platform, and versatility of man's real time operational involvement. The development of the ultraviolet stellar spectrometer for space shuttle is performed through the flights of the balloon-borne ultraviolet stellar spectrometer (BUSS) payload as well as through other concurrent laboratory based developments. The BUSS payload performs high resolution spectrophotometry of astronomical objects in the mid-ultraviolet. The first version of the BUSS payload has been developed and flown successfully four times. It comprises a pointable telescope (40 cm aperture, f/7.5 modified Ritchey-Chretien) to which a variety of instrumentation can be attached. Payload functions are commanded from the ground in real time, and the data are telemetered to the ground in real time, where they are monitored in real time and recorded. Further development of the payload has been accomplished in conjunction with the collaborative program with the Space Research Laboratory, Utrecht, the Netherlands. In this collaborative program, we are jointly investigating stellar UV spectra in the range 2000-3400 Å with a resolution of 30,000 ($\lambda/\Delta\lambda$), employing an echelle spectrograph in combination with an image intensified storage vidicon detector.

W78-70373**188-41-51**

Marshall Space Flight Center, Huntsville, Ala.

UV AND OPTICAL ASTRONOMY

C R O'Dell 205-453-3033

An observational and interpretative program of astronomical spectroscopy will be pursued using the Echelle grating nebular spectrograph. This will include the program on internal velocities in HII regions. The method of post-development image enhancement of photographic film by means of autoradiography will be further developed to select optimal films for ground-based and Spacelab astronomical experiments. The observation of identified and candidate optical counterparts to X-ray sources will be continued, with the objective of providing a more complete understanding of the nature and distribution of the X-ray sources. Methods of high time resolution photometry and spectrophotometry will be applied utilizing, among other observational equipment, the integrated digital video detector system and photon counting equipment.

W78-70374**188-41-52**

Goddard Space Flight Center, Greenbelt, Md.

INFRARED AND RADIO ASTRONOMY

M. J. Mumma 301-982-6994

The objective of the infrared and radio astronomy program is to provide a better understanding of the evolution, dynamics, physical conditions, and compositions of astrophysical objects such as radio galaxies, quasars, supernovae, pulsars, protostars, HII and HI regions, interstellar clouds, and solar system sources. This is achieved through making high resolution spatial, temporal, and spectroscopic observations of infrared and radio emission from these objects. Infrared/mm/radio observations provide new kinds of information not obtainable from observations in other spectral ranges such as the ultraviolet and visible. Much of our knowledge of the evolution of dust clouds into stars has come from the study of interstellar molecular lines. The dynamics and excitation conditions of HII regions is revealed by studying their fine structure infrared line profiles. The interpretation of radio source spectral and spatial signatures in terms of plasma physics and high energy processes sheds light on the fields, particles, and dynamic processes within the source. The approach is to use high resolution radio interferometry (VLBI), radio continuum receivers, and infrared and millimeter coherent spectral line receivers to observe these sources. Very high spectral resolution radio studies are also carried out in pursuit of molecular astrophysics and the search for extraterrestrial intelligence (SETI). Millimeter-wavelength spectral line observations are carried out

INFRARED ASTRONOMY

N W Bogges 202-755-3688

The objective is to advance stellar and galactic astronomy in the spectral region between 1 and 1000 microns through observational and theoretical programs. Observations in the infrared portion of the electromagnetic spectrum are particularly important for an understanding of the early and late stages in stellar evolution, interstellar matter, galaxies and quasistellar objects and the energy mechanisms associated with them and the residual radiation of the universe. A balanced program including observation, technique and instrumentation development, and theory is required to insure the advances needed for full utilization of future platforms in space. The approach includes the following elements: (1) support observational programs using ground-based telescopes, balloons, and airplanes, and (2) promote the development of infrared techniques and apparatus. Special emphasis is placed on far IR narrow band filters, spectra interferometers, modulation techniques, and multiple detector arrays in order to enhance the information content of an observation, and more recently, on development of cryogenic and low-background telescopes.

W78-70382**188-46-56**

Goddard Space Flight Center, Greenbelt, Md

PARTICLE ASTROPHYSICS AND SHUTTLE EXPERIMENT DEFINITION

F B. McDonald 301-982-4801

One objective is to measure the energy spectra, charge, and isotopic composition of the primary cosmic radiation and of solar cosmic rays and the distribution of cosmic rays in space. Supporting this objective is the development of new detector systems for the study of the properties of cosmic radiation, and the associated development of theoretical studies related to these experiments. The results will be used in astrophysical considerations concerning the origin, acceleration, and propagation of cosmic radiation. Another objective is to develop a variety of new detector systems for high energy astrophysics research, including cosmic ray, X ray, and gamma ray astronomy. Meaningful new experiments in these fields presently require the development of several new devices, incorporating new improvements in energy, charge, and isotope resolution, in temporal resolution and directional resolution, and utilizing very large payloads of great size and weight, capable of orbit with the shuttle.

W78-70383**188-46-56**

National Aeronautics and Space Administration, Washington D C

PARTICLE ASTROPHYSICSAlbert G Opp 202-755-8493
(188-46-57)

The objective of this RTOP is to study the isotopic and charge composition and energy of galactic and solar cosmic rays. The primary galactic radiation represents the direct penetration of material from the galaxy into the solar system. The study of the nuclear composition and energy of this material provides direct evidence of the stellar processes responsible for the cosmic radiation and information on the interstellar material transmitted by the cosmic radiation. The observation of solar cosmic rays provides information on the abundances of different elements in the sun, and information on the solar processes that accelerate energetic particles to their observed energies. The design, construction and test of cosmic ray detectors is the prime activity supported by this RTOP. Solid state detectors, magnetic spectrometers, scintillators, Cerenkov counters and ionization spectrometers are typical instruments developed and tested.

W78-70384**188-46-56**

Marshall Space Flight Center, Huntsville, Ala

PARTICLE ASTROPHYSICS

Thomas A Parnell 205-453-5130

The program consists of observations and the interpretation of data on the heavy cosmic ray nuclei (4 smaller than z) and on cosmic gamma rays between 0.1 and 10 MeV. Emphasis is also placed on the improvement of instrumentation and data

analysis techniques for further measurements on these particles and for application to Spacelab era experiments. Observations of the nuclei and gamma rays are performed on balloon flights, and measurements of detector response are made in the laboratory and at particle accelerators. Calculations concerning sources of particles, local background, and detector response are carried out and verified by measurement.

W78-70385**188-46-57**

Goddard Space Flight Center, Greenbelt, Md

GAMMA RAY ASTRONOMY

C E Fichtel 301-982-6281

The technical objective is to develop the most appropriate detector systems for the observation of the astrophysical sources of very energetic photons. The approach has been divided into several different parts. The first approach to the general problem of gamma ray astronomy was the development of a large telescope using digitized spark chambers tested on high altitude balloons and then flown on satellites. Whereas many improvements to this basic telescope system are still being pursued, other approaches to detector systems are now also being developed for the high energy gamma rays, intermediate gamma ray studies, and low energy gamma ray observations. Detectors for low energy gamma ray astronomy are now being studied, particularly for gamma ray lines. A first generation medium energy gamma ray detector was built and flown on a balloon, and a second generation experiment has now been designed. Improvements in the track imaging chamber systems are continuing, and special attention in the track imaging chamber research is now being directed at designing and building a low cost chamber of significantly larger size. At the same time, several approaches are being explored to improve angular resolution. Time-of-flight systems are being studied to improve the rejection rate of events which are not gamma rays by obtaining much improved directional measurements. Both conventional and Cherenkov time-of-flight systems are being developed. These developments should provide the improvements in sensitivity and angular accuracy which are critical to the future advancement of gamma ray astronomy, and at the same time reduce the cost.

W78-70386**188-46-57**

National Aeronautics and Space Administration, Washington D C

GAMMA RAY ASTRONOMYAlbert G. Opp 202-755-8493
(188-46-59)

The objective of this RTOP is to measure the characteristics of energetic photon emission from celestial sources, and to understand the physical processes responsible for the emissions. This RTOP includes photonic radiation from approximately 10 keV in energy upward to as high as can be measured that is from hard X rays to ultra-high energy gamma rays. Several sources have been identified, which have spectra extending into the hundreds of MeV or higher. The spectra of discrete sources and the spectra and distribution of the diffuse background will provide information on the physical processes active in stars, pulsars, galaxies, and interstellar space. Gamma ray photons result from a number of physical processes. These processes can furnish information on the synthesis and distribution of elements in the universe, on the magnetoplasma environment of a star, on the interaction of cosmic rays with interstellar material, as well as other astrophysically important parameters. Gamma rays, which are undeflected by magnetic fields, travel directly from their sources, and anisotropies in the direction of arrival of the photons give information on the location of the gamma ray sources.

W78-70387**188-46-57**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GAMMA-RAY ASTRONOMY

R. W. Davies 213-354-4156

This describes the JPL program in X- and gamma ray astronomy, part of which is a cooperative effort with UCSD. The primary objective of the program is to observe nuclear gamma ray line spectra from extraterrestrial sources in the 0.2 to 10 MeV energy range. Such observations could provide important information on nucleosynthesis, galactic history and the physical

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nature of various celestial objects including cosmic X-ray and gamma ray sources, both constant and transient. Under this program, a high resolution gamma ray spectrometer balloon system will be used in a series of astronomical observations. Additional activities will be the development of advanced concepts in detection techniques, instrumentation and data analysis. The specific objectives for this program for FY-78 are to reduce, analyze, and publish the data from previous balloon flights; conduct observational balloon flights for Palestine, Texas; and begin the design of the next generation high spectral resolution gamma ray telescope.

W78-70388

188-46-59

Goddard Space Flight Center, Greenbelt, Md
X-RAY ASTRONOMY
E A Boldt 301-982-5853

Celestial X-ray sources have introduced us to a rich new aspect of astronomy ranging from the millisecond bursts of hard X-rays coming from the innermost orbits of matter falling into a black hole to the beamed emission of a pulsar exhibiting Doppler shifted iron lines associated with fluorescence from an Alfvén shell corotating with an underlying neutron star. The combination of large sensitive area, low detector background, high temporal resolution and nondispersive spectroscopy over a broad bandwidth has been our approach in discovering and exploring these phenomena. The power of this approach is being well demonstrated. Extending it with improved spectral resolution and broad band imaging is a major area of development now indicated. This involves the creation and evaluation of new systems incorporating low noise ionization counters of optimum resolution, large area X-ray concentrators, and imaging counters.

W78-70389

188-46-59

National Aeronautics and Space Administration,
Washington D. C.

X-RAY ASTRONOMY

Albert G. Opp 202-755-8493
(188-46-56, 188-46-57)

The objective is to investigate and understand the nature of sources of X-ray emission. The number of such sources detected has been increasing by virtue of the active observational program being conducted with balloons, rockets, and satellites. As experimental techniques have been refined a number of point sources have been identified with unusual optical objects both galactic and extragalactic in origin. In addition, X-ray variability of different characteristic forms has been found; some sources are analogous to the radio and optical pulsars. The general cosmic X-ray background, as well as the point sources need further study in order to elucidate the emission mechanism and the cosmological significance of these objects. Specific objectives are the detection of additional sources, spatial mapping of the background accurate positional determination, and correlation with optically identifiable objects. These objectives are met by supporting laboratory studies, flight programs, and theoretical work. Research and development of advanced detectors, shielding systems, and focusing optical systems are being conducted. Data processing methods are being refined.

W78-70390

188-46-60

Goddard Space Flight Center, Greenbelt, Md
THEORETICAL HIGH ENERGY ASTROPHYSICS
R. Ramaty 301-982-4715
(188-46-56)

The objectives are: (1) to conduct theoretical research in high energy astrophysics with particular emphasis on areas of interest to the general program of the Laboratory for High Energy Astrophysics, (2) to provide support for graduate students and research associates from the University of Maryland to participate in research leading to doctoral dissertations and other publications in theoretical astrophysics, (3) to publish in the scientific literature the relevant and significant results obtained from research carried out by members of the group; and (4) to provide theoretical support for satellite experiments and mission definition studies, conducted both with and outside the Laboratory for High Energy Astrophysics. The theoretical group in the Laboratory for High Energy Astrophysics consists of two civil service employees (R

Ramaty and L. A. Fisk), one National Academy Research Associate (B. Smith, 1975-77), one graduate student (R. Bussard), and one research associate (T. Bai). Members of the group have maintained a high level of theoretical expertise in high energy astrophysics and have contributed and kept abreast with new developments in this area of astronomy. In particular, high energy spectroscopy, both in the X-ray and gamma ray regions is emphasized. Using the expertise, members of the group provide theoretical support to the various experimental programs of the Laboratory. They also advise graduate students at the University of Maryland.

W78-70391

188-48-51

Marshall Space Flight Center, Huntsville, Ala
INTERDISCIPLINARY SPACE SCIENCE RESEARCH
C R O'Dell 205-453-3033

The objective is to conduct space science research in various scientific and technical disciplines related to the astrophysics programs of NASA, to provide a quick-reaction capability of supporting research tasks unforeseen or which encounter unexpected difficulties, and which enhance the in-house scientific capabilities of the NSFC. Under the direction of the associate director for science, research is initiated in astrophysics-related scientific and technical areas that support the scientific missions of the Center. Research tasks selected for funding under this RTOP will contribute to the advancement of in-house capabilities and the state-of-the-art.

W78-70392

188-78-51

Goddard Space Flight Center, Greenbelt, Md
ADVANCED TECHNOLOGICAL DEVELOPMENT, GENERAL: SIGNAL AND DATA PROCESSING ELECTRONICS; SOLID STATE DETECTORS
James H. Trainor 301-982-6282

The objectives of this research project are to develop and test new onboard signal handling, data processing, storage, computing, and auxiliary electronics circuitry for use in energetic particle and astrophysics experiments on spacecraft, rockets, balloons, etc., as well as special test and analysis equipment applicable also for both ground and shuttle usage. The growing complexity of experiments and the often corresponding increase in the volume of data obtained have made signal handling, data processing, and data transmission capability-limiting factors. To reduce the transmission of unnecessary data, it is necessary to increase the experiment's onboard signal handling and data processing capability. This program is approached through: (1) the investigation and development of new techniques for signal shaping and handling, data processing, and auxiliary circuitry, and (2) the modification of existing techniques by the application of advanced technology and materials including MOS/LSI technology, thick film techniques, and multiple chips techniques. The technical objective of the research project is to conduct a program of research and development, and device test and evaluation in the field of silicon and germanium nuclear radiation detectors with emphasis on: (1) the improvement of detector technology, (2) the understanding of the radiation damage effects on device operation and lifetime, (3) the understanding of the effects on these detectors of chemicals commonly used near or on spacecraft, (4) to establish the technology for the fabrication of specialized devices not available from industry, and (5) to continue the pragmatic life testing.

W78-70393

188-78-51

Marshall Space Flight Center, Huntsville, Ala
LOW GRAVITY SUPERFLUID HELIUM ADVANCED TECHNOLOGY DEVELOPMENT
Richard A. Potter 205-453-3431

Several experiments are currently being developed which will require a low temperature environment for their proper operation in space. Superfluid helium will undoubtedly be used for many of these applications. Immediate application to experiments are to be found in cosmic ray, relativity and infrared astronomy. The purpose of this RTOP is to investigate theoretically and experimentally, where possible, the properties of superfluid helium to be expected when liquid helium dewars are flown into space. The properties of superfluid helium in this near zero gravity

environment will be assessed and methods will be investigated whereby problem areas may be resolved and/or controlled. The goal of this effort is to support the development of liquid helium dewar technology for space.

W78-70394

188-78-56

Goddard Inst for Space Studies, New York

DEVELOPMENT OF A THIN-FILM JOSEPHSON-JUNCTION FOR MILLIMETER AND SUBMILLIMETER WAVELENGTH APPLICATIONS

A R Kerr 212-678-5562
(405-02-02)

The purpose of this RTOP is to support the fabrication of thin-film Josephson-junctions in the Physics Department of the State University of New York, as part of a collaborative development of Josephson-effect far-infrared detectors with the Goddard Institute for Space Studies. Thin-film Josephson-junctions will be developed suitable for use in coherent detectors at millimeter, submillimeter, and far-infrared wavelengths. A detector using such a Josephson-junction will have two important advantages over existing Schottky-diode mixers: (1) it will be an order of magnitude more sensitive, and (2) it will require a local oscillator with five orders of magnitude less power. The latter feature is particularly significant in this wavelength range where local oscillators with sufficient power for diode mixers are either very expensive or not available. The development of these Josephson-junctions will provide the basis for a new generation of remote sensors for astronomy, meteorology, and space communications. Electron-beam lithography will be used to produce Josephson-junctions having particular characteristics required for millimeter and submillimeter wave detectors. This technology has recently been applied with great success to the fabrication of low-frequency Josephson effect devices (SQUIDS), and its extension to produce devices of high impedance level, low capacitance, and geometry appropriate for incorporation into submillimeter wavelength circuits, is expected to be straightforward. The crucial factor in this work is the technique for making sub-micron geometries with high reproducibility, which is now available to us.

W78-70395

188-78-60

Goddard Space Flight Center, Greenbelt, Md

GAMMA RAY ASTRONOMY OBSERVATORY

Marius Weinreb 301-982-6849

The objective of the Gamma Ray Astronomy Observatory (GRAO) is the study of the most energetic photons originating in our galaxy and beyond. These photons provide the most direct means of studying the largest transfer of energy occurring in astrophysical processes. Specific studies will include the dynamic high energy processes occurring in compact objects, examination of supernovae to determine if there was nucleosynthesis, a search for gamma ray point sources and their properties, ray bursts, and the detection and examination of other galaxies. A definition project will be established within GSFC to carry out the system definition phase activities. These activities will include in-house and contracted studies to prepare the GRAO Project for the execution Phase. At the conclusion of the definition phase a project plan will be submitted to headquarters.

W78-70396

188-78-60

Marshall Space Flight Center, Huntsville, Ala

ADVANCED MISSION STUDY - 1.2 METER X-RAY OBSERVATORY

James O Ballance 205-453-3431

The 1.2 meter X-ray Observatory will provide a means to make X-ray observations to study stellar structure and evolution, large scale galactic phenomena, the nature of active galaxies, and rich clusters of galaxies of cosmology. The 1.2 meter telescope will extend these observations to the coronas of main sequence and giant, late type stars, and to peculiar stars. It can resolve clusters of galaxies at extreme distances. This initial study will develop the necessary design for a long life (approximately 10 years), high angular resolution (approximately 0.5'), greater sensitivity grazing incidence telescope facility. This large free flying spacecraft will be designed for refurbishment and replacement of instruments as well as the supporting subsystems. Specific

major trade activities will include the optical design parameters, surface materials and fabrication techniques, image plane alignment, etc. Support modules to provide basic requirements such as those developed for the Space Telescope on the Multi-Mission spacecraft will be considered for the observatory.

Lunar Science

W78-70397

195-21-03

Ames Research Center, Moffett Field, Calif

IMPACT CRATERING EXPERIMENTAL STUDIES

V R Oberbeck 415-965-5496
(383-21-02)

The objectives are: (1) to study scaling laws and trajectories of debris ejected from impact craters formed in various targets; (2) to understand impact crater formation and emplacement of crater deposits on various planetary surfaces; and (3) to study the origin of rings of large lunar basins. The Ames vertical gun impact range will be used. A plate dissector is used with a high speed camera to record trajectories and velocities of fragments ejected throughout crater growth and to establish points of origin and deposition of ejecta. Special layered targets are impacted to study the origin of lunar and terrestrial impact melts, and to study the origin of rings of large lunar basins.

W78-70398

195-21-04

Ames Research Center, Moffett Field, Calif.

CHEMICAL AND ISOTOPIC STUDIES OF METEORITES

T E Bunc 415-965-5909

Major bulk chemical compositions, mineralogical data, element distribution patterns, grain morphology and crystal structure studies of carbonaceous chondrites and basaltic achondrites are to be continued and integrated with planetary IR spectra and solar system circumstellar dust data for modeling studies. The data will be used to improve the physico-chemical basis for testing and expanding theories on meteorite origin, planetary surface formation, and dust formation. Work will be continued on in-hand meteorite specimens (12 howardites and 4 carbonaceous chondrites), in addition to new samples (one howardite from the newly acquired Antarctic collection and xenolithic carbonaceous (Cc) inclusions in the Jodzie howardite). Electron microprobe, laser microprobe, X-ray diffraction, isotopic analyses, petrographic studies and scanning electron microscope (SEM) observations will be carried out to obtain data that will augment that obtained previously to permit refinement and testing of empirical models.

W78-70399

195-22-02

Goddard Space Flight Center, Greenbelt, Md

THEORETICAL STUDIES

J A O'Keefe 301-982-4445

Critical studies are made on problems of planetology. This field has grown very rapidly in the past 10 years, some generally accepted doctrines in the field have never been scientifically demonstrated. Among these are the propositions that: (1) The planets formed by accretion (some may have been formed by fission). (2) Most craters on planets other than the earth were impact-produced (possibly by volcanoes). (3) Mare-like areas (presumably lava flows) are filling basins formed by impact. (The mare lavas themselves may have depressed these areas). (4) Homogeneous glasses can be produced by meteorite impact on a planetary surface. (This is irreconcilable with the principles of glassmaking.) Included in this field are studies of planetary volcanic processes, planetary fission, planetary isostatic response mechanisms, and the application of glass technology to the formation of natural glasses. Special emphasis is placed on problems related to the origin of the planets. This effort will be stopped at the end of FY-77.

W78-70400

195-23-01

Jet Propulsion Lab., Calif Inst of Tech., Pasadena

EARTH BASED LUNAR OBSERVATIONS

R. S Saunders 213-354-3815

OFFICE OF SPACE SCIENCES

This proposal consists of four tasks aimed at investigating lunar chemical and physical properties using a variety of ground-based techniques. (1) lunar multispectral imaging this task utilizes the silicon imaging photometer system (SIPS) to acquire multispectral data of lunar regions. The basic objectives are to study the variation of surface composition parameters and soil maturity, to relate these to lunar stratigraphy and correlate spectral data with other orbital and ground based data sets to solve lunar problems, such as mare basalt composition variation with time and the distribution of anomalous materials such as KREEP rich soils. A large part of the effort is directed toward exploring data handling and display techniques designed to make optimal use of spectral data in synthesis. (2) near infrared lunar imaging this is a task involving the use of a variety of techniques to obtain near infrared lunar images, including line scan techniques and the modification of an existing CCD (charge coupled device) camera for lunar observations. (3) Microwave observation of the moon the scientific objectives of the proposed work are three fold (1) assess the global (front side) uniformity of heat flow rate, (2) assess the global uniformity of several thermophysical and electrical properties of the lunar regolith, and (3) reconcile the current best estimates of regolith properties with new measurements of the shape of the brightness temperature lunation curve at several wavelengths. (4) ALSEP/Quasar VLBI: The objective of this RTOP is the acquisition of intercontinental delta VLBI observations between lunar ALSEP transmitters and extragalactic radio sources. The ALSEP-quasar observations employ a four antenna technique in which the differential phase is obtained with no integer cycle ambiguities by continuous observations of both extragalactic source and a number of ALSEP transmitters on the lunar surface.

W78-70401 195-23-03
Jet Propulsion Lab., Calif Inst of Tech., Pasadena
LABORATORY SIMULATION
R S Saunders 213-354-3815

The purposes of this study are to compare the surface properties of solar system objects of lunar size, and to compare the processes (including interactions with the space environment) which affect the properties. The objective is to decipher the history of formation of the bodies and development of their surfaces as represented by their surface chemical and mineralogical composition. The approach will be to develop the necessary laboratory data that can be used to better interpret astronomical observations of those solar objects that are similar in size to the moon or smaller. The moon serves as an important bench-mark for comparison because the techniques available for studying the surface properties of objects have been developed largely through remote astronomical studies of the moon followed by in situ verification by Surveyor and Apollo missions. The proposed studies include (1) a laboratory study of the spectral reflectance and luminescence properties of candidate rock and mineral phases for the surfaces of outer planet satellites with emphasis on evaporites and other volatile-rich phases, (2) laboratory studies of the effects of proton irradiation and impact vitrification on the optical and chemical properties of evaporite and volatile-rich phases; and (3) comparison of the surface evolutionary histories of various satellites as evidenced by interpretation of optical telescopic data of these bodies.

W78-70402 195-23-06
Jet Propulsion Lab., Calif Inst of Tech., Pasadena
ADVANCED EXPERIMENT CONCEPTS
R S Saunders 213-354-3815

The objective of this program is to undertake scientific studies and long lead time engineering development in anticipation of an opportunity to chemically map the entire surface of planetary bodies such as the Moon, Mars and Mercury, from spacecraft placed in a close polar orbit. The experiment is also viable for comet and asteroid rendezvous missions. Reference points include the results of the Apollo 15 and 16 gamma ray experiment. This program is designed to establish the scientific potential and design requirements of gamma ray spectrometer built around a high resolution Ge detector, and to develop state of the art subsystems in order to respond to relevant flight opportunities

that can be used at other planetary bodies in addition to the Moon

Planetary Astronomy

W78-70403 196-41-50
Goddard Space Flight Center, Greenbelt, Md
GROUND-BASED INFRARED ASTRONOMY
V. G Kunde 301-982-5693

Ground-based measurements of Venus have been obtained with a Michelson interferometer in the 400-500 cm⁻¹ and 750-1200 cm⁻¹ regions with a spectral resolution of 0.2 cm⁻¹. Evident in the spectra are numerous CO₂ molecular absorption lines and several diffuse absorption features in the 850-1200 cm⁻¹ region. Preliminary interpretation of the diffuse features from the observed continuum, using homogenous model atmospheres, and considering only absorption, is consistent with a 75% solution of H₂SO₄ for the composition of the clouds of Venus. The scientific objective of this research is to develop a more complete understanding of the state of the Venusian atmosphere in the region above 200 mb. This will be accomplished by developing a more physically realistic radiative-transfer model for line formation including scattering in an inhomogeneous model atmosphere. Specific questions to be addressed with this model include more precise determinations of the cloud chemical composition, particle size distribution, and scale height, as well as a reconsideration of the atmospheric temperature profile.

W78-70404 196-41-51
Goddard Space Flight Center, Greenbelt, Md
RADIO AND RADAR PLANETARY STUDIES
J K Alexander 301-982-5461

The objective of this program is to obtain information on the nature, extent, and dynamical behavior of planetary magnetic fields, trapped radiation belts, and magnetospheres by studying the nonthermal radio emissions from the planets. The major approaches to this investigation are synoptic observations of Jupiter's decametric radiation via a global network of monitoring instruments and theoretical analyses of the generation and propagation of nonthermal radiation in a planetary magnetosphere. The Jupiter Monitor Network is providing unique data relative to the rate and stability of the magnetic field rotation, energetic particle trapping and precipitation processes, and the physics of satellite-plasma interactions in the magnetosphere, and correlative data both for other ground-based observations and fly-by in-situ measurements. The major emphasis in the coming year will be on full time operation of the four-station monitoring network in support of flight radio measurements from the Voyager spacecraft and on detailed analysis of new merged data catalogs compiled from the long series of joint decametric measurements obtained by the NASA network, the University of Florida, the University of Texas, and the University of Colorado. This study, utilizing the most comprehensive data set ever assembled, will seek to understand the behavior of relatively weak Io-independent emissions and to determine reliably whether there are solar wind correlations with the occurrence statistics.

W78-70405 196-41-52
Goddard Space Flight Center, Greenbelt, Md
IMAGING STUDIES OF COMETS
J. C Brandt 301-982-4701

This RTOP provides for the operation of a small high altitude observatory, Joint Observatory for Cometary Research (JOCR), for imaging research on comets and their interactions with solar radiation and the solar wind. In addition, if a suitable bright comet appears radio observations will be made with existing national facilities. The existing site in central New Mexico is one of the best dark sites left in the continental U.S. Extensive photography of comets Kohoutek, Kobayashi-Berger-Milon, and West has been carried out. These photographs show extensive features in the plasma approximately 0.1 au from the head which have been analyzed for phase speed and estimates of the tail magnetic field. Recently, we have convincingly associated

a structure in comet Kohoutek on January 20, 1974 with a specific excursion in the polar solar-wind speed; this is a first. The Physical Sciences Committee Report on Supporting Research and Technology and Data Research (May 1976, p. 69) notes that the JOCR has 'considerable potential at modest cost,' a fact supported by the 'possibility of a cometary flight mission in the 1980's'.

W78-70406**196-41-54**

Goddard Space Flight Center, Greenbelt, Md

ADVANCED INFRARED ASTRONOMY AND LABORATORY ASTROPHYSICS

Michael J. Mumma 301-982-6994

(188-41-52; 198-20-01, 185-47-55)

The objectives 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/MM 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 spatial distributions, and (5) ambient gas densities, and to carry out comparative studies of these objects. The physical information we seek is contained in the intensity profiles of isolated spectral lines and can be obtained by inversion of the observed line shapes. The measurement of spectral line shapes has recently become a tractable problem at IR wavelengths, and line shapes can now be measured by infrared heterodyne spectroscopy and by mm-wave coherent spectroscopy. The approach is to develop and employ coherent detection line receivers for use in the infrared and millimeter wavelength regions. The infrared front end has been built for use with gas lasers or semi-conductor diode lasers as local oscillators and HgCdTe photo-mixers, while the mm-wave front end features Klystron local oscillators and Schottky diode mixers. Both feed into a GSFC standard spectral line receiver which analyzes, displays, and outputs the spectral lines. Initial observations with these systems have been from the ground but both systems have been developed with an eye toward flight on the NASA C-141 and in space.

W78-70407**196-41-67**

Ames Research Center, Moffett Field, Calif

PLANETARY ASTRONOMY AND SUPPORTING LABORATORY RESEARCH

R. W. Boese 415-965-5501

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, which are needed to evaluate the possibilities of life on the planets and to design systems for exploratory missions and for the preparation of evolutionary models of planetary interiors. 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 absorption line and band intensities, absorption line half-widths, vibration-rotation interaction constants, and line pressure induced shifts and absorption. The dependence of these parameters on pressure and temperature will be obtained by using long path gas cells, cooled and heated gas cells, and high resolution spectrometers and interferometers operating primarily in the infrared. Spectra of the planets and their satellites will be obtained by using airborne and ground-based telescopes and will be analyzed to obtain information about the composition and structure of their atmosphere and the composition of their surface.

W78-70408**196-41-71**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GROUND-BASED OPTICAL ASTRONOMY

W. T. Huntress 213-354-3238

The general objective of the ground based optical astronomy task is a comprehensive astrophysical study of planets and their satellites by means of ground based observations at visible and near infrared wavelengths (approximately 0.3 to 2.0 micron). This task consists of several subtasks as follows: (1) Planetary spectroscopy, to investigate the physical and chemical properties of the upper tropospheres of Venus, Jupiter, Saturn, Uranus, and Neptune through high resolution astronomical spectroscopy; (2) Io sodium D-line patrol, to investigate the temporal and spatial behavior of the NA D-line emission from the Jovian satellite Io (J-1) through a synoptic program of spectroscopic observations; (3) Io spectroscopy, to investigate the physical state and bulk motions of the neutral sodium cloud associated with Io, through a variety of advanced high resolution spectroscopic techniques. In addition to these primary subtasks, the ground based optical astronomy task provides limited operational support (equipment maintenance and set-up, observing assistance) at Table Mountain Observatory (TMO) to programs supported from other sources. Among such programs are: (1) natural satellite patrol, which provides raw positional data on the satellite systems of Jupiter and Saturn; (2) lunar multispectral imaging; (3) outside observers from the academic community who use the TMO optical astronomy facilities from time to time.

W78-70409**196-41-72**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GROUND-BASED INFRARED ASTRONOMY

W. T. Huntress 213-354-3238

The objective of this program is to understand the physical and chemical state of planetary atmospheres by means of chemical and isotopic abundance analyses as determined by remote sensing methods in direct support of on-going and planned planetary missions. The principal approach employed is that of high resolution, near infrared (1-6 micrometer), astronomical spectroscopy using a Connes-type Fourier spectrometer at the coude focus of the 2.7 m telescope, McDonald Observatory (University of Texas). However, analysis of the resultant spectra also involves substantial efforts in model atmospheres, radiative transfer, spectrum synthesis and laboratory infrared spectroscopy. Furthermore, since we continually seek new and better methods for enhancing our understanding, we make a point of becoming involved as investigators on a number of solar system missions and related projects.

W78-70410**196-41-73**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

RADIO AND RADAR PLANETARY STUDIES

W. T. Huntress 213-354-3238

The ongoing objective of the task is to conduct comprehensive studies of the atmospheres, magnetospheres, and surfaces of planets and their satellites. Theoretical models are constructed and radio astronomical observations are made to test the models and provide input for theoretical refinements. Primary interest is currently focused on Venus, Mercury, and the four major planets and their satellites. The observational experiments are conducted at JPL's Table Mountain Observatory (TMO), the Deep Space Network Tracking Stations, Caltech's Owens Valley Radio Observatory and other observatories as required by specific needs of the program. Research programs at these facilities are planned in order to take full advantage of the unique capabilities of the individual systems, especially the new 36 GHz interferometer at TMO and the 64-m antennas and advanced low noise receivers at the DSN stations. The objective of the DSIF radar astronomy task is to obtain radar data on the planets for determining properties of their surfaces, orbits and spins, with Venus, Mercury, Mars, Saturn's rings and Jovian Satellites as prime goals. This work employs the unique facilities of the DSIF, and exploitation of synthetic aperture techniques. The objectives of a third task are to design, construct, and maintain advanced microwave and millimeter radiometer systems and associated digital systems for use at the Table Mountain, Goldstone, Owens Valley and other radiotelescope facilities that are used by the group.

W78-70411**196-41-75**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

GROUND-BASED LARGE INFRARED TELESCOPE SUPPORT

OFFICE OF SPACE SCIENCES

R E Covey 213-354-5590

The objectives of this RTOP are to provide NASA Headquarters with reviewing, monitoring, and consultive support on the Infrared Telescope Facility (IRTF) Project Overall management and subcontracting responsibility is assigned to the University of Hawaii JPL will provide, when requested by the Spaceflight, Science, and Support Facilities Division (BXE), monitoring and consulting support to that office This support includes but is not limited to review of documentation furnished by UH for approval JPL is to provide a JPL detailee as Project Manager to the University of Hawaii for a period of approximately three years beginning January 1976 The Project Manager detailee reports to and is responsible directly to the Director of the Institute for Astronomy (DIA), University of Hawaii, for the project as a whole As Project Manager, he is responsible for the overall control of all day-to-day activities of the project He organizes and supervises the activities of a specially organized Project Office and provides a direct interface between NASA, KPNO, ITDC, JPL, and Change Control Board He has direct responsibility for the day-to-day management and operation of the Project He directly supervises all the project-related work of the Project Office staff in addition to such regular Institute staff members as may be designated by the DIA to work fully or in part on the project.

W78-70412

196-41-76

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

COMETS AND ASTEROIDS

R S Saunders 213-354-3815

This RTOP contains two tasks to further the understanding of asteroids, their origins, compositions and relationships to other planets and satellites (1) Physical properties of asteroids, this task is an observational and theoretical study of compositions, spectral albedos and histories of comets and asteroids Plans are to accelerate the survey of asteroids at mid-infrared wavelengths (1.65 and 2.3 micron) as earlier data confirmed the great value of these observations to compositional classification and the study of asteroid surface morphology and processes (2) Origin of asteroids and small bodies The broad objectives of this task are to understand the morphology of the belt, identify and study the fragments of asteroid collision events called families, investigate the orbital evolution of special objects, understand the means by which asteroid collision debris may reach the earth, and provide support for the study of asteroids passing near the earth The studies of belt morphology and asteroid families previously performed can be extended to objects discovered since that study. Certain families, particularly those showing internal structure, deserve more detailed studies than have been carried out to date The dynamical evolution of unusual orbits can be studied through numerical integration Resonances will be the principal subject studied One type of resonance is being studied for its possibilities in delivering asteroidal collision debris to the earth as a source of meteorites Rapid orbit determination and ephemeris support will continue to be supplied to the Palomar search for close earth-approaching asteroids so that the physical properties of these objects can be studied during their brief periods near the earth

Upper Atmospheric Research

W78-70413

198-10-04

Ames Research Center, Moffett Field, Calif.

INSTRUMENT SYSTEMS FOR MEASUREMENT OF TRACE GAS CONSTITUENTS IN THE STRATOSPHERE

I G Poppoff 415-965-5027

The objective is to develop, flight test, and utilize airborne instrument systems for measurement of important gas species in the stratosphere. Several multiple species instrument systems for making accurate measurements of the minor gas constituents in the stratosphere are being developed for integration onboard aircraft and balloon platforms The ability to make coordinated simultaneous measurements on a routine basis is being empha-

sized. Techniques such as chemiluminescence, UV spectroscopy, and IR spectroscopy are being employed. Goals will be to study the geographic and seasonal variations of the measured species and respond to and participate in cooperative stratospheric rendezvous and collaborative experiment

W78-70414

198-10-05

Ames Research Center, Moffett Field, Calif

STRATOSPHERIC AEROSOL CHEMISTRY AND PHYSICAL STATE

N H Farlow 415-965-5493

(175-40-10)

Experimental and theoretical evidence suggests various fragile nitrogen compounds may exist in stratospheric aerosol particles. These compounds may exist in stratospheric aerosol particles. These compounds may link the odd-nitrogen chemistry with the sulfur chemistry to provide a mechanism whereby trace nitrogen compounds are removed from the stratosphere via sulfate particulates In addition, tropospheric materials, possibly derived from sea salt reactions, may be penetrating into the stratosphere in the intertropical convergence zone and perhaps elsewhere In quiet periods, devoid of major volcanic eruptions, these materials may dominate the particulate composition Identification of nitrogen-sulfur compounds and the intruding tropospheric materials can provide needed information about the chemistry of the lower stratosphere, the influence of these aerosols on other trace constituents, and troposphere-stratosphere exchange processes Three coordinated tasks will enable the collection of upper atmospheric aerosols by U-2 aircraft and balloons from 12 to 40 km at different geographic regions (1) Special devices will preserve the collections in their unchanged state so that fragile compounds can be identified in the laboratory (2) In situ methods will provide means for determining physical state at altitude. (3) Unique collecting surfaces will isolate insoluble fractions in the aerosol particles for subsequent analyses to deduce their possible tropospheric origin The combination of these already demonstrated techniques will reveal the detailed chemical composition, physical state, sizes (including Aitken nuclei) and probable origins of stratospheric aerosols

W78-70415

198-10-06

Ames Research Center, Moffett Field, Calif

DEVELOPMENT OF NEW INSTRUMENT SYSTEMS FOR DETECTION OF TRACE CONSTITUENTS IN THE STRATOSPHERE

I. G. Poppoff 415-965-5027

The objective is to develop new airborne instrumentation to measure trace gas constituents in the stratosphere This includes performing applied research necessary to develop fundamental principles and sensor techniques to a level of feasibility for making routine in-flight measurements A study of many new techniques for measuring trace gas constituents in the stratosphere has been in progress for several years This study has yielded promising results for several species such as the halocarbons, methane, chlorine compounds, and hydroxyl radicals Airborne systems based on these techniques are being developed for in situ measurements

W78-70416

198-10-06

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

STRATOSPHERIC RESEARCH, FIELD MEASUREMENTS PROGRAM

W T Huntress 213-354-3238

(176-10-51)

The primary objectives of the stratospheric field measurements program at JPL are to respond within present capabilities as quickly as possible to the need for concentration measurements of species deemed critical to stratospheric stability by the NASA Office of Upper Atmospheric Research and to continue to develop the instrumentation and experimental techniques in those areas where more sensitive or extended measurement capabilities are needed In addition to the individual measurements to be made by the JPL instruments, a major objective for the current fiscal year is to bring several of them together to make simultaneous measurements of one or more of the families of species which are currently considered to play vital roles in stratosphere ozone

chemistry. At least five distinctive methods for making these measurements will be employed. They comprise high resolution spectroscopy in the near- and middle-infrared spectral region, laser heterodyne radiometry at mid-infrared wavelengths, pressure modulator radiometry at selected infrared wavelengths, microwave and submillimeter radiometry, and optoacoustic (spectrophone) techniques. This complement of instruments will measure HCl, ClONO₂, ClO, HNO₃, N₂O, NO₂, NO, H₂O, H₂O₂, O₃, CH₄, CH₃Cl, CFCI₃, CF₂Cl₂, and possible HO₂NO₂ and N₂O₅. In several instances, species concentrations will be measured by more than one instrument, allowing for cross correlation of the measurement techniques, diurnal variation in ClO, ClONO₂ and certain other species will also be measured. The participation of non-JPL investigators in the flights, to measure such quantities as the OH concentration and the solar flux, will be solicited.

W78-70417**198-10-06**

Lewis Research Center, Cleveland, Ohio

GLOBAL ATMOSPHERIC SAMPLING PROGRAM (GASP)

D. A. Petrash 216-294-6684

The concentrations of various particulate and gaseous species in the region of the atmosphere between 6.1 and 13.7 Km are being measured by employing sampling devices on 747 commercial air transports. These measurements will be used to establish baseline data on the contaminants in the atmosphere in order to deduce the contribution of jet aircraft and other anthropogenic sources to upper atmosphere pollution. Components to be measured include carbon monoxide, oxides of nitrogen, ozone, water vapor, chlorofluoromethanes (CFM's), condensation nuclei, total particle count and size distribution, and anions collected on filter samplers. Statistical studies of the data base will be made to acquire sufficient understanding of the physical transport and chemical processes occurring in the altitude range sampled in order to accurately model the upper atmosphere. The models in turn can be utilized to predict the effects of jet engine exhaust and other pollutants on the stratosphere.

W78-70418**198-10-10**

Ames Research Center, Moffett Field, Calif.

AIRBORNE PLATFORM SUPPORT FOR STRATOSPHERIC SAMPLING PROGRAM

I. G. Poppoff 415-965-5027

(198-10-04, 198-10-06, 176-10-11)

The objectives are to define, plan, organize and support observational programs requiring airborne platforms. With the use of experiment working groups, important observational needs will be defined and guidelines will be prepared for experiments that require airborne platforms. The necessary missions will then be planned and organized by Ames personnel and the participants will be selected by Headquarters. Multiexperiment missions will be managed by Ames personnel using the guidelines prepared by the working group. Experiment plans, progress and results will be reviewed by the working group through a series of workshops. Data will be made available to all interested scientists.

W78-70419**198-20-01**

Goddard Space Flight Center, Greenbelt, Md

UPPER ATMOSPHERE RESEARCH PROGRAM

Spencer N. W. 301-982-5001

The principal goal of this Upper Atmosphere Research Program is to develop an organized, solid body of knowledge of the physics, chemistry, and transport processes in the stratosphere and mesosphere. The several objectives leading to the overall goal of the program, and the approach to be taken, are to (1) determine the specific local chemical and physical interactions in the atmosphere by a combination of theoretical studies and coordinated in-situ measurement campaigns from balloon, rocket, and aircraft platforms, (2) investigate the variations and perturbations of the chemical and physical state of the atmosphere, i.e. variations with altitude, solar conditions, season, latitude, and perturbations from volcanoes, tropical storms, industrial and agricultural activity (by combined theoretical studies and experimental investigations involving instruments at various balloon and rocket launch sites and from aircraft and long-duration balloons) (3) develop and calibrate selected instruments for local

and remote investigations of the atmosphere (undertaken during the experimental program), and (4) study the physical and chemical processes of the whole atmosphere, the global distributions, transport, seasonal and long-term variations of the atmosphere and determine the cause-effect relationships of these variations (The main measurements program for this objective ultimately use dedicated satellites)

W78-70420**198-20-03**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

LABORATORY MEASUREMENTS/STRATOSPHERIC RESEARCH

W. T. Huntress 213-354-3238

A program of laboratory studies related to stratospheric research will be conducted in the following areas: (1) kinetics of stratospheric reactions, (2) kinetic studies and development of advanced laboratory methods, (3) data survey and evaluation, (4) photochemical studies, (5) analysis of atmospheric reaction schemes, and (6) ionic processes in the upper atmosphere. The program will be designed to provide data needs and guidance for both chemical models and field measurements. Primary emphasis will be on the acquisition of kinetic data including reaction rate constants, temperature dependences, and product formation. Photochemical quantum yields, absorption cross sections, and product distributions will be measured. A broad base of data knowledge in all the foregoing areas will be maintained through literature surveys and through contact with other groups active in these areas. Atmospheric reaction schemes will be examined both experimentally and analytically for possible errors or omissions. A program of laboratory studies will be conducted on ionic processes in the upper atmosphere.

W78-70421**198-30-02**

Ames Research Center, Moffett Field, Calif.

STRATOSPHERIC RESEARCH

I. G. Poppoff 415-965-5027

The objectives are to (1) understand the composition, structure, and dynamics of the Earth's stratosphere and mesosphere, and the important chemical and physical processes which occur there, (2) assess the effects on important stratospheric properties (e.g., ozone abundance and radiation balance) of man-caused and natural perturbations, and (3) collaborate with the academic community to advance new model development. Several types of chemical and dynamic models of the stratosphere have been or are being developed to provide improved descriptions of the complex processes which occur in the upper atmosphere. These models, which are each addressed to specific types of problems, contain varying degrees of complexity with respect to chemistry and atmospheric motions. Development will continue such that each one is optimized according to its potential applications to fundamental and applied problems. Collaboration with scientists in the academic community is continuing.

W78-70422**198-30-03**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

THEORETICAL STUDIES/STRATOSPHERIC RESEARCH

W. T. Huntress 213-354-3238

A program of theoretical studies related to the upper atmospheric (stratospheric-mesospheric) research will be conducted in the following areas: upper atmospheric energetics, and the thermal responses of the stratosphere and mesosphere to solar variabilities and magnetospheric storms, and atmospheric dynamical studies. The program is designed to provide a sound body of knowledge needed to understand two pressing problems on the current frontiers of upper atmospheric research, viz., the possible role of the stratosphere and the mesosphere in the mysterious sun-weather/climate relationships, and understanding the influence of dynamical processes on the upper atmospheric photochemistry. A detailed study will be undertaken of the various sources and sinks of energy in the upper atmosphere properly taking into account several new relevant developments in the trace species chemistry. The improved model of the upper atmospheric energetics will then be used to investigate the nature of the changes in the upper atmospheric thermal structure, stability, and infrared feedbacks induced by solar EUV and corpuscular variabilities and by magnetospheric activities. The

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effect of variable mass transport and fluctuating temperature on the concentrations of photochemically important trace species will be studied

Life Sciences

W78-70423 199-51-04
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ADVANCED TELEOPERATOR TECHNOLOGY DEVELOPMENT
A. K. Bejczy 213-354-3124

The objectives of this plan are to develop technical information about remotely manned systems (RMS) and teleoperators so that shuttle based orbital space missions requiring the use of such systems can be planned and implemented with the required reliability performance, and economy. Specific objectives are to identify requirements, develop conceptual designs and breadboards, and determine the machine's and man's complementary roles in the operation of RMS and teleoperators including time delay requirements with emphasis on supervisory control. The approach is through experimental studies identifying the scientific and operational mission requirements and by developing the resultant necessary RMS and teleoperator functions. From the implied capability requirements for man and machine, the necessary technology developments for teleoperator systems and subsystems is derived. Required developments are defined and implemented experimentally using breadboard set-ups. The experimental studies will give insight into the functions to be performed by man or machine or both for remote explorations and operators. Function allocations will be made between man and machine for various communication time delay requirements, so that optimum system performance can be achieved and critical technology development requirements can be identified. New concepts of teleoperator systems and subsystems will be developed and breadboarded when appropriate and related feasibility studies will be conducted. Man-machine system performance evaluations will be conducted and performance criteria will be established. Emphasis is given to the concept of shuttle based flight experiments to give the work focus. The specific tasks are described in the attached NASA Forms T-41: remote manipulator system control and development; and audio-vocal man-machine interface. The tasks are aimed at developing technology advancing teleoperators toward semi-autonomous operations.

OFFICE OF TRACKING AND DATA ACQUISITION

Supporting Research and Technology

W78-70424 310-10-20
Goddard Space Flight Center, Greenbelt, Md.
DISTRIBUTED COMPUTATIONAL RESEARCH FACILITY
K. K. Tasaki 301-982-5076

The primary objective of this RTOP is to demonstrate the applicabilities of minicomputers, microprocessors and other small-scale processors to solving of various classes of flight dynamics problems. These classes of problems range from spacecraft ephemeris generation at user sites with specific accuracy and timing requirements to real-time and non-real time operational support for future missions. Most of these problems are currently solved by using large-scale computers (i.e., IBM 360/95 and 75) and rather generalized software systems (i.e., Goddard Trajectory Determination System). Under this RTOP, an attempt will be made to physically distribute some of these computing functions to user and support organization sites (i.e., experimenters, tracking stations, operations control centers, general users), using minicomputers, which are available at such sites, and microprocessors which are commercially available at low costs. In addition, the feasibility of providing operational support using only minicomputers and auxiliary processors will be demonstrated. The approach involves the development of a

distributed computational research facility with which the feasibility of achieving the two objectives can be demonstrated. Using the existing processors (an IMP-16 microprocessor and a PDP 11/70 minicomputer) as a basis, this research facility will be developed with one additional minicomputer and a number of microprocessors (up to five). Configuring these processors in an optimal manner, the new algorithms and new techniques developed under an on-going RTOP, Attitude-Orbit Analysis (RTOP 310-10-26), as well as currently available specifications which have been implemented on large-scale computers, will be implemented to demonstrate the applicability of these smaller processors.

W78-70425 310-10-22
Goddard Space Flight Center, Greenbelt, Md.
MISSION SUPPORT COMPUTING SYSTEMS AND TECHNIQUES
D. S. Woolston 301-982-5571
(310-10-26)

The objective of this RTOP is to ensure the availability of computing systems and techniques to meet the operational mission support requirements of forthcoming spacecraft missions. Orbit determination and propagation are major areas of emphasis. Ongoing studies include: the development and enhancement of efficient mission analysis tools for long range mission planning; development of techniques for on-board orbit estimation for autonomous navigation systems; the modeling and analysis of TDRS and GPS relay satellite systems as data sources for orbit estimation; and the definition of flight maneuver support requirements of shuttle payloads.

W78-70426 310-10-23
Goddard Space Flight Center, Greenbelt, Md.
SOFTWARE ENGINEERING FOR FLIGHT MECHANICS
F. E. McGarry 301-982-5048
(310-10-22; 310-10-26)

The major objective of this work is the development of software development methodologies in the flight mechanics area which will significantly reduce costs and enhance software quality and reliability. Many suggestions have been recently offered by computer scientists in the areas of software management, implementation and evaluation (e.g., chief programmer teams, structured design and coding, higher order languages, etc.). It is generally recognized that the most effective software engineering techniques selected for use in operational systems will depend on the operating environment and characteristics of the problems to be solved (e.g., onboard processing, near real-time operations, control computations, etc.). This work will therefore address the problem of evaluating software development methodologies in the following areas: (1) real-time on-board processing for attitude/orbit determination and control; (2) graphics aided near-real-time mini-computer processing of telemetry, tracking, and image data for navigation, and (3) batch processing. The approach will be to establish a software development laboratory in which software engineering methods can be tested in a realistic environment. The laboratory will consist of a government furnished minicomputer facility supported by structured design and implementation software (e.g., structured FORTRAN precompilers and other higher-order language processors) which will be used to implement applications software in the above cited areas. Based on criteria such as cost in man-hours, maintainability, reliability, minimum debugging time, and operational simplicity, various approaches to software development will be evaluated. The ultimate objective of this project will be the development of a methodology which will result in a higher quality software at a reduction in cost of between 30% to 50%.

W78-70427 310-10-26
Goddard Space Flight Center, Greenbelt, Md.
ATTITUDE - ORBIT ANALYSIS
E. J. Lefferts 301-982-5508
(310-10-22)

The objectives of this RTOP are to increase the efficiency and decrease the resources needed to meet the requirements for spacecraft missions by: (1) the use of new data types and their onboard processing to decrease the quantity and usage of

tracking and telemetry data for attitude and orbit determination and control, (2) the provision of generalized and flexible computing systems utilizing onboard and small ground computers to increase the speed of information flow to be used and to reduce the demand upon the central computer facility, and (3) by providing standardized sensor combinations, telemetry interfaces and computational algorithms suitable to meet the demands of changing computer environment to effect a reduction in the attitude and orbit determination software development cost. The approach involves the development of computational software to permit the analysis and evaluation of coupled attitude-orbit-landmark registration process. Such studies were started with simple attitude models. Extension to the use of wheel speed data and later to the use of gyro and star camera data will be made. The generation of efficient reliable algorithms suitable for minicomputer and onboard implementation of autonomous attitude and orbit determination and control will be continued. Attitude determination algorithms for onboard processing have been sized and timed for the NASA Standard Spacecraft Computer (NSSC). Extensions of the orbit processing to the consideration of GPS data will be made. Simulations of onboard processors with their fixed point arithmetical computations will enable the evaluation of developed algorithms and their software implementation.

W78-70428**310-10-42**

Goddard Space Flight Center, Greenbelt, Md
PRECISION TIME AND FREQUENCY SOURCES
 Victor S. Reinhardt 301-982-5946
 (644-03-15)

The objective of this RTOP is to develop improved frequency and time standards with a frequency stability of 10 to the minus 15 power at 10 to the 4th power s and with a frequency accuracy of 10 to the minus 14 power, to aid in the transfer of existing hydrogen maser technology to provide a contractor source of operational hydrogen masers, and to develop improved frequency and time distribution systems for meeting critical NASA applications, such as, optical and microwave range and range rate tracking, very long baseline interferometry, and the Space-lab Applications Facility. Task A involves operational hydrogen maser standards and will make it necessary to finish instrumentation for the Frequency Standard and Test Facility, evaluate performance of NX and NR hydrogen masers, and construct NRX masers with hybrid cavity and Teflon film storage bulb. Task B involves calibration standards. This work includes an accuracy evaluation of concertina maser, construction of zero wall shift maser, and construction of mercury ion frequency standard. Task C involves time and frequency distribution systems. It includes work needed to evaluate the performance of present distribution systems, identify weak elements and improved systems.

W78-70429**310-10-43**

Goddard Space Flight Center, Greenbelt, Md.
ADVANCED LASER RANGING SYSTEMS DEVELOPMENT
 T S Johnson 301-982-5538
 (161-02-01, 506-20-33)

The objective is the development, field test, evaluation and intercomparison of advanced prototype laser ranging systems to meet the requirements for economy, reliability and accuracy for these systems in the operational laser tracking network. The concepts of very low level signal detection systems using low power, high repetition rate short pulse lasers already demonstrated under this RTOP, a reliable low cost laser based on a space qualifiable laser being developed under OAST RTOP 506-20-33 and range timing subsystems under OA RTOP 161-02-01 will be combined to produce a system operating at low radiated energy levels and will offer reliability as well as low operating cost when deployed in the laser tracking network.

W78-70430**310-10-60**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
NAVIGATION ACCURACY ANALYSIS
 D. W. Trask 213-354-4878
 (310-10-61; 310-30-69)

DSN tracking system uncertainties limit spacecraft navigation capability. The current limit is about 100 km at Mars. A ten-fold

increase in required radio metric accuracy is anticipated for future outer planet missions. Hence, it is important to determine limiting uncertainties and possible improvements. The effects of the transmission media and uncertainties in platform parameters such as DSS locations, UT1, and polar motion, represent limitations for future missions, especially those to the outer planets. Methods of removing these limitations either by calibration or by utilization of less sensitive data will be developed and analyzed. Calibration techniques include the use of the S- and X-band dual frequency system for the charged particle component of the transmission media and the water vapor radiometer for the wet component of the troposphere. A VLBI system is being developed to reduce the uncertainties of the platform parameters. Also, data types are being developed which are less sensitive to the above limitations. They include the use of two stations to obtain differential VLBI data to measure the spacecraft position with respect to an extragalactic radio source and the use of a single station to track one spacecraft with respect to a second. This RTOP also develops tracking techniques to overcome other limitations such as those arising from the trajectory or spacecraft characteristics. Examples include multistation tracking where the differencing of simultaneous range from widely separated DSS is used to overcome the degradation of single station data for low declination spacecraft, and the differencing simultaneous Doppler is used to overcome unmodeled spacecraft forces. Also this RTOP provides for the analysis of navigation measurement needs in the 1980-1990 time frame. The value of advanced radiometric data types is to be established in terms of navigational performance. Planning of advanced systems will be supported. Economical ways of monitoring the spacecraft position during cruise are being analyzed, instantaneous angle measurement based only on transmissions from the spacecraft, is one such technique.

W78-70431**310-10-61**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
RADIO METRIC INSTRUMENTATION DEVELOPMENT
 R L Sydnor 213-354-2763
 (310-10-60; 310-20-65, 310-30-69)

The objective of this RTOP is to develop and demonstrate high quality instrumentation and efficient techniques for DSN radio metric data acquisition to support flight project navigation needs over the next decade for outer planet satellite, orbiter, and entry probe missions. Specific requirements are determined by RTOP 310-10-60 and include the following: (1) accurate frequency and time standards for differenced range and Doppler measurements, (2) VLBI instrumentation systems for interstation time synchronization and station location measurements, (3) improved group and phase delay stabilities and related tracking station equipment calibrations for accurate range, Doppler and VLBI measurements, (4) troposphere and ionosphere delay calibrations of radio metric data, and (5) instrumentation for flight project radio science support including precision occultation and relativity measurements. Specific instrumentation and techniques under development include: (1) hydrogen masers, nanosecond clocks and performance monitoring and control equipment, (2) a VLBI instrument for interstation time synchronization to 10 nanoseconds, and UT1/pole motion and station location measurements to 50 cm; (3) precision phase calibration of equipment to 1 nsec; (4) development of the water vapor radiometer technique as a means of measurement of the troposphere delay down to 2-3 cm, (5) studies of radio metric methods to improve Doppler to 10 cm over 10 hours and range to 30 cm for use in relativity verification experiments, (6) improved frequency standards for future mission and science requirements at the 10E-17 level, (7) high-speed design for accurate reduction of VLBI data in near real-time, and (8) development of advanced ranging and other metric data types to meet future requirements. A systems approach is being used in these developments to assure that balanced error contributions result and that efficient low life-cycle cost design approaches are utilized.

W78-70432**310-10-64**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
X-BAND UPLINK DEVELOPMENT
 R L Leu 213-354-5692
 (310-20-66, 310-30-68, 310-30-69)

OFFICE OF TRACKING AND DATA ACQUISITION

This RTOP developed an X-band radar capability to obtain operational experience at an X-band frequency, to prepare for an X-band uplink for flight project support and to obtain planetary data to assist in future flight project mission planning and design. A system gain of up to 7 dB over S-band radar is achieved on targets without a dense atmosphere, thus, better experiments can be conducted and information obtained on the rings of Saturn, Mercury, Mars, Jovian Moons, and asteroids. The operational experience gained using the radar as a test bed (RTOP 69) has proved that (1) 400 KW is obtainable at X-band in one waveguide, (2) the klystron and klystron protective circuitry is more critical at X-band, and a redesign of the present circuitry is mandatory, and (3) automatic self test, control and monitor are necessary for reliable operation of an X-band uplink. The objective in FY 78 is to improve the reliability and operability of the X-band uplink and to demonstrate this by supporting radar experiments on Jupiter, Mars and Saturn. The buffer amplifier will be redesigned and rebuilt to relieve the congestion of the high density packaging, to incorporate the automatic self-test of the high speed RF and arc protection circuits, and to improve its reliability. The test circuit will be used to verify, on a daily basis, that the arc detectors and reflected power protective circuits are operating within the required 10 microsecs. In addition, engineering labor shall be provided to participate in the hi-reliability, hi-power transmitter improvement project in 311-03 and 312-03. The task will be to (1) analyze past transmitter and klystron failures, (2) analyze existing protective circuits, and (3) develop a reliable protective circuit design. Starting in FY 79, utilizing the data obtained from the transmitter reliability improvement project, the 7.2 GHz uplink system will be developed. This shall include the transmitter, microwave, receiver, and coolant subsystems.

W78-70433

310-20-27

Goddard Space Flight Center, Greenbelt, Md NETWORK TIMING AND SYNCHRONIZATION TECHNOLOGY

A R Chi 301-982-2502

The objectives of this research are to study and develop techniques for time synchronization, to coordinate time determination methods and dissemination formats to meet NASA needs and network requirements, and to conduct theoretical investigations and experimental tests for network applications. The approach is the development of a worldwide time synchronization system through which time can be disseminated to the network users. A time word which is transmitted from a ground control station via the Tracking and Data Relay Satellite System (TDRSS) is used to transfer all time units in a self contained manner to resolve ambiguities from day of year to nanoseconds, the system resolution. The two-way time transfer technique, which was developed under a jointly sponsored program by NASA and the Federal Aviation Administration (FAA), is used to measure the propagation path delay. The reference clock from which time is coded as a data word for transmission via a satellite could be monitored and synchronized to the primary clock of the National Bureau of Standards (NBS) at Boulder, Colorado. The use of a standard time scale (e.g. UTC-NBS) would remove the need for post-time corrections during data processing.

W78-70434

310-20-28

Goddard Space Flight Center, Greenbelt, Md STUDY OF CONCATENATED CODES

John Rende 301-982-4677

The studies will be directed in the following aspects of error correcting decoding. (1) Since the Viterbi decoding algorithm is being used frequently for GSFC programs, this decoding scheme will be studied. Different communications channels will be subjected to various error patterns as these channels operate in conjunction with a Viterbi decoder. Having a prior knowledge of the data being communicated, the output of the Viterbi decoder will be observed for particular characteristics that may or may not correlate with given error patterns into the channels used. It is expected to perform these tests by means of computer simulations. (2) At the present time a concatenation scheme is being proposed for sophisticated error correction when needed. This scheme requires a Viterbi decoder for the 'inner' encoder

and a Reed-Solomon burst decoder for the 'outer' decoder. There is ample reason to believe that an inner generalized BCH decoder with a simple burst error corrector employed for the outer decoder can perform equally well in a concatenation arrangement. The latter arrangement will be fabricated and tested for performance data and compared with data available on the Viterbi - R.S. concatenation scheme.

W78-70435

310-20-29

Goddard Space Flight Center, Greenbelt, Md

WIDEBAND DATA TRANSMISSION AND SWITCHING FOR THE 1980'S

T. W. McDonald 301-982-6130

The objective of this RTOP is the development of wideband data matrix switches and transmission lines for the STDN of the 1980's. A substantial increase in spacecraft data rates is expected; data rates which the network is not now equipped to adequately handle. An example of this deficiency is the necessity of hardwiring with triaxial cable the MFR video output for support of LANDSAT. Here the support requirement is 15 Mbits/s. Future requirements could equal or even exceed 300 Mbits/s. Other examples of projects using high data rates are: SEASAT, Earth Observation Satellite (EOS) and TDRS. Current electronic data switching on the network is limited to 20 MHz bandwidth at best. Some matrices are limited to approximately 5 MHz bandwidth. Fiber optics and integrated optics are viewed as a method of providing wideband data transmission and switching capability. In particular, feasibility and techniques of utilizing fiber optics for transmission, and integrated optics for switching of wideband data will be investigated. Primary emphasis of this RTOP will be in the area of switching data utilizing integrated optical circuits (IOC's). Major emphasis will also be expended on investigating the utilization of fiber optic cable as transmission lines to route the data between the various ground station data equipment systems.

W78-70436

310-20-31

Goddard Space Flight Center, Greenbelt, Md

A GROUND ANTENNA FOR WIDEBAND DATA TRANSMISSION SYSTEMS

Richard F. Schmidt 301-982-4920

Future advanced spacecraft systems will transmit data to the ground at rates much higher than current NASA STDN operational capabilities. Launch support for Space Shuttle and orbital support for LANDSAT-D will require high data rate digital signal systems with low bit error rates. Existing NASA ground stations are not presently equipped for such requirements. Future wideband (approximately 1 GHz) systems for LANDSAT-D and Space Shuttle require the use of frequencies at which the necessary bandwidths can be allocated. High data rate systems require highly efficient ground antenna systems. Emphasis on overall system efficiency is essential for economically feasible future ground stations. In this RTOP, particular attention is devoted to techniques and components which yield high efficiency antenna systems, feed systems and low noise preamplifiers. In addition, dichroic subreflector techniques permitting simultaneous and efficient operation of an antenna at different frequencies without degradation of overall performance or flexibility will be refined. Analytical procedures and design tools will be further developed to support the specific requirements of these advanced antenna systems and the general antenna development program.

W78-70437

310-20-32

Goddard Space Flight Center, Greenbelt, Md

PRECISION COMPUTER CONTROL OF GODDARD NETWORK TRACKING SYSTEMS

A J. Rolinski 301-982-4977

The objective of this RTOP is the development of a precision computer control which will enable the Goddard satellite tracking systems to meet critical NASA applications such as antenna tracking as Ku-band and angle pointing of laser beams for precision ranging. Currently, Satellite Tracking and Data Acquisition Network (STDN) antennas are operating at S-Band with an angular accuracy of 0.9 mrad RMS. In the future, the STDN antennas will operate at Ku-band with a required tracking accuracy of 0.2 mrad RMS. The dynamic laser ranging system requires accurate beam pointing

to minimize range instability due to differences in transmitter pointing angles over the duration of the pass. The present Mobile Laser Ranging System (MOBLAS) achieves laser ranging accuracy of 7.7 cm RSS. Near future requirements call for a range accuracy of 5 cm and for earthquake hazards estimation, precision surveying, plate tectonics and orbital determination applications, a 1 cm range accuracy is highly desirable. Furthermore, link downtime must be minimized to reduce operational costs and loss of data. The computer control system will enable operators to quickly align, calibrate and check-out the tracking system prior to mission support. To meet these objectives it is proposed that a computer control system be developed with computer algorithms incorporating Kalman estimators and microprocessors in the control loop.

W78-70438**310-20-47**

Goddard Space Flight Center, Greenbelt, Md
GSTDN SYSTEM OPTIMIZATION
 Hal Theiss 301-982-2526

Significant changes in the role of the Ground Network (GSTDN) are anticipated in the post TDRSS era. Support requirements will be confined primarily to missions with geosynchronous and highly elliptical orbits. Such support usually consists of handling relatively low (less than 50 Kb/s) data rates. In addition to radical changes in GSTDN support requirements, profound changes have occurred and are occurring in the electronics industry. The appearance of low cost, highly reliable, modular equipment makes feasible a new approach to achieving effective and economic site maintenance and operation. Full utilization of this new technology is of extreme importance to T&DA in the light of ever increasing site manning costs. Projected figures for the 1980 network indicate that these costs will exceed \$1M per position per year! This RTOP will investigate two candidate areas with the goal of achieving optimum efficiency and economy in the 1982-90 time period: (1) Site Operations which will require elimination of operator positions and reduction in skill level requirements by utilization of computer aided operations, remote control, and unattended (dedicated) equipment; (2) Corrective Maintenance which will require hardware design with adequate redundancy to permit 'on-call' maintenance (with uninterrupted support capability). These areas will be investigated from two aspects and this RTOP will be partitioned accordingly, part 1 will be new (dedicated) equipment for Specialized Applications, i.e., Dedicated (unattended) antennas and systems for Geosynchronous Support, and part 2 will be modification/reconfiguration of existing systems.

W78-70439**310-20-48**

Goddard Space Flight Center, Greenbelt, Md
STDN SIGNAL STUDY
 George C. Kronmiller, Jr. 301-982-5068

The objective of this program is to develop an alternate telecommunications system design for the Spaceflight Tracking and Data Network (STDN). The program will consider the current signal design and present state of the art signal design techniques to determine an improved system design for the STDN. The first phase of the program will be a basic study to evaluate signal design techniques and develop feasible alternatives, with both technical and cost considerations, from which an optimum new system design can be selected. The final phase of the program will develop prototype hardware for further system evaluation and test.

W78-70440**310-20-65**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ANTENNA SYSTEMS DEVELOPMENT
 R. Levy 213-354-3872
 (310-10-61; 310-20-66; 310-30-68; 310-30-73)

This RTOP develops the technology for increasing the communication capabilities of the DSN ground based antennas as part of optimizing the overall flight-ground communications link for planned NASA missions to the outer planets. Communications capability is measured by the antenna figure of merit which is defined as the ratio of gain to system noise temperature, usable operational frequencies; and environmental limits of operation. The technology developed provides communication options for spacecraft planning in both the telemetry and radio

metric data types. Megabit data rates and higher frequencies require improved reflector surfaces and antenna pointing techniques. The VLBI navigation techniques impose additional requirements on structural stability and pointing. For VLBI, the antenna must be pointed blind without reference to the received signal direction. The steadily increasing costs for new construction and modification of antenna structures is a major influence in the development of low cost technology to meet the evolving needs of the DSN. Flight-ground tradeoff studies are used to balance the needs between communication link requirements, spacecraft parameters and DSN related capabilities. Overall increased performance and economy in supporting spacecraft communication requirements, based on these tradeoff studies, are the key objectives of this program. Advances in ground antenna performance are sought in the areas of microwave techniques; and in antenna structural, mechanical and pointing systems. Emphasis in the microwave area is on the study of dual frequency techniques at X- and K-Band, and on the development of effective alternates to the present reflex feeds, such as concentric dual frequency feeds, for combinations of S-, X- and K-Bands. Advanced analytical techniques are used to extend the scope of structural design for development of antenna configurations which have improved performance and lower cost. A 4 to 5 dB improvement in antenna figure of merit through operation at K-Band frequencies and reduced noise, achieved by a succession of improvements in each antenna and microwave element, is a long term goal.

W78-70441**310-20-66**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
RADIO SYSTEMS DEVELOPMENT
 W. H. Higa 213-354-4240
 (310-10-61; 310-20-65)

The objective is to improve the spacecraft-to-ground radio system elements of the communications link in order to meet future navigation and high data rate telecommunications requirements of the planetary exploration program. Future missions to the outer planets will require sensitive, radio frequency interference (RFI) resistant, and stable, higher frequency receivers and wideband radio communication for high rate video, telemetry, navigation, and radio science data. They will also require calibration and models of the propagation medium of the DSN ground radio parameters for efficient link design. The ever increasing usage of the microwave spectrum by the international community has also made it necessary to characterize and to monitor the man-made microwave environment (RFI) at the DSN sites so that corrective strategies may be developed. The natural microwave environment due to the atmosphere also needs to be monitored and understood. X-band radiometry has provided the weather dependent data for the past two years and probability density functions have been derived. Similar measurements for K-band will be initiated. The K-band radiometer development which was initiated in FY75 can be completed and the equipment installed at DSS 13 so that data collection can commence. An advanced X-band TWM will be tested in a 4.5 K CCR. Future requirements may make it necessary to operate the new TWM at 3 K, a CCR capable of providing the lower temperature has been developed and is now being tested. In addition, parametric upconverters are being investigated for use in multifrequency, wideband, ultra low noise amplifiers at S-, X-, and K bands, which use a single TWM at K-band. Separate upconverters are provided for each band. Upward of 300 MHz bandwidth can be obtained; this wide bandwidth capability will be particularly useful for DSN RFI and VLBI investigations.

W78-70442**310-20-67**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
DIGITAL SYSTEMS DEVELOPMENT
 R. A. Winkelstein 213-354-3843
 (310-10-61; 310-10-66; 310-30-69)

The objective of this RTOP is to develop data handling systems which permit effective communications between earth and spacecraft for mission types of the next decade. Specific objectives include the development of digital receiver technology for rapid reconfiguration and increased telemetry data rate reception, methods for the improved use of the spacecraft-ground

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telecommunications link, and means for detection and early warning of radio frequency interference (RFI) signals which might disrupt reception of spacecraft telemetry. A further objective is to improve high rate telemetry reception during the overlap time when a spacecraft signal is being received by antennas at two different DSN complexes. Development of digital receiver technology consists of digitizing the received signal at the receiver intermediate frequency of 10 MHz and thereafter using digital phase locked loop techniques for carrier tracking. In addition, telemetry digital demodulation methods will be developed for data rates in the 5 megabit per second range. To improve utilization of the spacecraft-ground communications link, special coding studies and analyses are being carried out in order to minimize the effect of radio frequency interference on the channel. Modeling studies are also being conducted to predict effects of weather on X-band system performance. For RFI detection, development is underway of a multichannel spectrum analyzer with an ultimate capability of 10E6 frequency points at a bandwidth of 300 MHz. Improvement in telemetry reception during an overlap viewing period of stations in two DSN complexes will be carried out by developing special hardware to combine the recorded telemetry received by these stations so as to obtain an overall improvement of the signal-to-noise ratio. Since this recombination would take place after the overseas recordings are transported to JPL, the system is called non-real time arraying.

W78-70443 **310-30-68**
Jet Propulsion Lab., Calif Inst of Tech., Pasadena
STATION AND NETWORK MONITOR & CONTROL TECHNOLOGY DEVELOPMENT
R M Gosline 213-354-4942
(310-20-67; 310-30-69, 810-40-72, 810-40-73)

This RTOP is developing techniques for unattended tracking station operations. The objective is to obtain the data needed to determine how unattended station operations can increase network productivity and decrease network life-cycle costs. The approach is the development of DSS 13 as a remote-controlled unattended station. Information obtained from the development itself and from subsequent use of the station will form a data base to be used in RTOP 310-40-73 to predict life cycle costs of automation and to study the feasibility of implementing an automated network. A number of demonstrations will be conducted to study the applicability of unattended operations to the various types of activities supported by the DSN. In particular, during the DSS 12 down time for S-X conversion, DSS 13 will be used in an unattended mode to supplement flight project tracking and to accumulate data about the reliability and capability of unattended spacecraft tracking. Because substantial progress has already been made in the automation of command and telemetry processing, the emphasis here is on the RF and electro-mechanical subsystems.

W78-70444 **310-30-69**
Jet Propulsion Lab., Calif Inst of Tech., Pasadena
TRACKING STATION SYSTEMS TECHNOLOGY
R R Green 213-354-3015
(310-20-65, 310-30-68; 310-40-72)

The objectives of this RTOP are to develop, demonstrate and evaluate new tracking station capabilities and new network technology for reliable, cost-effective and productive support of deep space missions. A key facility used for demonstrating new capabilities and concepts is the planetary radar system operating at both S- and X-band frequencies. This radar test bed will be upgraded and used to test and verify the specifications of the frequency and time distribution assembly and the reliability of the X-band high power transmitter which is under development in RTOP 64. In addition, data obtained from use of the planetary radar system provide essential information about the surface properties and ephemerides of the planets, their moons and rings and other interplanetary objects of interest. The frequency and time distribution assembly is being developed to obviate the need for expensive hydrogen maser standards at every station in a complex. A major goal of this RTOP is the development and demonstration of the Bent Pipe concept wherein the raw telemetry signals and noise from spacecraft, amplified by DSN receivers, are sent via wideband satellite links to a central

processing facility. Use of the bent pipe techniques will reduce the expense of operating and maintaining processing equipment at overseas complexes. In later years the bent pipe demonstration will be expanded to include radio metric data processing. This RTOP will also provide microwave and radio frequency subsystems for the radio frequency interference (RFI) monitoring and alarming system. Real-time data processing elements are being developed to handle the extra data resulting from three-station radar interferometry and may be applicable to such projects as RFI and VOIR.

W78-70445 **310-40-26**
Goddard Space Flight Center, Greenbelt, Md.
EVOLUTION OF OPERATIONS SUPPORT COMPUTING INTO THE 1980'S (DEMOS)
R L Larsen 301-982-2777

RTOP 310-40-26 consists of three task areas which shall be addressed separately in subsequent paragraphs. All three tasks are directly related to the development of a unified systems approach to direct the evolution of OSCD support systems. The first task area addresses the development of requirements for future OSCD support systems, and is a task begun in FY-77, which is to be completed in FY-78 using primarily civil service personnel. The second task area is in response to the increasing need for intercomputer communication experienced within NASA in recent years. This task's objective is to provide a comparative analysis of alternative schemes for intercomputer communication and is being performed under contract to the University of Maryland. The third task area is new for FY-78 and is proposed as a result of the requirements analysis and technology survey performed in FY-77. This task will investigate the feasibility of constructing a uniform operational system architecture which transcends individual machine boundaries and can form the foundation for the long term evolution of OSCD systems. This task will be performed under contract to Computer Sciences Corporation.

W78-70446 **310-40-36**
Goddard Space Flight Center, Greenbelt, Md.
AUTOMATIC DATA HANDLING
J C Rodgers 301-982-4189
(150-22-36)

Improvements to meet the large increases in support requirements demanded by NASA's future space programs specifically include a higher level of automation for Goddard Space Flight Center (GSFC) facilities resulting in increased data and information exchanges between the various GSFC facilities. This RTOP shall study methods of handling data and information and shall result in the design and development of a prototype Integrated Telecommunications Distribution System providing a communications network between the operational M and DOD computer systems. The Integrated Telecommunications Distribution System will interconnect existing M and DOD computer systems and will permit any computer on the telecommunications network to communicate with any other computer on the network, provide resource sharing of data sets, programs, and peripherals, and provide a standard telecommunications method.

W78-70447 **310-40-39**
Goddard Space Flight Center, Greenbelt, Md.
IMAGE PROCESSING FACILITY PERFORMANCE EVALUATION AND IMPROVEMENT
B. Peavey 301-982-4995

This RTOP supports the development of digital image processing techniques for sensors such as Multispectral Scanner (MSS) and Thematic Mapper (TM), system performance evaluation methods, and an archival data storage system. In the area of image processing techniques, very accurate radiometric interpolation methods (e.g. 6 x 6 cubic function) are investigated as to their attendant degradation and impact on system throughput. In addition, Ground Control Point (GCP) identification and registration methods are evaluated, or developed for the purpose of achieving a geodetic registration accuracy of less than 30 meters. Implementation feasibility of system performance measurement methods (e.g. modulation transfer function) on the previously developed Image Display and Recording System

(IDARS) is studied in terms of software and hardware resource requirements. Promising high density laser-disc recording systems which can store 10 to the 14th power - 10 to the 15th power bits of data are to be studied with respect to operational environment, online operation with image processing systems, and implementation cost. These will be systems which were previously surveyed as to their potential applicability and technological feasibility.

W78-70448 310-40-40
Goddard Space Flight Center, Greenbelt, Md
POCCNET: PAYLOAD OPERATIONS CONTROL CENTER COMPUTATIONAL SYSTEM OF THE 1980S
R DesJardins 301-982-4168

The goal of this RTOP is to develop a control center computational systems organization (hardware/software) for GSFC for the 1980s, christened POCCNET (Payload Operations Control Center Network), embodying the following features: (1) robust, fail-soft hardware/software design, (2) high visibility of systems implementation status and operational state, (3) virtualization of computational system functions (subsystems functional independence), (4) flexibility and ease of reconfiguration, (5) simplified integration and test of applications systems, (6) reduced development time and cost, (7) special attention to human interfaces and to software engineering, and (8) Common Software Modules and supporting services for the Multimission Modular Spacecraft (MMS) and other standard envelopes of requirements. The effort is divided into four elements which are spread over five years (1975-1979) and includes (1) identifying probable computational requirements on GSFC POCCs in the 1980s, (2) identifying applicable advanced technologies and develop specifications, (3) identifying applicable software engineering methodologies, and (4) designing POCCNET subsystems in both the systems and applications areas

W78-70449 310-40-41
Goddard Space Flight Center, Greenbelt, Md.
COMPUTER USAGE TECHNIQUES
P B Schneek 301-982-6251

The objective is to configure a prototype (which may be converted to production use) minicomputer/array processor to determine the increased cost/effectiveness of such a configuration. A prototype system consisting of minicomputer, array processor, and supporting peripherals has been ordered. They will be configured to permit use of the array processor as a large capacity arithmetic processor. Representative test programs will be coded and benchmarked on the system to determine the speed and cost/effectiveness of this approach compared with using a conventional system.

W78-70450 310-40-42
Goddard Space Flight Center, Greenbelt, Md
IMPACT OF SPACECRAFT TIMING SYSTEMS ON DATA PROCESSING
G A Smith 301-982-6370

Timing accuracy requirements for satellite experiment data have increased significantly over the past decade. Methods of improving or maintaining time accuracy at lower cost and higher efficiency have become essential. The total timing system, from onboard time reference and electronics to ground time correction, correlation, and tagging or time verification, for each spacecraft will be studied to identify limitations, areas where improvement is possible, and tradeoffs within the total system where savings in processing time or cost can occur. Because of similarities in spacecraft systems, a study of a few classes of timing accuracy designs and processes will be sufficient to identify most significant improvement possibilities. Cost savings by reduction of programming effort, computer time usage, and analyst's effort and improvement in the accuracy of a timing system will result. A presentation will be given and a final report will be written to provide results of the study.

W78-70451 310-40-72
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
NETWORK CONTROL AND DATA PROCESSING DEVELOPMENT

R C Tausworthe 213-354-2773
(310-30-68, 310-30-69)

The objective of this RTOP is to develop the techniques necessary for the efficient and cost-effective application of computational resources to the jobs of the DSN Software-Hardware design methods being in this RTOP will improve management control of systems development by facilitating the top-down hierarchical expansion from functional requirements to detailed software and hardware design. The Advanced Systems segment of the DSN Programming Systems work utilizes pathfinder projects such as the machine independent design of the MBASIC language processor to generalize a software methodology appropriate to DSN needs. This methodology in turn contributed to standard practices, standard languages, etc., for DSN implementation to improve the overall productivity of the DSN. Mathematical analyses are applied to several specific areas of data system as relevant to techniques for RFI identification, superfast generation of pseudorandom numbers for simulation, spectrum surveillance algorithms, signal detection and estimation techniques, hardware element utilization, complexity of structured and non-structured programs, inherent complexity of data manipulation programs, and theory of very large data design. Maintenance of logical hardware in the network environment represents a sizeable cost item for the DSN. This cost is being attacked through the development of a standard set of logical building blocks, the Control and Computational Modules, which will be used for the fabrication of a variety of digital systems, from a dedicated signal processor to a multipurpose digital controller. The automation development experiments led by RTOPs 310-30-68 and -69 are supported in part by computer technology developments in this RTOP.

W78-70452 310-40-73
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
NETWORK PRODUCTIVITY RESEARCH
H L Kirkbride 213-354-7766
(310-30-68)

The objective of this RTOP is to increase the effectiveness of DSN use of NASA resources for tracking and data acquisition support of flight projects and other end-users. The steadily rising cost of providing flight project support is rapidly consuming the resources available to meet needed new flight project support requirements. The remedy is either to secure more funding or to increase network productivity and cost-effectiveness: network productivity is the ratio of end-user station hours to operations and operations support work-years, network cost-effectiveness is defined as end-user station hours per dollar of DSN funding. The approach used in this RTOP to achieve the latter of the two alternatives above will be to develop a standard life-cycle cost technique for use in the evaluation of new technology prior to its incorporation in the network, and to develop and transfer techniques for more efficient spares provisioning and repair scheduling. In addition, work done under this RTOP will lend support to feasibility studies of new technologies which promise an increase in network productivity in the form of cost-benefit and life-cycle cost analyses.

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Advanced Development/LSS

W78-70453 907-41-00
Marshall Space Flight Center, Huntsville, Ala
MAN-SYSTEMS-VEHICLE INTEGRATION
J D. Johnston 205-453-3447

The overall objective is to develop the capability for the augmentation of man's performance in space systems through the application of manipulator systems, sensors and actuators for earth orbital and scientific teleoperators. Specific objectives are: to identify requirements and baseline systems, to develop conceptual and prototype designs and breadboards; to determine the machine's and man's role in the operation of teleoperators and to establish their feasibility in space application to spacecraft deployment, retrieval, servicing and structure assembly. The

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approach will be to identify the scientific and operational mission requirements through technical studies and develop the resultant teleoperator functions. From the implied capability requirements for man and machine, the necessary technology developments for teleoperator systems and subsystems will be derived. Required developments will be defined and implemented analytically and/or experimentally using simulation techniques, breadboard setups or prototype equipment. New concepts of teleoperator systems and subsystems will be developed when appropriate and related feasibility studies will be conducted. Flight demonstrations and evaluations will be defined and developed as required to support the technology program.

W78-70454 **907-41-16**
Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
GROUND DEMONSTRATION OF SENSOR AND DISPLAY AUGMENTED CONTROL FOR SHUTTLE REMOTE MANIPULATOR SYSTEM (RMS)
A. K. Bęczy 213-354-3124
(199-51-04)

The objectives of this plan are to demonstrate and evaluate sensor, display and computer aided control concepts (developed on the JPL RMS man-machine breadboard) for the space shuttle manipulator operations. The specific, immediate objectives are to demonstrate and evaluate the application of proximity and force-torque sensor and control technology to the shuttle RMS operating conditions. This control technology offers significant performance benefits for shuttle payload handling: higher success ratio, shorter capture time, less incidental collisions prior to capture, prevention of jamming and/or overstress, and decreased operator fatigue. The approach is to implement new control capability demonstrations and evaluations at the shuttle RMS test and training facility of JSC. Proximity and force-torque sensors, displays, and related electronics will be provided by JPL and where feasible, existing hardware will be utilized. The physical scale of the control tasks will, however, require building new sensors with modified electronics and displays. Existing test facility equipment at JSC will be utilized to the greatest extent possible. Minor changes to this test equipment, necessary to accommodate the control demonstrations and evaluations, will be provided by JSC. The basic control demonstration will be the integrated use of proximity sensor, force-torque sensor and visual information to position and align end effectors for successful grappling of a payload receptor, and to prevent jamming and overstress of shuttle RMS during payload handling. The control demonstrations will be done jointly with JSC personnel, including control task definitions and performance evaluation. The results will be documented in a form suitable for specification of design requirements.

Advanced Development

W78-70455 **910-01-00**
Marshall Space Flight Center, Huntsville, Ala
STRUCTURES
E. E. Engler 205-453-3958

The general objective of this RTOP is to provide technology and development data for structures to be utilized on future space transportation systems and systems for large space structures, such as elements, joints, and associated fabrication methods. The areas to be studied include the following: (1) lightweight shell structures of advanced composites; (2) large space structural element joints and modules for fabrication on the ground and in orbit; (3) structural members for large space structures suitable for automated space fabrication and assembly techniques; (4) techniques required for composite structural members for large space structures suitable for space fabrication; (5) 'Space Spider' concept for constructing large space structures. The approach for this program will be to develop test hardware or systems for the areas above. These test items will be evaluated according to the requirements developed within the program. The following tasks will be performed: (1) design, analyze, and fabricate a lightweight shell structure; (2) develop structural

attachments for large space structure systems; (3) develop techniques for space fabrication and assembly of large space structure; (4) develop techniques and equipment, and demonstrate the feasibility of space, fabrication of composite structural elements; (5) design, develop and test a 'Space Spider' laboratory demonstrator; and (6) define requirements for flight testing and determine associated costs.

W78-70456 **910-02-00**
Lyndon B. Johnson Space Center, Houston, Tex.
THERMAL CONTROL
W. E. Ellis 713-483-4941

The primary means for rejecting heat from current manned spacecraft while in-orbit, is through a space radiator system which is mounted on the vehicle and which rejects heat from a fluid circulating through it by radiation to the space environment. Radiator systems for all foreseeable future space missions will need to be compactly stored during launch and subsequently deployed in orbit. In addition, for some missions they will need to operate for time periods and at temperature levels which considerably exceed the life capabilities of existing fluid circulating systems. The overall goal and objective of this effort is to develop radiator heat rejection systems that meet these basic requirements for the three types of future missions envisioned: (1) enhancement of orbiter capability to reject heat generated by high powered payloads; (2) heat rejection from a shuttle tended space station; and (3) heat rejection for long term space industrialization/construction/solar power type missions. Thus, this task has applicability to a very broad range of future possible missions. This independent development approach has significant potential to reduce spacecraft development costs by: (1) reducing development and qualification testing; (2) providing a longer projection run; (3) simplifying integration between the heat rejection system and vehicle; and (4) reusing heat rejection systems which are returned from orbit on other experiments.

W78-70457 **910-02-00**
Marshall Space Flight Center, Huntsville, Ala.
THERMAL CONTROL
J. L. Vaniman 205-453-1171
(506-16-33)

The general objective is to develop thermal control methods required to maintain satisfactory thermal conditions for long duration spacecraft operating under environmental extremes. Specific objectives are to analyze, design and develop thermal control systems (including hardware) and demonstrate system application and feasibility for maintaining thermally critical hardware (electronic components, optical sensors, fuel cells, batteries, etc.) within specified thermal limits, to provide thermal control surface coating technology required for long life space missions. Proposed space base missions and configurations are continually analyzed and evaluated to identify thermal requirements which are compared with current thermal technology. Thermal areas requiring additional development are identified and follow-on activities include completing detail designs and specifications of selected systems/elements, upgrading technological development of elements deemed necessary and beneficial, fabricating and testing breadboards of selected options to optimize system parameters and select most beneficial systems and techniques. FY-78 effort includes continuing the transverse flat plate heat pipe development activity and investigating on-orbit servicing of thermal control surfaces.

W78-70458 **910-03-00**
Marshall Space Flight Center, Huntsville, Ala
PROPULSION
Toán R. Ferrell 205-453-0709
(790-40-12)

This RTOP consists of two tasks: (1) tripropellant engine study, SSME modification and (2) Orbital Transfer Vehicle (OTV) engine trade studies. The Space Shuttle Main Engine (SSME) will be evaluated to determine the components and subsystems which could be utilized in an advanced engine designed to operate with LOx and hydrogen and/or hydrocarbon used in either a tripropellant or dual fuel mode (sequential burn). OTV engine design studies and engine trade-off studies will be conducted to

optimize engine design and provide data for detail vehicle and mission studies. This will include feasibility studies for any desired options.

W78-70459**910-03-02**

Lewis Research Center, Cleveland, Ohio

PROPULSIONJohn W. Gregory 216-433-4000
(506-21-12, 790-40-12)

The objective is to provide improvements in the technology of components for advanced high performance reusable rocket engines. The work is applicable to both conventional bell nozzle engines and plug nozzle engines for advanced space transportation systems, including orbit transfer vehicles (OTV), single-stage-to-orbit (SSTO) shuttles, Space Shuttle growth or improvement, and heavy-lift launch vehicles (HLLV). Included in this program are efforts on components such as long life seals for liquid oxygen turbopumps, complete turbopump assemblies, and boost pump/drive systems for advanced engines. To accomplish the objectives, the following tasks will be performed: Task 10 - liquid oxygen turbopump assembly, Task 02 - LOx turbopump seal demonstration, and Task 03 - liquid hydrogen boost pump/roller drive system. Technology will be advanced through analysis, design, fabrication and testing of realistic hardware at representative conditions. For the LOx turbopump, turbopump seal demonstration work and liquid hydrogen boost pump/drive, testing emphasis is on component performance and life.

W78-70460**910-04-00**

Lyndon B. Johnson Space Center, Houston, Tex

ATTITUDE CONTROL PROPULSION

D. L. Connolly 713-483-3851

The technical objectives include a follow-on effort to refine design, fabricate, and carry out ground tests of a full-scale tank/propellant acquisition device (PAD) for large spherical propellant tanks (20 ft cu) for earth storable and cryogenic (O₂-H₂) propellants. Particular emphasis will be placed on the development and demonstration of zero-g on-orbit tank/PAD operations including reloading and checkout operations. This program is to be accomplished in 3 phases. Phase I (FY-77) is the design, fabrication, and test of key components of the acquisition system. Phase II (FY-78) is the design refinement, fabrication, and test demonstration of a full-scale prototype tank with earth storable propellants. Phase III is the design refinement, fabrication, and test demonstration of a full-scale prototype tank with cryogenic O₂-H₂ propellants.

W78-70461**910-04-00**

Marshall Space Flight Center, Huntsville, Ala.

ATTITUDE CONTROL PROPULSION

Francisco F. Garcia 205-453-1242

This effort will evaluate the increased service life of an improved monopropellant hydrazine (N₂H₄) thruster. A hydrazine thruster for an Attitude Control Propulsion System (ACPS) based on the radial flow catalyst bed technology developed for the Space Shuttle APU gas generator will be designed, fabricated, tested, and delivered to MSFC.

W78-70462**910-04-03**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

ATTITUDE CONTROL PROPULSION

D. L. Young 213-354-3217

The objective of this work is to investigate propellant substitution as a means of reducing the recurring costs associated with the shuttle operation. During FY-77 the RCS engine supplier completed a contracted study effort to assess the result of a direct substitution of N₂H₄ for MMH and began an experimental determination of the wall temperature using a workhorse RCS engine to verify the thermal results found during the assessment study. During FY-78, the thermal model verification will be completed and the performance (Isp) as a function of mixture ratio will be verified using a workhorse injector and chamber.

W78-70463**910-05-00**

Lyndon B. Johnson Space Center, Houston, Tex

ELECTRICAL POWER

David Bell, III 713-483-6128

The objective is to advance various interrelated electrical power technologies applicable to larger scale manned space operations. Specific objectives are: (1) continuation of the development of a highly efficient, low cost, long lived, versatile fuel cell based on the solid polymer electrolyte technology (emphasis will be placed on the controlled laboratory tests of subscale and full scale reactor stacks), (2) application of electrolysis technology to provide a system for production of large quantities of hydrogen and oxygen for use by propulsion, power generation and life support subsystems (existing oxygen would be used by propulsion, power generation and life support subsystems and existing fuel cell/electrolysis technologies would be used to develop large area cells and evaluate subassembly performance), (3) continue cycling tests of large capacity nickel cadmium cells through expended life; and (4) establish technology base for large, high voltage power distribution systems. Parametric studies will be conducted to establish where technology gaps exist and establish a plan for advancing those technology areas found lacking.

W78-70464**910-05-00**

Marshall Space Flight Center, Huntsville, Ala.

ELECTRICAL POWER

J. L. Miller 205-453-2113

The objectives of the RTOP are to develop essential technology design requirements, design specifications and to perform component research and breadboard/prototype development necessary to produce flight qualified hardware for long life, cost effective power systems. The following tasks will be performed: (1) task 02 (high voltage dc power processing) to develop microprocessor control and related power processing for high voltage (100-300 V) dc distribution systems; (2) task 03 (lightweight fuel cell) to develop a 15 lb/KW fuel cell which uses propellant grade reactants; (3) task 07 (photovoltaic/electrolysis/fuel cell power system) to characterize a space station power system which can be five times lighter than batteries; (4) task 08 (nickel hydrogen batteries) evaluate lightweight secondary batteries for low-earth orbit; (5) task xx (utilization of the SEP solar array for power module phase A/B definition to determine SEP solar array design iterations for power module. The objective of this RTOP will be accomplished through a combination of in-house and contracted efforts. Unique and/or exotic fabrication will be accomplished exclusively on contract. Engineering breadboards will be fabricated and tested with the bulk of effort being done essentially in-house. The nickel hydrogen batteries will be purchased off the shelf for evaluation. Support to the power module solar array effort will be primarily analytical, with a limited amount of in-house testing of cell interconnects to verify their applicability to low earth orbit.

W78-70465**910-07-00**

Lyndon B. Johnson Space Center, Houston, Tex

COMMUNICATIONS

M. Engert 713-483-2918

This RTOP addresses the general area of communications systems. Electro-optical systems for ranging, tracking and television as well as basic communications elements such as antennas, transponders, modulation and coding systems are included. General objectives to reduce cost, size, weight, power and increase performance are addressed in the following task areas: (1) reduction of TV camera cost, size and weight by exploiting solid-state image sensors; (2) increase RF amplifier power and reliability by improving heat transfer from internal elements; (3) increase efficiency of slotted waveguide antennas by developing efficiency math models and parameter optimization; (4) obtain proximity operations (0 to 5,000 ft) ranging and tracking capability by improving receiver recovery times and optimization of power and modulation parameters; (5) develop very accurate electro-optical ranging techniques for large space structure assembly and control by exploiting scanning lasers and optimizing targets; and (6) increase space-to-space data rates and decrease antenna size by developing ultramicrowave communications elements.

W78-70466**910-07-00**

John F. Kennedy Space Center, Cocoa Beach, Fla

OFFICE OF SPACE FLIGHT

COMMUNICATION

P. D. Toft 305-867-2780

The objective of the effort is to demonstrate the installation, operation, and maintenance of a wideband fiber optic cable transmission system. Field tests will be conducted at KSC in an operational environment in order to determine and define the installation and maintenance requirements for a fiber optic cable system.

W78-70467

910-07-00

Marshall Space Flight Center, Huntsville, Ala.

COMMUNICATIONS

D. O. Lowrey 205-453-1578

(506-19-19)

The objective of this RTOP is to perform studies, design analysis, and tradeoffs of concepts and techniques that will lead to the development, fabrication and testing of an active electronically steerable Ku-Band phased array system. Circuit techniques and design concepts will be designed by computer aided techniques and performance evaluation performed by computer simulation to determine the theoretical performance. The optimized design will be determined and circuits and components fabricated for laboratory testing. The modules will be integrated into a two-way telecommunications system that is capable of electronically pointing and steering the radiated beam and retrodirectively tracking a distant communicating source such as a relay satellite. The Ku-Band phased array system will permit the Space Base/Station to provide a high capacity data telecommunications system without mechanical disturbance and protruding antenna systems as is encountered with conventional antenna systems. The Ku-Band phased array system will utilize a standardized module that can be utilized in any position in the array assembly. The module circuitry will be of the microwave integrated design to provide identical fabrication features and performance characteristics, thereby resulting in a flexibility of sizing the array systems to meet particular application requirements.

W78-70468

910-08-00

Marshall Space Flight Center, Huntsville, Ala.

STABILIZATION AND CONTROL

S. M. Seltzer 205-453-4580

The overall objective is to extend and develop stabilization and control techniques for space vehicle applications. Specific objectives are (1) the development of design and verification tools to perform digital control system design and verification and to analyze and predict the dynamic interaction between the space vehicle control system and its flexible structural members, (2) the development of stabilization and control techniques for stabilizing and pointing large area orbiting space structures and stabilizing large multi-unit space stations during their assembly; (3) the investigation of both CMG and rate gyro-scope package applications to the power module. The approach will be to utilize analytical studies to continue the identification and technical description of significant nonlinearities that interact dynamically with a spacecraft digital control system. Then, limit-cycle behavior will be investigated, and when possible, eliminated or reduced. Criteria for location of sensors and actuators will be developed, following assessment of the effects of structural flexibility. Current stabilization and control technology will be assessed for applicability to large area space structures and to space station modules during the assembly phase.

W78-70469

910-10-00

Lyndon B. Johnson Space Center, Houston, Tex.

GUIDANCE AND NAVIGATION

Charles E. Manry 713-483-4217

This RTOP provides for the design, fabrication, and flight demonstration on the Space Shuttle vehicle of manual optical device(s) suitable for navigation and pointing of manned space vehicles. It is intended that the instrument(s) be window-mounted and provide range, range rate, and pointing capability over distances from several miles to within a few feet of the target. This should encompass the spectrum of requirements of terminal rendezvous, line-of-sight navigation, stationkeeping, and docking/berthing associated with the assembly of orbital modules

and other large space structures. The device is envisioned as either a primary instrument or as a crew monitor for automatic systems. The device will be designed around conventional optical elements and will include the evaluation of image intensifiers for use at night or in deep shadowing conditions. An optical sight will be developed and, after simulation studies, a range/range rate measurement capability will be added. Laser techniques, as well as conventional stadiametric ranging will be investigated. Specifications will be developed for a flight demonstration using the Space Shuttle.

W78-70470

910-10-00

Marshall Space Flight Center, Huntsville, Ala.

GUIDANCE AND NAVIGATION

D. O. Lowrey 205-453-1578

(506-19-19)

This RTOP describes the advanced development program and analytical studies and tradeoffs planned in the guidance and navigation area to develop a Scanning Laser Radar (SLR) system that can provide a rendezvous and docking sensor for Space Base/Station and other spacecraft such as the Space Transportation System and the Orbital Operations. The Scanning Laser Radar Sensor is a system that provides highly accurate measurements of range, range rate, azimuth and elevation angles and angle rates, and the relative roll index between a target vehicle and the vehicle on which the sensor is mounted. The system can measure ranges from 110 nautical miles down to close dock range of approximately 2-5 centimeters. The Scanning Laser Radar development is an in-house development program. The SLR utilizes optical techniques for collimating an extremely narrow beam of invisible energy at a wavelength of 0.83 microns. The laser power generating source is a solid-state gallium arsenide laser diode operating in the internal selected mode. The SLC system scans a 30 x 30 degree field of view and can be utilized as radar sensor for stationkeeping of free flyer spacecraft in the proximity of the space base. The system is also adaptable to alignment measurements of large space structural members.

W78-70471

910-13-00

John F. Kennedy Space Center, Cocoa Beach, Fla.

INSTRUMENTATION

P. D. Toft 305-867-2780

The objective of this project is to provide instrumentation to support KSC launch operations. The automation of chemical analytical instrumentation processes is desired to reduce the manpower required, to increase proficiency, and to optimize processing equipment requirements to support microchemical sample analyses. The development of signature and modal analysis techniques for malfunction investigations will reduce O & M requirements for GSE equipment at KSC. Automation of the failure analysis process for electropneumatic components can decrease time for the process and improve the individual hardware item test results. This could result in increased cost effectiveness for reducing checkout time and costs.

W78-70472

910-13-00

Marshall Space Flight Center, Huntsville, Ala.

ADVANCED INSTRUMENTATION

T. A. Parnell 205-453-5130

The objective is to establish design criteria and operational limitations on future manned space missions and systems that may be imposed by the radiation environment of space. Specific objectives are: (1) to identify the radiation hazards and significant effects from trapped belt, cosmic ray, and solar flare particles, (2) to define possible protective measures and required monitoring instrumentation for the radiation, (3) to determine operational modes that minimize radiation effects, and (4) to identify and investigate previously unconsidered radiation problems related to future space missions, especially those of long duration or with large structures. Models of various components of space radiation are kept current and improved where new data exists from other sources, particularly the GSFC data bank. The presently available particle transport programs will be improved where necessary for specific analyses, particularly for bremsstrahlung and for the lowest energy protons. Efficient particle transport methods for treating heavy cosmic ray nuclei in complex structures

will be developed. The radiation environment models and transport methods will be applied to future space missions and systems to assess hazards, significant effects, and possible operational impacts from the radiation

W78-70473 910-13-14
 Lyndon B. Johnson Space Center, Houston, Tex
FIBER OPTICS INSTRUMENTATION FOR OXIDIZER TANKS

A. W. Wardell 713-483-3958

The United States Space program now and in the future uses highly explosive fuel such as liquid hydrogen (LH2) and oxygen (LOx). In the past when a hazardous condition existed, the risk has been controlled by very careful quality control and extensive testing to reduce the probability of failure to a low number. The result of this approach is to increase the cost of inexpensive hardware. The objective of this RTOP is to eliminate the current carrying wires inside spacecraft tanks by developing sensors that use fiber optics to carry the measurement signal. The approach is to develop liquid level, pressure, and temperature sensors for use in LH2 and LOx tanks. The tank penetration will be a fiber optic bundle which will transmit light to passive sensors which will measure the level, temperature, and pressure by some optical property thereby eliminating the need to pass electrical current into the tank. A secondary benefit to this approach will be a weight savings due to the light weight of glass fibers compared to copper wire leads of conventional sensors.

W78-70474 910-21-12
 John F. Kennedy Space Center, Cocoa Beach, Fla
MANUFACTURING AND INSPECTION
 P. D. Toft 305-867-2780

The objective of this effort is to develop the necessary technology to provide an improved cost effective Shuttle Thermal Protection System Repair technique. The current Shuttle Program baseline requires replacement of repaired thermal tiles on the Orbiter after a single flight. The technology developed under this RTOP will significantly impact this established baseline and reduce-orbiter refurbishment costs and time.

W78-70475 910-26-00
 Lyndon B. Johnson Space Center, Houston, Tex
ALGORITHM DEVELOPMENT - DEVELOPMENT OF ANALYTICAL ORBIT PROPAGATION TECHNIQUE WITH DRAG
 G. Weisskopf 713-483-2855

The objective of this RTOP is to produce an efficient and well documented computer program for the prediction of earth satellite orbits. The program will be based on analytical solutions to the equations of motion as opposed to numerical integration. The program will include a method for taking into account the effects of atmospheric drag and the higher order zonal and tesseral terms of the earth's geopotential function. The approach in accomplishing the objective of this RTOP will be to build upon and refine some of the developments from several previous and related RTOPs. In particular Pioncere Similar (PS) element formulation, 'mean-element' initialization, and an analytical drag formulation will be refined and combined into one program. This program will be tested against existing and proven methods, and a complete program and user's guide documentation will be provided. This analytic orbit propagation program with drag will be of great practical value in applications such as analysis of long term orbit stability and satellite attitude control for large space structures, like the solar power satellite. It will also be of significant value in on-going programs involving the mission planning and flight design for the Space Shuttle and its payloads.

W78-70476 910-27-03
 Lyndon B. Johnson Space Center, Houston, Tex
PAYLOAD DEPLOYMENT AND RETRIEVAL SYSTEMS SIMULATION DEVELOPMENT
 R. E. McAdams 713-483-6347

The overall objective of this RTOP is to provide a computer dynamic simulation capability incorporating the Orbiter, Payload (PL), and Payload Deployment and Retrieval Systems (PDRS) dynamics, and the proximity plume impingement effects from

the Orbiter control systems and from the PL control systems. This will provide a capability for dynamic digital analysis of payload deployment and retrieval concepts and applications. The scope of the tasks delineated in the original RTOP have been changed to the extent that the program development has been accelerated and the modeling of specific payloads has been incorporated. Briefly, this task entails the modification of existing models which simulate the various shuttle systems employed during PDRS operations for the purpose of assimilating those models into an existing 6-DOF digital computer program which can be used to analyze and assess the combined dynamical effects of the integrated systems in simulated natural and induced environments (e.g., plume impingement effects). In addition, the simulation will provide the capability to perform detailed relative motion analysis of the Orbiter and payload. Also, preliminary analysis involving planned specific payload will be performed to verify and demonstrate the simulation capability and flexibility to accommodate future payloads as yet undefined.

W78-70477 910-27-04
 Lyndon B. Johnson Space Center, Houston, Tex
ADVANCED MISSION DESIGN PROTOTYPE SYSTEM
 E. C. Lineberry 713-483-5276

This task continues the conceptual development and feasibility studies of executive control logic (MDEX) for an advanced flight design system. The logic will provide overall control for the flight design system, and will provide interactive assistance to the user of the system. This includes module sequencing for interactive analysis, prompting, initialization control for batch processing, data base interface, automated documentation interface control, and graphics interface control. Support will be provided for integration assistance in the overall development of the flight design system. This integration activity includes MDEX, the data base, the interactive operating mode, the batch operating mode, graphics, and automated documentation. In addition, the operational suitability of the overall approach will be evaluated.

W78-70478 910-27-05
 Lyndon B. Johnson Space Center, Houston, Tex
NUMERICAL INTEGRATION, NUMERICAL AND DYNAMICAL STABILITY
 Bobby Uzzell 713-483-4907

The objective of this study is to continue the development of efficient Runge-Kutta (RK) methods which have pairs of solutions that may be used to estimate the local truncation errors. In particular, m-fold Runge-Kutta methods for both first and second order differential equations will be included. These methods are now more applicable than ever because of the large effort currently being devoted to the development of algorithms and portable compilers that utilize the Taylor series method. The advantage of these portable compilers will be that the first few terms of a Taylor series can be computed efficiently, with little effort by the user. However, this efficiency diminishes rapidly as the number of terms increases. As a consequence, the combination of the Taylor series method and the m-fold RK methods will provide a very efficient software package for solving ordinary differential equations. A second objective of this study will be to study the interaction of numerical and dynamical stability of several systems of ordinary differential equations, which apply to trajectory propagation. The approach will be to investigate the behavior of integrals of motion of the various systems of equations during numerical integration.

W78-70479 910-27-07
 Lyndon B. Johnson Space Center, Houston, Tex
DEVELOPMENT OF METHODS FOR STUDYING ORBIT DESIGN, CONTROL, AND LIFETIME
 Victor R. Bond 713-483-4907

Orbit computational methods that have been developed to a large extent under previous Advanced Development RTOP's will be used in the development of computer software which will support mission planning activities for shuttle operations and shuttle delivered payloads. Specifically, the objectives which will be addressed are: (1) orbit design and control for the Solar Power Satellite (SPS), (2) utilization of non-gravitational (for example, solar pressure) perturbations for spacecraft trajectory

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and attitude control (for SPS and spacecraft using solar pressure for propulsion), (3) develop techniques for stationkeeping and assessing methods of avoidance of other spacecraft at geosynchronous altitudes; and (4) geosynchronous satellite lifetime studies. The approach will be to use existing documented trajectory propagation programs (KSFAST, KSMULT, STEPR, PSANS) and other computational algorithms using the highly efficient and accuracy-controlled orbital elements such as KS, PS, and DS

W78-70480

910-28-00

Marshall Space Flight Center, Huntsville, Ala
SOFTWARE PROCESSES

John D. Capps 205-453-0134

The objectives of this effort are to develop automated techniques and management disciplines for the specification and verification of software, to demonstrate the useability and application of these methods and to develop generalized user procedures. The FY-75 effort placed emphasis on analysis of existing techniques and design of a unified system approach to software development and testing. FY-76 efforts completed the implementation of these techniques. FY-77 efforts began the application, testing, and refinement of the Software Specifications and Evaluation System (SSES) components. The FY-78 effort will continue the FY-77 activities. This total RTOP effort will provide new capabilities for reducing total software testing time without sacrificing confidence in performance, and at the same time improve the cost ratio between hardware/software systems.

W78-70481

910-31-00

Marshall Space Flight Center, Huntsville, Ala
SPACE OPERATIONS TECHNIQUES

E. E. Engler 205-453-3958

The general objective of this RTOP is to provide a coordinated program of development for operational techniques in two different areas. The areas to be studied are the following: (1) space qualified, leakproof, fluid connectors for orbiting vehicles, and (2) man/system simulation requirements for extending man's capabilities to perform assembly, maintenance, and transfer activities in space. The approach for this program will be to develop test hardware or systems for the areas above. These test items will be evaluated according to the requirements developed within the program. The following tasks will be performed: (1) zero gravity/vacuum leakproof fluid connector, and (2) develop and perform man system simulation tests to evaluate design and hardware concepts.

W78-70482

910-31-01

Lyndon B. Johnson Space Center, Houston, Tex
FORMULATION OF CONSUMABLES MANAGEMENT MODELS

W. Scott 713-483-3278

The overall objective of this RTOP is to define and develop the consumables management requirements for all phases of a repetitive vehicle space program. This RTOP is directed toward development of Advanced Spacecraft consumables management techniques which do not require personnel specifically trained in consumables technology in the routine planning, crew training, and flight operation for highly repetitive vehicles. The goal is to provide a management system which will result in a saving of \$35,000/flight over currently employed techniques. The best approach to satisfying the objectives is to develop a relatively automated (ground or onboard) method of processing flight data to maintain the mission planning, crew training, and flight data base for the fleet and/or individual delivery spacecraft as required to support consumables subsystem maintenance, logistics, as well as reduce planning and flight dispersions. The developmental consumables management software will be modified into a more automated version which will process the flight data base for the consumables management portion of the total flight planning system.

W78-70483

910-31-02

Lyndon B. Johnson Space Center, Houston, Tex
DEVELOPMENT OF CRYOGENIC PVT ALGORITHMS FOR SPACE APPLICATIONS
W. Scott 713-483-3278

The objectives of the continuation of this RTOP are to accomplish the following task: (1) fluid pack maintenance, a low level of effort designed to support the basic fluids pack developed under the current RTOP; (2) develop software to predict slush cryogen storage time (for self pressurization) from triple point to near solid, for both mixed and unmixed fluids in cryogenic tanks over a range of heat leaks to be determined; (3) continue RF gaging work and develop software to provide predictive capability for gage verifications and error analysis; and (4) correlation of He2 properties in support of the NASA/ARC IR telescope for Spacelab 1. The first two objectives will be continuations of the work started this fiscal year. Task 1 is a continuing item which provides new data to the fluids pack as NBS makes it available. Task 2 will aid the mission planners and systems designers in determining quality requirements for each cryogenic tank used on extended mission. Task 3 results from problems uncovered in the current RF gaging program. The software diagnostic program will be used to supplement the experimental program and subsequently provide the basis for performing an error analysis of the system. Task 4 is a PVT development of the He2 properties for use by the IR telescope for Spacelab 1. This would not only benefit the Ames Research Center but would be an enhancement to the fluids pack program.

W78-70484

910-31-03

Lyndon B. Johnson Space Center, Houston, Tex
SPACE OPERATIONS TECHNIQUES

R. C. Ried 713-483-3676

The technical objectives are to determine similitude modeling methods and requirements for design, development and certification of the structure and control systems for large space erectable structures and to provide analysis techniques for describing the dynamic characteristics (including loads and displacements) of large variable geometry structures. Similitude techniques will be used to establish scaling laws necessary to define the structural response of prototype structures from model test data. Once applicable similitude has been established, experimental approaches for verification will be designed, built and tested. The similitude relationships will then be used to design prototype structures, supported systems and attitude and stability control systems. Select variable geometry structural characteristics will be weighed against existing dynamic analysis capabilities to define development requirements and assess approaches necessary for extension. Analysis capabilities will be developed as required to adequately describe dynamic motions and loads for structures which are being deployed, assembled or manufactured in space.

W78-70485

910-31-08

Lyndon B. Johnson Space Center, Houston, Tex
ADVANCED CREW ACTIVITY PLANNING SYSTEM
J. A. Wegener 713-483-2541

The purpose of the study is to develop software techniques that provide advanced interactive computer capabilities for the Crew Activity Planner. The prototype planning modules developed through this study will be utilized for the preflight and real time automated generation of crew activity timelines for STS operations, and will provide capabilities directly applicable to autonomous on-board activity scheduling required for space station and space construction operations. The contractor will participate in the requirements definition and conceptual design studies to support the development of the crew activity planning system. The contractor will then develop and implement the software required utilizing GFE computers.

W78-70486

910-31-10

Goddard Space Flight Center, Greenbelt, Md.
CONTINGENCY IN-ORBIT SERVICING STUDY
James E. Phenix 301-982-4121

The objective of this RTOP program is to develop and demonstrate the concepts necessary to: (1) perform planned EVA and emergency jettison of Flight Support System (FSS) safety critical elements; (2) perform Remote Manipulator System (RMS) deploy/retrieval of MMS-class spacecraft directly from/into the retention cradle (RC); and (3) develop design concepts for an RMS end effector capable of removing or installing spacecraft appendages such as solar arrays, antennas, etc. The specific

objectives related to these three operations are as follows (1) determine Flight Support System (FSS) structural/mechanical interface designs which permit efficient EVA disassembly; (2) determine FSS RMS grapple interface designs which permit RMS removal and Orbiter separation; (3) determine EVA tool designs necessary for disconnecting jettisonable FSS elements; (4) determine procedures and remote TV and lighting requirements for RMS MMS direct to retention cradle berthing; (5) determine RMS end effector tool design requirements necessary for the installation or removal of nonstandard payload appendages

W78-70487**910-31-13**

Lyndon B Johnson Space Center, Houston, Tex

SPACE DEBRIS

D J Kessler 713-483-5311

As the number of objects in Earth orbit increases, a point will be reached where collisional break-up becomes a significant source of new objects. This process parallels the evolution of the asteroid belt, but in a much shorter time frame. Once the process begins, a belt of debris will be formed that potentially will exceed the natural meteoroid flux near Earth. The objectives of this study are to: (1) define the debris environment in Earth orbit; (2) determine when collisional break-up will become a significant source; (3) determine the consequences of this source; (4) evaluate the most effective actions to minimize the hazard to other spacecraft; (5) determine when these actions are required; and (6) evaluate the need for a space based experiment. The objectives will be accomplished through a combination of math modeling, ground based observation, and hyper-velocity impact test

W78-70488**910-31-15**

Goddard Space Flight Center, Greenbelt, Md

SPACECRAFT RETRIEVAL AIDS

David Suddeth 301-982-2697

The objective of the satellite-mounted deployable boom system study is to develop a design approach for a mechanism suitable for aiding the Shuttle during spacecraft retrieval operations. Spacecraft of different weights may require differences in the design. This study is intended to establish those differences as well as a fundamental design approach. A combination of in-house and out-of-house effort is required to support the above objectives. The orbital relationship among the Shuttle, the spacecraft and the RMS fitting at the end of the boom will be compared, the dynamics of the boom and the deploying-retracting mechanism will be evaluated

W78-70489**910-31-16**

Lyndon B Johnson Space Center, Houston, Tex.

FORMULATION OF CONSUMABLES MANAGEMENT MODELS FOR ADVANCED SYSTEMS STUDIES

Walter Scott 713-483-3278

The objective is to provide the capability for effective modeling and data management of consumables-related subsystems performance analysis of advanced missions and spacecraft in support of consumables analysis. The objective stated above will be accomplished through the following steps (1) identify advanced component and performance analysis requirement for advanced space vehicle system including definition of specific characteristics and requirements for management of subsystem with regard to criticality of sequencing of events, consumable loading, dump and resupply scheduling, and redline criteria; (2) establish menu of current and anticipated future state-of-the-art components and networks that may be applied to advanced spacecraft; (3) develop an interactive/conversational computer program for performance analysis of consumables-related subsystems with maximum utilization of existing software; and (4) verify and document the program

W78-70490**910-32-00**

Lyndon B Johnson Space Center, Houston, Tex

ADVANCED TECHNOLOGY--NONVOLATILE SEMICONDUCTOR MEMORY

Michael K. Hendrix 713-483-4061

The objective of this development is the acceptability demonstration through thorough evaluation testing of a low cost,

standardized, prototype non-volatile (information is retained if power to the device is lost) semiconductor memory. This device may be used advantageously in experiments control systems, and particularly in data systems applications where low power, small size, and high reliability are required. The memories will be designed as a standardized functional block which can be assembled into large, low cost, mass memory arrays. This development effort will be conducted in three stages: (1) A previously completed study was made to determine which microelectronic integrated circuit technology best satisfied the performance, cost, and reliability requirements consistent with the specific data storage applications. The results of this study will be used to define the design requirements for the microelectronic chip. (2) A microelectronic chip will be designed, fabricated, and tested. Key design parameters will be retention time, interrogation time, power dissipation, transient tolerance, and radiation resistance. Evaluation testing of key electronic parameters will verify performance of device and demonstrate its reliable use in higher level assemblies. (3) A microelectronic hybrid assembly (consisting of several non-volatile chips interconnected on a common substrate) will be designed, fabricated, and tested to the requirements of Data Systems Branch/EG4. The results of subsequent detailed evaluation testing will prove the acceptability of using the nonvolatile microelectronic chip in spacecraft systems applications.

W78-70491**910-33-00**

Lyndon B Johnson Space Center, Houston, Tex.

INFORMATION MANAGEMENT SYSTEMS

E. A Dalke 713-483-2851

The objective of this RTOP is to develop the technology of advanced information management systems required for large and complex manned and unmanned space systems operating in earth orbit environments. The basis for the advanced system will be a distributed architecture utilizing the maturing microprocessor technology to develop intelligent vehicle subsystems. Fibre optics will serve as the inter-system communication medium and holographic techniques will be evaluated for mass data storage and retrieval. Particular emphasis will be placed on the mechanization of techniques of fibre optics bus system representative of large information systems including methods of bus splitting and terminal connection in black boxes to insure proper data transmission and EMI compatibility. The approach will be to synthesize representative distributive architecture and to mechanize a laboratory version of critical system elements utilizing off-the-shelf microprocessors and fibre optics components to evaluate hardware/software concepts and resolve system issues. Representative fibre optics elements will also be subjected to EMI test and evaluation. EMC design guidelines and eventual design specifications will be documented. Holographic Technology applicable to mass data storage will be evaluated and high development risk areas assessed. Breadboard hardware will be fabricated to demonstrate the technology and to produce low cost light weight systems

W78-70492**910-33-00**

Marshall Space Flight Center, Huntsville, Ala.

INFORMATION MANAGEMENT SYSTEM

J B White 205-453-3987

(790-40-29, 656-50-01; 656-12-01, 656-21-02, 506-20-69; 506-20-59)

The objective of this effort is to define an advanced technology flight computational system which will be capable of performing, reliably, the functions required by space systems such as space base, large space structures, space transportation systems structures, and teleoperators/manipulators. Key technical areas to be addressed are requirements generation, definition of computational characteristics, candidate system architectures and configuration analysis and evaluation, definition of level of redundancy to be used, LSI technology selection, computational system specification, preliminary design, and fabrication and testing of an engineering breadboard. The approach which will be taken is cost effective, since full advantage will be taken of all the spinoff, fallouts, knowledge, and experience achieved from past and ongoing programs. No new computer components/circuits/modules will be developed, but maximum use will be

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made of off-the-shelf, commercially available LSI functional blocks and elements. These elements will be organized, employed, and interconnected in a manner to optimize the required configuration and yield performance compatible with the latest technology developments. Power, weight, and volume will be minimized through the application of LSI technology.

W78-70493 **910-35-00**
Lyndon B. Johnson Space Center, Houston, Tex
SYSTEMS ENGINEERING ANALYSIS
H. P. Davis 713-483-3083

Large scale operations in geosynchronous space will require the fueling of orbital transfer vehicles in low Earth orbit according to current concepts. The transfer of propellant to low Earth orbit and its subsequent use in the OTV's involves questions of zero-transfer and storage that need resolution in terms of the overall systems impact. This RTOP will provide a preliminary design definition and comparative systems analysis for several orbital propellant provisioning concepts. Techniques for the storage and transfer of propellants in orbit will be further defined and evaluated. The production of cryogenic oxygen and hydrogen by the electrolysis of water in orbit will be studied further based upon FY-77 study results and evaluated against conventional methods for a range of volume and usage rate requirements. Evaluation criteria will include technical risk and cost.

W78-70494 **910-36-00**
Lyndon B. Johnson Space Center, Houston, Tex
MECHANICAL SYSTEMS
C. Covington 713-483-4310

The objectives of the tasks covered in this RTOP include: (1) evaluation of design concepts for space crane joints, end effectors, and control systems; (2) definition of operational requirements, design concepts and analysis, and evaluation of candidate concepts for orbital assembly berthing systems; and (3) development of a single unit electromechanical flight control actuator capable of performing rotor position sensing and tachometer functions. The approach will include: conducting an orderly phased program approach by developing system requirements to meet the technical objectives, conducting conceptual and/or preliminary design of candidate concepts and hardware requirements, and performing detailed design and manufacture of selected scaled or full sized hardware for in-house test and/or evaluation.

W78-70495 **910-37-00**
Marshall Space Flight Center, Huntsville, Ala
CRYOGENICS
E. H. Hyde 205-453-3626

The basic program objective is to develop a cryogen component technology base suitable for input into realistic trade studies involving cryogen propellant management subsystem options. Analytical studies, environmental parameters, and component development will be combined to establish design data on performance and reusability. Operational constraints and interface design criteria will be a principal output of the subsystem and system testing. Subsystem concepts will be tested to identify system interface problem areas and assess the maintenance/cost relationship. Advanced concepts developed under prior technology programs which have not been applied to flight vehicles, but already have a hardware development history, will be utilized. Specific propellant management areas to be assessed in combined component testing include Multilayer Insulation (MLI) reusability, zero-g propellant acquisition, and low or zero NPSH pumping. Analytical studies will define the parameters and components that control subsystem performance. Subsystem concepts will be integrated and tested to identify system interface problems and the maintenance/cost trade relationships.

W78-70496 **910-37-04**
John F. Kennedy Space Center, Cocoa Beach, Fla
CRYOGENICS
W. H. Boggs 305-867-2780

The FY-78 objective will be to complete the technology base for producing and handling slush oxygen and slush hydrogen

in preparation for future long space missions. This effort is in concept with related activities at JSC.

W78-70497 **910-38-00**
Lyndon B. Johnson Space Center, Houston, Tex
MATERIALS
R. E. Johnson 713-483-2050

The objectives of this RTOP are to provide technical design data applicable to the development and testing of large structures to be fabricated or assembled in space for the purpose of power generation in space or for the construction of large antenna in space. A second objective is to provide a room-temperature curing paint system that meets spacecraft compatibility requirements as well as providing an improvement over existing systems in flammability resistance. The approach to be taken in FY-78 will be to define material requirements from design definitions and environmental definitions now in work at JSC. From these requirements, coatings, films and composite materials will be selected for further study. No significant testing will be done in FY-78 but test techniques, equipment requirements and accept/reject criteria will be established for use in subsequent RTOP activity. The interior paint study will complete the development of a latex-fluorocarbon paint system by incorporating intumescent agents to improve fire resistance.

W78-70498 **910-38-00**
Marshall Space Flight Center, Huntsville, Ala.
MATERIALS
J. C. Horton 205-453-5090

The objectives of all the tasks described below are the development of materials, and the materials data, needed for advanced space systems requiring long life with a minimum of degradation in the space environment. Included will be the development and testing of new space lubricants, study of solar radiation effects on glasses and means of prevention, characterization of materials for expanded rigidized structures in space, and the study of the effects of space exposure and outgassing products on materials. All the tasks will be continuing efforts, except the last, which is a new start. The tasks include: (1) task 10-ferrofluid bearing lubrication development, (2) task 14-evaluation of space compatible lubricants, (3) task 15-evaluate effects of solar radiation on glasses, (4) task 16-expandable UV-rigidized materials for space structures, and (5) task XX-effects of space exposure on composite materials and effects of outgassing products on solar arrays.

W78-70499 **910-39-00**
Marshall Space Flight Center, Huntsville, Ala
AEROTHERMODYNAMICS
W. K. Dahm 205-453-3017

The objective of the RTOP is to provide engineering tools to solve critical aerothermodynamic problems of advanced space vehicles. The task to be performed is TASK 04 - Aerodynamics for aeromaneuvering and Aerobraking Vehicles. Tethered subsatellites and aerobraking and aeromaneuvering spacecraft operate in the hypersonic transitional rarefied gas flow regime of the upper atmosphere. Vehicle design requires confident prediction of aerodynamic characteristics; however, wind tunnel test capabilities are quite inadequate in this regime, and analytical means for aerodynamic design are virtually nonexistent. This task is to develop computer programs for aerodynamic and aerothermodynamic design of vehicles in this flow regime. Considerable lead time is required to give the programs maturity by the time they are to be applied. The task requires the solution of the full Navier-Stokes equation for low density, hypersonic flow around bodies of arbitrary shape and attitude. Finite rate chemical reactions must eventually be included. Modern computer capabilities render such solutions possible. Axisymmetric bodies will be treated at the start, proceeding eventually to arbitrary body shapes. Results will be checked against available wind tunnel data at the periphery of the regime, and against the available set of academic solutions.

W78-70500 **910-42-00**
Marshall Space Flight Center, Huntsville, Ala.
SIMULATION (ADVANCED HYBRID COMPUTING SYSTEM - AHSC)

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obtained by specialized data packages, will be utilized to verify aerodynamics and aerothermodynamic performance as well as resolve many basic fluid mechanic questions.

W78-70295

750-04-04

Langley Research Center, Langley Station, Va
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING (SILTS)

J. C. Dunavant 804-827-3984
(506-26-13)

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 of leeside surface temperatures during shuttle orbiter entry with an infrared scanner. 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. This experiment utilizes a highly developed infrared scanner and recording system which will be qualified for the severe ascent environment in a development program at the Langley Research Center. The instrumentation and supporting equipment will be installed in a pod and tested by the Langley Research Center, the structural pod will be manufactured by the shuttle orbiter contractor, and the experiment installation modification kit will be delivered to the Palmdale orbiter assembly site for installation in the Orbiter 102. The SILTS instrument will be installed at KSC.

W78-70296

750-04-05

Ames Research Center, Moffett Field, Calif
INFRARED IMAGERY OF SHUTTLE
B. L. Swenson 415-965-5263

The objective is to design, develop, and conduct an experiment to be used in conjunction with the first orbital flights of Shuttle. The experiment is part of the Orbiter Experiments program and will obtain measurements of surface temperature of the lower and side surfaces of Orbiter by means of remote high resolution infrared imagery. This imagery is obtained on board the C-141 Airborne Infrared Observatory. The experimental equipment to be developed consist of an acquisition telescope and appropriate servo system, a cryogenically cooled focal plane and detector array, and a data handling and storage system.

W78-70297

750-04-06

Ames Research Center, Moffett Field, Calif
OEX THERMAL PROTECTION EXPERIMENTS
H. K. Larson 415-965-5369
(506-16-41)

The objectives of these experiments will be (1) the flight demonstration of advanced thermal protection systems (TPS) materials for the Shuttle Orbiter and (2) to obtain a better understanding of TPS re-entry heating effects that may permit TPS cost and weight reductions for shuttle and advanced Space Transportation Systems. Five separate experiments will be flown as test panels or tiles replacing baseline TPS on the Shuttle Orbiter during Orbital Flight Tests (OFT) and operational flights. These experiments will take advantage of the real entry heating environment that cannot be fully simulated in ground facilities to demonstrate advanced TPS materials for possible orbiter retrofit and to investigate TPS heating effects. Temperature data will be obtained with existing and follow-on orbiter instrumentation. Baseline TPS procedures and tooling will be used, and none of the experiments will impact orbiter operations. The experiments will be designed and fabricated by both in-house and contract efforts, and experiment hardware will be provided as GFE.

W78-70298

750-05-01

Marshall Space Flight Center, Huntsville, Ala.
SHUTTLE TECHNOLOGY PAYLOAD PROGRAM SUPPORT
Dave Gardiner 205-453-2277

Technical and programmatic support will be given the OAST Shuttle/Spacelab Payloads Office in the following areas of the Office's responsibility (1) Identification of R&T program efforts that can be advanced through Shuttle-borne space experiments;

(2) selection of efforts warranting definition studies, (3) review of definition study results and project plans, (4) preparation of announcements of opportunity and evaluation of experiment proposals subsequently received, (5) preparation of supporting data to be utilized in the selection of experiments and payloads; (6) maintenance of an experiment/payload data bank, (7) determination of mission/payload feasibility, (8) preparation and justification of mission models, (9) verification of Space Transportation System (STS) accommodations and requirements for planned mission, and (10) assurance that experiment development/implementation phase efforts remain compatible with mission requirements and STS accommodations. To aid in experiment acquisition efforts, MSFC will furnish the chairmen for peer evaluation groups and the executive secretary to the OAST Experiment Review Subcommittee. Remaining support activities will be furnished by normal MSFC organizational activities.

OFFICE OF APPLICATIONS

Technical Consultant and Support Studies

W78-70299

643-10-01

Goddard Space Flight Center, Greenbelt, Md
TECHNICAL CONSULTATION SERVICES
John E. Miller 301-982-5885

The objectives are to perform studies and collect corroborative data supporting frequency allocations for space applications leading to efficient orbit-spectrum utilization and providing technical support to NASA's Technical Consultation Services Program. The major elements are (1) orbit-spectrum utilization studies, (2) propagation and RFI modeling and measurements, and (3) special studies. This RTOP supports (1) public services communications satellites, (2) NASA application satellites (LANDSAT, Seasat, Search & Rescue, ATS-6, CTS etc.), (3) active and passive microwave/millimeter wave sensors, (4) data collection, and (5) NASA technical support to FCC and national preparation to the 1979 G-WARC and 1982 RARC-B. These in turn support the following end objectives (1) frequency allocation/coordination for NASA applications satellites, (2) NASA and U.S. positions for the 1979 G-WARC and 1982 RARC-B, and (3) promote the development and efficient utilization of space telecommunications systems. Expected results. Interference analysis, sharing criteria and frequency use plans for NASA applications mission will continue to be developed. Documentation for the Land-Mobile Satellite Service allocations will be completed. Papers/Reports will be prepared and critiqued for the 1979 G-WARC and 1982 RARC-B preparation. Modeling/prediction of attenuation and depolarization in the 10 - 40 GHz band due to rain will continue and be documented in the Propagation Handbook.

W78-70300

643-10-01

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
TECHNICAL CONSULTATION SERVICES
S. A. Brunstein 213-354-6219
(650-10-15)

The objective of this RTOP is to determine the technical and operational techniques that will allow effective space applications of the radio spectrum and of earth orbits while providing for equitable frequency and orbit sharing between services concerned. Also to actively support NASA/OA, OTP, FCC and DoS in gaining the necessary national and international acceptance of these techniques for efficient frequency and orbit utilization and sharing. The approach will be to determine the requirements and technical factors affecting each user, and then to develop an orbit and spectrum utilization design that allows effective operation and sharing by each user while minimizing

performance capability as a payload pointing system providing high accuracy pointing and stability (0.01 sec) and to demonstrate its payload isolation effectiveness from carrier vehicle disturbances. In addition, flight qualification of the integrated system will be provided and will thus establish payload pointing system technology commensurate with payload requirements for the 1980-1990 time period.

W78-70287**750-03-18**

Lewis Research Center, Cleveland, Ohio.

CRYOGENIC FLUID MANAGEMENT

Robert R. Lovell 216-433-4000

A shuttle spacelab flight experiment will be developed to obtain data on the storage and supply of subcritical cryogenic fluids in a low-g environment.

W78-70288**750-03-20**

Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

SPACE CALIBRATION OF SOLAR CELLS

R. G. Downing 213-354-6603

(506-23-15)

The objective of this program is to continue the solar cell calibration program taking advantage of the space environment of Spacelab and to correlate these data with those obtained from balloon flights. The Spacelab program will provide the opportunity to evaluate existing calibration procedures as applied to current and new types of photovoltaic devices being developed for future space solar power applications. Work to be accomplished in FY-78 includes evaluation of the balloon flight tracker and identification of design modifications which may be required to permit safe operation of this existing tracker design in the Shuttle/Spacelab environment.

W78-70289**750-03-21**

Lewis Research Center, Cleveland, Ohio

SPACELAB TWO PHASE HEAT TRANSFER

Robert R. Lovell 216-433-4000

(750-01-22; 506-21-12)

A Spacelab facility will be developed to provide a capability to perform two phase heat transfer experiments in the low-g environment of space. This effort will involve the user community throughout the design phase in order to make the facility as universal as possible.

W78-70290**750-03-25**

Lewis Research Center, Cleveland, Ohio

SPACELAB 0-G COMBUSTION

Robert R. Lovell 216-433-4000

(750-01-52; 506-21-42)

A Spacelab facility will be developed to provide a capability to perform combustion experiments in the low-g environment of space. This effort will involve the user community throughout the design phase in order to make the facility as universal as possible.

W78-70291**750-03-26**

Marshall Space Flight Center, Huntsville, Ala

GEOPHYSICAL FLUID FLOW EXPERIMENTS ON SPACE-LAB

George H. Fichtl 205-453-0875

This effort has as its objective the successful performance of geophysical fluid flow experiments on the first Spacelab mission with scientific team members Profs. John E. Hart (PI) and Jun Toomre (CI) of the University of Colorado; Dr. Peter Gilman (CI) of the High Altitude Observatory, National Center for Atmospheric Research, and Drs. George H. Fichtl (CI) and William Fowles (CI) of the NASA/MSFC. An experiment is viewed by the PI/CI team as being composed of the scientific theoretical and ground-based laboratory studies of PI/CI team members, the flight of the Geophysical Fluid Flow Cell (GFFC) (the instrument within which the experiments shall be performed) and the post flight analysis in which experimental and theoretical results will be analyzed, compared and correlated by the PI/CI team and other members of the scientific Geophysical Fluid Dynamics (GFD) community. The scientific approach for accomplishing the GFD experiments shall be to use a spinning spherical capacitor (in

earth orbit to eliminate background gravitational forces) with a dielectric fluid and an imposed radial electric field across the capacitor gap to simulate a radial gravitational force field to, in turn, simulate GFD systems like the convective zone of the sun, planetary atmospheres, etc. With this experimental arrangement the vector relationship between the simulated gravitational field and the rotation vector consistent with solar and planetary flows will be obtained. The programmatic approach will be a balanced effort involving (1) experiment instrument definition, (2) science definition and support; (3) instrument design, fabrication, and test; (4) flight of the instrument on the Spacelab, and (5) post flight data analysis and comparison and correlation of results with theoretical predictions.

W78-70292**750-03-27**

Marshall Space Flight Center, Huntsville, Ala

TRIBOLOGICAL EXPERIMENTS IN ZERO GRAVITY

Keith E. Demorest 205-453-1504

The following paragraphs summarize the technical scope of two tribological experiments selected for development for flight on Spacelab. (1) The experiment entitled, 'Tribological Studies of Fluid Lubricated Journal Bearings in Zero Gravity,' proposes the operation of a conventional journal bearing and of a journal bearing which utilizes ferrolubricants. Basic behavior characteristics of journal bearings operating in zero gravity should be provided by this experiment. (2) The experiment entitled, 'Wetting, Spreading and Operating Characteristics of Bearing Lubricants in a Zero Gravity Environment,' will monitor the wetting process for selected lubricant-surface combinations and provide an understanding of the mechanism of properly maintaining lubricant films and the effect of surface wettability on bearing performance and life in a space environment.

W78-70293**750-04-01**

Lyndon B. Johnson Space Center, Houston, Tex

ORBITER EXPERIMENTS (OEX)

Donald P. Gerke 713-483-3987

The OEX Program has been initiated in support of OAST to utilize the Space Shuttle as a research vehicle. The program objective is to collect data in the technology disciplines that will augment the research and technology base for future spacecraft design. The data will be collected by utilizing the currently planned DFI configuration, by modifications and/or augmentations to the present OFT baseline instrumentation, and by development of experiments beyond the DFI capabilities for flight on the orbiter. The primary goal of this activity is a more efficient utilization of the STS capabilities to obtain data with which to advance spacecraft technology. This RTOP includes the effort associated with project initiation, project support, experiment development initiation, experiment compatibility assessments, experiment integration activities, and integration hardware development initiation. The experiment development effort is the subject of additional RTOP's from the appropriate NASA Centers. This RTOP is for FY-78 only.

W78-70294**750-04-02**

Langley Research Center, Langley Station, Va

SHUTTLE ENTRY AIR DATA SYSTEM (SEADS)

P. M. Siemers 804-827-3984

(506-26-13; 506-26-33)

The objectives are 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 provide a data base for studies of future aeronautical and aerospace vehicles. The design, development, and calibration of the Shuttle Entry Air Data System will be accomplished through in-house (LaRC) analysis and test programs supported by contracted studies. The installed instrumented, nose cap incorporating the Shuttle Entry Air Data System will obtain flight data during each orbiter flight. These data, in conjunction with inertial data, development flight instrumentation data, and data

R L Lawrence 205-453-5935

The objective is to cosponsor the design and development of an Advanced Hybrid Computing System (AHCS) with the Department of the Army, in particular, the Command of BRL, which will direct an all-digital approach to the AHCS, and MICOM, which will direct the analog attempt. This objective should be met by the early 1980's. Another objective is to jointly participate in defining and reviewing the hardware and software requirements and system architecture for the prototype development of the AHCS and evaluation of these prototypes. The cosponsoring government agencies will have representation on a committee which will contract Phase B studies and monitor the efforts on these contracts. It is anticipated that Phase C and D efforts will be follow-on contracts to Phase B studies. NASA will transfer funds to the two different commands, as needed, to participate in this project (as BRL has contracted for the digital AHCS to be delivered in March 1979, all NASA funds will be used by MSFC and MICOM). Optional funding will allow NASA a hardware prototype from this effort.

W78-70501

910-47-00

Marshall Space Flight Center, Huntsville, Ala

ENVIRONMENT CONDITIONS

W C Snoddy 205-453-2573

The objectives are to characterize the naturally occurring environmental phenomena of spacecraft charging and the effects on charging caused by different surface materials, and to define an optimum system for the prediction of impending changes in the spacecraft environment due to eruptions of major solar flares. These objectives will impact the design and operations of geosynchronous space structures. The approach will be to extract appropriate data from existing sources such as AST-6, plan additional measurements using the upcoming SCATHA and ISEE satellites, develop models of the interaction of large space structures with the environment, carry out an engineering assessment, and develop design criteria. For the second objective, a correlative analysis of solar flare data will be undertaken to determine those observations that serve as flare precursors. Specific data to be used are Skylab/ATM flare observations, NOAA satellite data and data obtained with the MSFC vector magnetograph facility (RTSM). A flare alert system will then be defined recommending, as appropriate, the use of existing and planned ground-based and satellite facilities. To accomplish these objectives the following tasks will be performed:
Task 01 - spacecraft charging at geosynchronous orbit, and
Task 02 - solar flare alert system definition.

W78-70502

910-49-02

John F. Kennedy Space Center, Cocoa Beach, Fla

METEOROLOGICAL INFORMATION SYSTEMS

P D Toft 305-867-2780

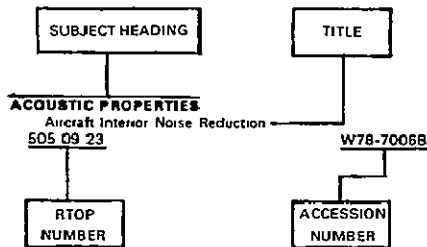
The objective of this effort is the improvement of meteorological forecasting and data gathering, transmission, and analyses at the Kennedy Space Center (KSC).

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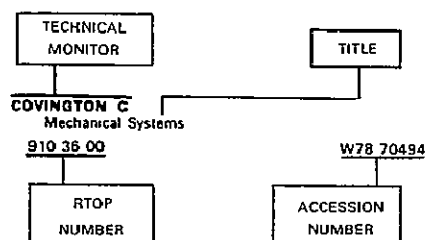
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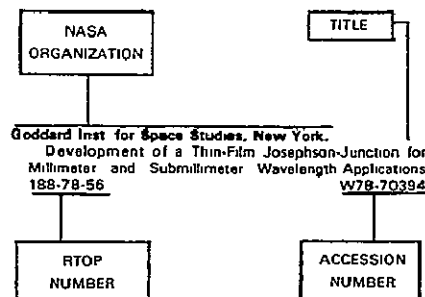
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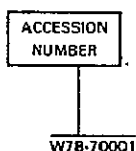
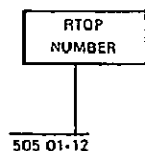
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