Research and Technology Operating Plan

SUMMARY

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FISCAL YEAR 1972

RESEARCH AND TECHNOLOGY PROGRAM

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INTRODUCTION

This publication represents the NASA Research and Technology program for FY 1972. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Operating Plan) 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.

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

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

National Aeronautics and Space Administration
Office of Advanced Research and Technology
Resources and Institutional Management Division (RMS)
Washington, D.C. 20546

Roy P. Jackson
Associate Administrator for
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OFFICE OF MANNED SPACE FLIGHT

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OFFICE OF ADVANCED RESEARCH & TECHNOLOGY

RESEARCH AND TECHNOLOGY OPERATING PLAN

a summary **FISCAL YEAR 1972**

RTOP NO. 110-06-08 TITLE: FLIGHT PATH DESIGN PROGRAM AND INTERACTIVE GRAPHICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

IN THE COURSE OF DESIGNING THE FLIGHT-PATH AND RELATED PARAMETERS FOR A SPACE MISSION, THE MISSION ANALYST (MA) MUST EVALUATE THE OUTPUT FROM THE SEQUENTIAL EXECUTION OF MANY RELATIVELY COMPLEX PROGRAMS, CHANGE-MISSION PARAMETERS, AND MAKE MANY TRADE-OFF STUDIES TO DETERMINE HOW BEST TO SATISFY THE MISSION OBJECTIVES, WHILE STILL IMPOSING THE LEAST NUMBER OF UNDESIRABLE CONSTRAINTS UPON THE VARIOUS SYSTEMS COMPRISING THE OVERALL PROJECT. THE PROCEDURE IS VULNERABLE TO DELAYS CAUSED BY NORMAL PROCESSING OF THE INDIVIDUAL COMPUTER RUNS, AND MANUAL PLOTTING OF THE NEEDED DATA. THUS, IT IS DIFFICULT FOR THE MISSION ANALYST TO RESPOND QUICKLY TO CHANGES IN MISSION PLANS AND GROUND RULES AT VARIOUS STAGES DURING THE MISSION SELECTION AND DESIGN PERIOD. WITH THE AID OF THE "THIRD-GENERATION" COMPUTER SYSTEMS (SUCH AS UNIVAC 1108 OR IBM 360 AND ASSOCIATED GRAPHICS HARDWARE), A PRELIMINARY FLIGHT PATH DESIGN PROGRAM (FPDP) IS BEING DEVELOPED BY PULLING TOGETHER THE 'BEST' EXISTING CHECKED-OUT PROGRAMS AS "SUBPROGRAMS" WHICH CAN NOW BE ACCESSED FROM A MASTER CONTROL MODULE (MCM). THE MCM FORMS THE 'BRAIN' OF THE FPDP, AND CONTAINS THE NECESSARY LOGIC TO ENABLE THE MA TO UTILIZE THE VARIOUS SUBPROGRAMS WHILE STILL MAINTAINING THE SIMPLEST FLOW OF KEY PARAMETERS ACROSS THE VARIOUS INTERFACES.THE MCM ALSO 'KNOWS' WHAT INFORMATION TO REQUEST FROM THE MA AT EACH STEP DURING THE INTERACTIVE MISSION DESIGN PROCESS. BY THE END OF FY'71, THE FPDP WILL ALLOW THE MA TO PERFORM A MAJOR PORTION OF THE NECESSARY DESIGN AND ANALYSIS OF SINGLE AND MULTI-PLANET FLYBY MISSIONS FROM A REMOTE GRAPHICS TERMINAL RESULTING IN SIGNIFICANT DECREASES IN BOTH MAN AND MACHINE TIME. PLANNED----

RTOP NO. 110-06-09 TITLE: ADVANCED SPACE PROPULSION CONCEPTS AND ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO INVESTIGATE ADVANCED PROPULSION CONCEPTS FOR USE IN PLANETARY AND INTERPLANETARY SPACECRAFT. STUDIES ARE TO EVALUATE SYSTEM CHARACTERISTICS OVER A RANGE OF MISSION PARAMETERS. PERFORMANCE DATA AND COST DATA WILL BE OBTAINED. WHERE POSSIBLE, COMPARISONS WILL BE MADE TO OTHER METHODS OF PROPULSION. NUCLEAR ELECTRIC POWER SYSTEMS WILL BE CONSIDERED FOR COMMONALITY BETWEEN UNMANNED PROPULSION AND MANNED AUXILIARY POWER MISSIONS. BOTH TITAN CLASS AND SHUTTLE LAUNCH VEHICLES WILL BE ASSUMED IN DETERMINING MULTIMISSION PAYLOAD CAPABILITY.

RTOP NO. 110-06-11 TITLE: IMAGING SYSTEM QUANTITATIVE EVALUATION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

DETERMINATION OF TECHNOLOGY REQUIREMENTS FOR FUTURE SPACE IMAGING MISSIONS SHOULD BE BASED ON QUANTITATIVE EVALUATION OF PERFORMANCE. ELEMENTARY TECHNIQUES ADEQUATE FOR THE LIMITED OBJECTIVES OF "FIRST-LOOK" IMAGING MISSIONS ARE NOT ADEQUATE FOR THE SOPHISTICATED USE OF IMAGING SYSTEMS DEMANDED BY FUTURE MISSIONS. THE LARGE NUMBER OF COMPLEX PARAMETERS MUST BE HANDLED BY DIGITAL COMPUTER SIMULATION. COMPUTER TECHNIQUES WILL BE USED TO DEVELOP PERFORMANCE DATA. MERIT CRITERIA AND FUNCTIONS WILL BE DEVELOPED TOOPTIMIZE MISSION DESIGN AND TO EVALUATE EXPECTED MISSION PERFORMANCE. MERIT CRITERIA EVALUATION AND MAXIMIZATION WILL PROVIDE A GUIDE TO FUTURE TECHNOLOGY REQUIREMENTS.

RTOP NO. 110-06-12 TITLE: NAVIGATION SYSTEMS STUDY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6585
TECHNICAL SUMMARY

THE BASIC NASA MISSION OF SPACE EXPLORATION REQUIRES THAT SPACECRAFT BE NAVIGATED. NASA MUST BE ASSURED THAT THE TECHNOLOGY ASSOCIATED WITH DEEP SPACE NAVIGATION IS, AND WILL BE MAINTAINED ON A TIMELY BASIS, ADEQUATE TO PROPERLY EXPLOIT ITS PLANETARY MISSIONS. THE QUESTION HAS BEEN RAISED AS TO THE CAPABILITY OF PRESENT TECHNOLOGY FOR MEETING THE DELIVERY ACCURACY REQUIREMENTS FOR MISSIONS BEYOND VIKING AND THE CURRENT BASELINE OUTER PLANETS GRAND TOUR PROGRAM. THIS 3 MONTH LONG STUDY WILL RELATE CURRENT NAVIGATION SYSTEM ELEMENT STATE OF THE ART AND ONGOING SRT ACTIVITIES TO THE EXPECTED NAVIGATION REQUIREMENTS OF THE LIKELY SET OF CANDIDATE FUTURE MISSIONS. THE STUDY WILL ANSWER THE FOLLOWING QUESTIONS: 1. WHAT ARE THE CANDIDATE MISSIONS FOR THE LATE 1970'S AND 1980'S TIME PERIOD? 2. WHAT ARE THE NAVIGATION REQUIREMENTS AND THE CRITICAL NAVIGATION CHALLENGES ASSOCIATED WITH THESE MISSIONS? 3. IS NASA'S ABILITY TO CARRY OUT AND PROPERLY EXPLOIT PLANETARY MISSIONS LIKELY TO BE COMPROMISED BY A LACK OF PROGRAMMATIC DEVELOPMENT IN THE NAVIGATION SYSTEM AREA? 4. WHAT NEW PROGRAMS ARE NECESSARY TO ADDRESS THE CRITICAL NEEDS AND HOW SHOULD THIS PROGRAM DEVELOPMENT BE UNDERTAKEN? 5. HOW SHOULD THESE PROGRAMS BE TIME PHASED TO THEIR "NEED DATES"? 6. WHAT RECOMMENDATIONS SHOULD BE MADE TO IDENTIFY NEW CRITICAL RESEARCH AND ADVANCED DEVELOPMENT ACTIVITIES FOR THE FY '73? BY PROVIDING THE ANSWERS BEFORE THE END OF THE FIRST QUARTER OF FY '72, THE FINAL REPORT SHOULD BE VALUABLE IN PLANNING NAVIGATION SRT ACTIVITIES IN FY '73. THE JPL MANAGEMENT (REPRESENTED BY THE JPL NAVIGATION PROJECT) AND RELATED JPL EXPERTISE (WITH SUPPORT FROM ONGOING OART, OTDA AND OSSA----

RTOP NO. 111-05-01 TITLE: AEROSPACE SAFETY DATA BANK
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GOLDSTEIN, C. M. TEL. 216-433-6600
TECHNICAL SUMMARY

TO ESTABLISH AN AEROSPACE SAFETY DATA BANK TO GATHER, ANALYZE AND DISSEMINATE TECHNICAL SAFETY-RELATED INFORMATION AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS AND THE TECHNICAL COMMUNITY; TO ASSURE THAT INFORMATION ON THE LATEST STATE-OF-THE-ART REGARDING SAFETY IS AVAILABLE FOR USE IN PLANNING, DESIGN, FABRICATION, TESTING AND OPERATIONS OF AEROSPACE VEHICLES AND SYSTEMS AND ASSOCIATED GROUND FACILITIES. ASRDI WILL CALL ON ALL ELEMENTS OF NASA, ITS CONTRACTORS, AND OTHER ORGANIZATIONS TO PROVIDE BASIC, APPLIED AND OPERATIONAL DATA RELATED TO GROUND-BASED AND FLIGHT SAFETY EXPERIENCE FOR THE AEROSPACE SAFETY DATA BANK. INVESTIGATION WILL BE MADE OF SIMILAR ACTIVITIES IN GOVERNMENT AND INDUSTRY TO ESTABLISH THE EXTENT AND NATURE OF EXISTING COMPILATIONS OF ACCURATE DATA. LIAISON WILL BE ESTABLISHED WITH THESE ACTIVITIES TO ASSURE ACCESS TO THE INFORMATION CONTAINED IN THESE SOURCES AS NEEDED, AND/OR SELECTED INFORMATION WILL BE IDENTIFIED AND INCORPORATED INTO THE ASRDI AEROSPACE SAFETY DATA BANK AS APPROPRIATE. A MANAGEMENT MECHANISM WILL BE ESTABLISHED TO PROVIDE FOR THE FLOW OF ALL SUCH INFORMATION INTO THE DATA BANK. THE INFORMATION WILL BE ANALYZED, VERIFIED, CORRELATED AND QUALIFIED AS REQUIRED. THIS INFORMATION WILL BE MADE AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS, OTHER GOVERNMENT AGENCIES AND THE TECHNICAL COMMUNITY. IMPROVED METHODS OF STORING, SEARCHING AND RETRIEVING INFORMATION WILL HAVE A WIDESPREAD APPLICABILITY IN THE GENERAL AREA OF INFORMATION PROCESSING.

RTOP NO. 111-05-02 TITLE: AERONAUTICAL SAFETY RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: WEISS, S. TEL. 216-433-6898
TECHNICAL SUMMARY

ASRDI WILL MAINTAIN AN OVERVIEW OF AERONAUTICAL SAFETY RESEARCH PROGRAMS. IT WILL COMPARE CURRENT PROGRAMS WITH AIRCRAFT SAFETY INFORMATION REQUIREMENTS TO ESTABLISH THE NEED FOR ADDITIONAL RESEARCH. IN ASSOCIATION WITH THE OART, NASA CENTERS, AND THE AIRCRAFT COMMUNITY, CONDUCT RESEARCH PROGRAMS AS REQUIRED TO SEEK PRACTICAL SOLUTIONS TO SAFETY PROBLEMS ASSOCIATED WITH AIRCRAFT AND THEIR GROUND BASED ACTIVITIES. THESE RESEARCH PROGRAMS WILL BE DESIGNED TO PROVIDE NEW TECHNIQUES FOR HANDLING PRESENT SAFETY PROBLEMS AND THOSE ANTICIPATED BY THE INTRODUCTION OF NEW AIRCRAFT TYPES, NOVEL AIRCRAFT COMPONENTS AND UNCONVENTIONAL FUELS. ACCORDINGLY, ASRDI IS INVOLVED IN RESEARCH ON BAROMETRIC ALTIMETRY SYSTEMS, LUBRICATION SUMP FIRE MITIGATION, NON-DESTRUCTIVE EVALUATION OF MATERIALS, AND THE ORGANIZATION OF SAFETY RELATED LITERATURE ASSOCIATED WITH AIRCRAFT OPERATING PROBLEMS AND WITH THE MECHANICS OF STRUCTURAL FAILURE.

RTOP NO. 111-05-03 TITLE: SPACE SAFETY RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HACKER, P. T. TEL. 216-433-6898
TECHNICAL SUMMARY

THE OBJECTIVES ARE: (1) TO DEFINE THE REQUIREMENTS OF SPACE VEHICLE AND FACILITY SYSTEMS THAT MINIMIZE RISK AND (2) TO IMPROVE THE SAFETY OF SUPPORT FUNCTIONS IN NASA AND CONTRACTOR OPERATIONS IN THE INDUSTRIAL AND PUBLIC AREAS. SPACE VEHICLES REPRESENT COMPACT COMBINATIONS OF VITAL SYSTEMS IN WHICH A FAILURE IN ONE HAS A HIGH LIKELIHOOD OF DAMAGING THE OTHER. THE NEED FOR LOW SYSTEM FAILURE PROBABILITY AND HIGH RECOVERY RATE, SHOULD FAILURE OCCUR, IS MORE STRINGENT THAN PRESENT ENGINEERING EXPERIENCE OFTEN PROVIDES. TO IMPROVE THIS SITUATION, ASRDI WILL CONDUCT, OR HAVE CONDUCTED FOR IT, ENGINEERING EVALUATIONS OF EXISTING SAFETY RELATED INFORMATION, DRAWN FROM THE LITERATURE AND CURRENT PROGRAMS, WHICH FOCUS ON SPACE VEHICLE SAFETY TECHNOLOGY. GAPS IN INFORMATION WILL BE FILLED BY RESEARCH PROGRAMS CONDUCTED IN ASSOCIATION WITH OTHER SEGMENTS OF NASA. RESEARCH IS OFTEN REQUIRED TO PROVIDE A BASIS FOR IMPROVED SAFETY CODES, PRACTICES AND AUXILIARY SAFETY EQUIPMENT. ASRDI WILL CONTRIBUTE RESEARCH AND OTHER TECHNICAL SUPPORT TO IMPROVE THE RULES AND TECHNIQUES BY WHICH SAFETY IS ACHIEVED IN THE AEROSPACE INDUSTRY.

RTOP NO. 111-05-31 TITLE: NUCLEAR FLIGHT SAFETY RESEARCH AND ANALYSIS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE: (1) TO CONDUCT RESEARCH THAT WILL PERMIT ACCURATE AND AUTHORITATIVE PREDICTIONS OF REENTRY CONDITIONS FOR NUCLEAR SPACE POWER SYSTEMS, (2) TO CONDUCT RESEARCH LEADING TO THE ULTIMATE DEVELOPMENT OF NUCLEAR SPACE POWER SYSTEM INTACT REENTRY AND GROUND IMPACT VEHICLES, AND (3) TO PARTICIPATE IN AND PROVIDE SUPPORT FOR THE JOINT DOD/AEC/NASA NUCLEAR FLIGHT SAFETY REVIEW AND EVALUATIONS. TIME-TO-MELT AND HEATING-RATE EXPERIMENTS WILL BE PERFORMED ON THERMALLY SCALED MODELS AT APPROPRIATE ARC JET TEST CONDITIONS. CANDIDATE CONFIGURATIONS WILL BE TESTED IN SHOCK TUNNELS AND WIND TUNNELS. RESULTS WILL BE APPLICABLE TO RADIOISOTOPE POWER SYSTEMS THAT ARE CANDIDATES FOR MANNED AND UNMANNED SPACE OPERATIONS.

RTOP NO. 111-05-34 TITLE: RECOVERY AIDS FOR AEROSPACE NUCLEAR SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THIS RTOP COVERS THE TECHNOLOGY DEVELOPMENT OF UNDERWATER SOUND GENERATORS DETECTION DEVICES THAT WILL PERMIT ACCURATE LOCATION OF NUCLEAR ELECTRICAL POWER SYSTEMS IN SEA WATER. THE SENSOR DESIGN WILL BE CAREFULLY ASSESSED TO ASSURE RELIABLE OPERATION AFTER VEHICLE REENTRY AND FREE-FALL WATER IMPACT.

RTOP NO. 113-26-11 TITLE: MERCURY ELECTRON BOMBARDMENT ION THRUSTER R/T
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: READER, P. D. TEL. 216-433-4000
TECHNICAL SUMMARY

THE BROAD OBJECTIVE OF THE WORK DESCRIBED HEREIN IS TO PROVIDE THE BASIC RESEARCH AND TECHNOLOGY PROGRAMS NECESSARY TO ENSURE ORDERLY AND MEANINGFUL ADVANCES IN THE STATE-OF-THE-ART OF ELECTROSTATIC THRUSTERS. THE OVERALL PROGRAM IS DIRECTED AT OBTAINING A MORE THOROUGH UNDERSTANDING OF THE BASIC PHYSICAL PROCESSES OCCURRING IN ELECTROSTATIC THRUSTERS BY CONDUCTING PERTINENT EXPERIMENTAL AND ANALYTIC STUDIES; APPLYING THE KNOWLEDGE GAINED TO THE DESIGN, FABRICATION AND TESTING OF NEW THRUSTER COMPONENTS; INTEGRATION OF PROMISING NEW COMPONENTS INTO THRUSTERS SIZED FOR WIDEST POSSIBLE APPLICATIONS AND EVALUATING THRUSTER PERFORMANCE AND LIFE. A MAJOR PROGRAM IS DIRECTED AT PRODUCING A FLIGHT READY CLUSTER OF MERCURY ELECTRON-BOMBARDMENT ION THRUSTERS OF HIGH EFFICIENCY AND DURABILITY SUITABLE FOR MISSION APPLICATION. A SPECIFIC GOAL IS TO PROVIDE A QUALIFIED THRUSTER FOR SYNCHRONOUS SATELLITE RAISING MISSIONS AND 1.0 TO 3 A.U. INTERPLANETARY MISSIONS. PERTINENT INFORMATION FROM EXPERIMENTAL AND ANALYTICAL STUDIES AND DEMONSTRATED COMPONENTS WILL BE INTEGRATED INTO A SPECIFIC THRUSTER SYSTEM DESIGN. THIS DESIGN WILL COVER THE WIDEST POSSIBLE RANGE OF CURRENTLY FORESEEN MISSION TYPES. STUDIES AND INVESTIGATIONS INTO THRUSTER SYSTEM INTERACTION AND INTEGRATION PROBLEMS WILL BE CONDUCTED TO THE EXTENT NECESSARY TO CLEARLY DEFINE INTERFACE PROBLEM AREAS.

RTOP NO. 113-26-12 TITLE: ADVANCED ELECTRIC THRUSTER RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SEIKEL, G. R. TEL. 216-433-4000
TECHNICAL SUMMARY

TO STUDY ADVANCED ELECTRIC THRUSTERS THAT SHOW PROMISE FOR SPACE MISSIONS. INVESTIGATIONS ARE AIMED AT UNDERSTANDING THE PHYSICS OF THE PROCESSES IN THE THRUSTERS, ACHIEVING EFFICIENT PERFORMANCE, AND DELINEATING MEANS FOR OBTAINING LONG LIFE, LIGHTWEIGHT, AND RELIABLE THRUSTER SYSTEMS. ANALYTICAL STUDIES AND EXPERIMENTAL STUDIES WHICH INCLUDE EXTENSIVE DIAGNOSTICS AS WELL AS THRUST AND ENERGY EFFICIENCY MEASUREMENTS. LIFETIME AND SYSTEM COMPONENT PROBLEMS WILL ALSO BE INVESTIGATED. ADVANCED ELECTRIC THRUSTERS FOR BOTH HIGH AND LOW POWER WILL BE INVESTIGATED.

RTOP NO. 113-26-13 TITLE: RESISTOJET SYSTEM TECHNOLOGY FOR MANNED SPACE STATION REACTION CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE APPLICATION OF BIOWASTE RESISTOJETS ON THE SPACE STATION TO PROVIDE THE IMPULSE REQUIRED FOR CONTROL MOMENT GYRO (CMG)

DESATURATION AND ORBIT MAINTENANCE. THESE UNITS SHALL HAVE HIGH PERFORMANCE, LONG LIFE AND MINIMUM POWER CONSUMPTION. A HIGH THERMAL EFFICIENCY AMMONIA - HYDROGEN RESISTOJET WAS DEVELOPED AS PART OF THE MORL PROGRAM. THE BIOWASTE RESISTOJET CURRENTLY UNDER DEVELOPMENT IS AN EVOLUTION OF THE MORL DESIGN, WITH THE INCORPORATION OF HEATER MATERIALS COMPATIBLE WITH THE OXIDIZING BIOWASTE GASES AT THE HIGH TEMPERATURE REQUIRED FOR GOOD PERFORMANCE. THE MORL AND ALTERNATE RESISTOJET CONCEPTS ARE BEING EVALUATED FOR PROPELLANT PERFORMANCE, LIFE, POWER CONSUMPTION AND SYSTEM SUITABILITY. A PROGRAM HAS BEEN INITIATED TO DEVELOP THE PROPELLANT COLLECTION AND MANAGEMENT SYSTEM REQUIRED TO INTERFACE THE RESISTOJET WITH THE LIFE SUPPORT SYSTEM. STUDIES CONDUCTED BY THE PRIME SPACE STATION CONTRACTORS HAVE PROVIDED INFORMATION REGARDING THRUSTER DUTY CYCLES, THRUST LEVELS, PROPELLANT AVAILABILITY, ETC. THIS INFORMATION WILL BE USED IN FUTURE THRUSTER EVALUATION PROGRAMS AND IN THE DEVELOPMENT OF A PROTOTYPE PROPELLANT COLLECTION AND SUPPLY SYSTEM. THE COMBINED THRUSTER AND PROPELLANT COLLECTION SYSTEM WILL THEN BE TESTED AT LRC TO REVEAL SYSTEM OPERATIONAL CHARACTERISTICS, RESISTOJET-LIFE SUPPORT SYSTEM INTERFACE PROBLEMS AND TO DEMONSTRATE THE TOTAL SYSTEMS CAPABILITY TO PROVIDE THE IMPULSE REQUIRED ON A DUTY CYCLE DICTATED BY CMG AND ORBIT MAINTENANCE REQUIREMENTS.

RTOP NO. 113-26-14 TITLE: ADVANCED PLASMA THRUSTER RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THERE ARE PRESENTLY TWO TYPES OF PLASMA THRUSTERS BEING FUNDED THROUGH LANGLEY RESEARCH CENTER, A REPETITIVELY PULSED QUASI-STEADY THRUSTER (I.E., MILLISEC. CURRENT PULSE) AND SHORT PULSED TEFLON-FEED THRUSTER (I.E., MICROSEC. CURRENT PULSES) SIMILAR TO THE PLASMA THRUSTER BEING UTILIZED ON THE LES-6 COMMUNICATION SATELLITE. THE QUASI-STEADY THRUSTER IS BEING STUDIED FOR POSSIBLE APPLICATION FOR PRIMARY PROPULSION, WHILE THE SHORT-PULSED ENGINE IS BEING DEVELOPED FOR NORTH-SOUTH STATIONKEEPING ON SATELLITES IN THE 1000 TO 2000 LB. RANGE. RECENT RESEARCH ON THE SHORT-PULSED ENGINE HAS RESULTED IN A SUBSTANTIAL IMPROVEMENT IN PERFORMANCE, AND SHOWS GREAT PROMISE FOR NORTH-SOUTH STATIONKEEPING OF EARTH ORIENTED SATELLITES. THIS HAS BEEN ACCOMPLISHED THROUGH MODIFICATION OF THE PROPELLANT FEED SYSTEM AND AN INCREASE IN THE DISCHARGE ENERGY. RESEARCH ON THE SHORT-PULSED ENGINE WILL BE CONTINUED WITH EMPHASIS PLACED ON INVESTIGATING THESE EFFECTS AS WELL AS DESIGNING AND LIFE TESTING HARDWARE. RECENT RESEARCH ON THE QUASI-STEADY THRUSTER HAS LED TO A DETERMINATION OF THEIR PERFORMANCE AS A FUNCTION OF A NUMBER OF CRITICAL PARAMETERS WHICH IF EXCEEDED RESULTS IN EXCESS EROSION FROM ELECTRODES AND INSULATORS. FOR THE POWER LEVELS STUDIED TO DATE, THE PERFORMANCE HAS NOT BEEN HIGH ENOUGH TO MEET THE REQUIREMENTS OF A PRIME PROPULSION SYSTEM, ALTHOUGH IT IS WITHIN THE RANGE NECESSARY FOR NORTH-SOUTH STATIONKEEPING. THE PERFORMANCE DATA THAT HAVE BEEN OBTAINED CONTINUES TO INDICATE INCREASING PERFORMANCE WITH INCREASING INSTANTANEOUS POWER. RESEARCH ON THE QUASI-STEADY THRUSTER WILL BE CONTINUED WITH EMPHASIS PLACED ON OPERATION AT HIGH PULSEDPOWERS AND CONTINUED INVESTIGATION----

RTOP NO. 113-26-16 TITLE: ELECTRIC PROPULSION SYSTEMS TECHNOLOGY FOR UNMANNED PLANETARY/INTERPLANETARY SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PREPARE THE TECHNOLOGY OF SOLAR-POWERED ELECTRIC PROPULSION FOR UNMANNED MISSIONS. IT IS BROKEN INTO TWO MAJOR AREAS, NAVIGATION AND MISSION ANALYSIS, AND PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT. THE OBJECTIVE OF THE ELECTRIC PROPULSION NAVIGATION AND MISSION ANALYSIS EFFORT IS TO DETERMINE THE NAVIGATION REQUIREMENTS, MISSION REQUIREMENTS AND CHARACTERISTICS, AND SPACECRAFT AND SUBSYSTEM PERFORMANCE REQUIREMENTS THAT ARE PECULIAR TO PRIMARY ELECTRIC PROPULSION AND TO DEVELOP THE CAPABILITY FOR IDENTIFYING, ANALYZING AND CONDUCTING MEANINGFUL ELECTRIC PROPULSION MISSIONS. STATE ESTIMATION TECHNIQUES AND GUIDANCE/CONTROL TECHNIQUES ARE BEING DEVELOPED AND APPLIED TO PARTICULAR MISSIONS. MISSION AND TRAJECTORY STUDIES ARE CONDUCTED TO IDENTIFY AND EVALUATE FEASIBLE MODES OF OPERATION CONSIDERING ACTUAL SPACECRAFT LIMITATIONS. THE PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT EFFORT WILL EMPHASIZE THE ESTABLISHMENT OF A FIRM TECHNOLOGY BASE AND THE GENERAL UPGRADING OF THAT BASE TECHNOLOGY TO APPROACH FLIGHT REQUIREMENTS. THE BREADBOARD THRUST SUBSYSTEM DEVELOPED OVER THE PAST FOUR YEARS WILL BE UTILIZED AS A TEST BED TO EVALUATE SUBSYSTEM ELEMENT AND SYSTEM MODIFICATIONS FOUND DESIRABLE AS A RESULT OF CURRENT SEPST (SOLAR ELECTRIC PROPULSION SYSTEM TECHNOLOGY) III SYSTEM TESTING OR FROM MORE DETAILED SPACECRAFT AND MISSION STUDIES CONDUCTED AS PART OF THE SOLAR ELECTRIC MULTI-MISSION SPACECRAFT (SEMMS) EFFORT. ON THE ELEMENT LEVEL, PROPELLANT TANKS WILL BE SUBJECTED TO ENVIRONMENTAL TEST TO DETERMINE THE EFFECTS OF PROPELLANT OFF-LOADING ON TANK STRUCTURAL REQUIREMENTS AND ADVANCED TECHNOLOGY POWERCONDITIONING UNITS WILL BE INTEGRATED----

RTOP NO. 113-26-17 TITLE: AUXILIARY PROPULSION SYSTEMS TECHNOLOGY FOR UNMANNED SPACECRAFT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: CALLENS, R. A. TEL. 301-982-4205

TECHNICAL SUMMARY

UNMANNED METEOROLOGICAL, COMMUNICATION AND EARTH OBSERVATION SPACECRAFT REQUIRE, NOT ONLY LONG-LIVED, LIGHT-WEIGHT AUXILIARY PROPULSION SYSTEMS, BUT ALSO ONES CAPABLE OF PROVIDING NORTH-SOUTH STATION KEEPING, PRECESSION CONTROL, EAST-WEST STATION KEEPING OR VERY PRECISE ATTITUDE CONTROL. THE OBJECTIVE OF THIS TASK IS TO IDENTIFY AND DEVELOP THE AUXILIARY PROPULSION SYSTEMS NEEDED FOR THESE SOPHISTICATED SPACECRAFT. WHEN FEASIBLE, THE THRUSTER SYSTEMS WILL BE EVALUATED IN EITHER GSFC'S ELECTRIC PROPULSION LABORATORY OR THE HYDRAZINE TEST FACILITY. ADDITIONALLY, SPACE FLIGHT TESTS OF CANDIDATE SYSTEMS WILL BE CONDUCTED TO FURTHER DEMONSTRATE THEIR CAPABILITY FOR SPACE FLIGHT APPLICATION.

RTOP NO. 113-26-21 TITLE: PULSED PLASMA ATTITUDE CONTROL SYSTEM TECHNOLOGY FOR PLANETARY MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE: (A) TO COMPLETE THE FEASIBILITY ASSESSMENT OF AN IMPROVED PERFORMANCE REACTION CONTROL SYSTEM FOR LONG DURATION PLANETARY MISSIONS (B) TO DEVELOP ADVANCED TESTING FACILITIES FOR MICROTHRUSTER PERFORMANCE EVALUATION IN THE MICRONEWTON TO MILLINEWTON RANGE (C) TO SUPPORT OTHER NASA CENTER (GSFC, LARC) PULSED PLASMA THRUSTER DEVELOPMENT AND APPLICATIONS. THIS PROGRAM WILL EXTEND WORK CONDUCTED JOINTLY WITH THE GODDARD SPACE FLIGHT CENTER UNDER FY'71 NASA RTOP 120-26-17 TOGETHER WITH JPL RTOP 120-26-21.

RTOP NO. 113-31-01 TITLE: ZERO GRAVITY PROPELLANT TRANSFER TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: OTTO, E. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS RTOP OUTLINES A TECHNOLOGY PROGRAM THAT REVIEWS AND AUGMENTS THE PRESENT ZERO GRAVITY FLUID BEHAVIOR AND THERMAL PROTECTION TECHNOLOGY AND CULMINATES IN A FUNCTIONALLY AND ENVIRONMENTALLY TESTED ENGINEERING MODEL OF A LIQUID HYDROGEN TRANSFER FLIGHT EXPERIMENT. THE OBJECTIVE OF THE FLIGHT EXPERIMENT WOULD BE TO EVALUATE ONE OR MORE PROPELLENT TRANSFER SYSTEMS THUS PROVIDING TECHNOLOGY AND DESIGN DATA FOR PREDICTABLE AND EFFICIENT ZERO-G PROPELLANT TRANSFER OPERATIONS IN SPACE. THE PROGRAM IS TO BE CONDUCTED IN TWO PHASES - AN EXPERIMENT DEFINITION PHASE AND AN EXPERIMENT DEVELOPMENT PHASE. THE EXPERIMENT DEFINITION PHASE WILL CONSIST OF TWO PARALLEL STUDY CONTRACTS AUGMENTED BY IN-HOUSE RESEARCH. THE TWO MAIN OBJECTIVES OF THIS PHASE ARE (1) TO DEFINE AND CONDUCT THOSE ITEMS OF RESEARCH THAT FILL GAPS IN DATA NECESSARY FOR EXPERIMENT DEFINITION AND FOR DESIGN AND FABRICATION TECHNOLOGY, AND (2) TO DEFINE THE EXPERIMENT. THE FIRST PHASE LASTS UNTIL LATE CY 1973. THE EXPERIMENT DEVELOPMENT PHASE WILL CONSIST OF A CONTRACT FOR THE DESIGN, FABRICATION, AND TEST OF AN ENGINEERING MODEL OF THE FLIGHT EXPERIMENT TOGETHER WITH THE NECESSARY GROUND SUPPORT EQUIPMENT. IT IS TO BE CONDUCTED OVER A PERIOD OF TWO AND ONE HALF YEARS AND IS CONCLUDED IN LATE CY 1975.

RTOP NO. 113-31-02 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF ENGINE COMPONENTS FOR THE AUXILIARY PROPULSION SYSTEM OF THE SPACE SHUTTLE. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE THRUSTER ASSEMBLY, INCLUDING THE INJECTOR, THRUST CHAMBER, IGNITER, AND VALVES. THE OPERATING CONDITIONS FOR

THE EXPERIMENTAL WORK ARE SELECTEDTO FIT THE PARTICULAR REQUIREMENTS OF THE SPACE SHUTTLE. THIS INCLUDES OPERATION WITH GASEOUS HYDROGEN/GASEOUS OXYGEN PROPELLANTS AT THRUST LEVELS IN THE RANGE FROM 1500-2000 POUNDS, CHAMBER PRESSURES FROM 100-500 PSIA, AND APPROPRIATE RANGES OF PROPELLANT INLET PRESSURES AND TEMPERATURES. POINT DESIGN, NEAR-FLIGHT WEIGHT INTEGRATED THRUSTER ASSEMBLIES WILL BE FABRICATED AND TESTED TO PROVIDE AN EVALUATION OF OVERALL PERFORMANCE (BOTH PULSING AND STEADY-STATE), THRUSTER LIFE, AND OPERATING CHARACTERISTICS FOR TYPICAL DUTY CYCLES. OTHER PROGRAMS RELATING TO THE SUPPLY AND REGULATION OF THE PROPELLANTS FED TO THE ATTITUDE CONTROL ENGINES AS WELL AS MORE BASIC PROGRAMS TO EVALUATE CRITICAL PROBLEM AREAS IN COMBUSTION, VALVES AND IGNITION DEVICES ARE INCLUDED.

RTOP NO. 113-31-03 TITLE: DESIGN CRITERIA FOR CHEMICAL ROCKET PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: DOUGLASS, H. W. TEL. 216-433-6915
TECHNICAL SUMMARY

THIS PROGRAM IS DIRECTED AT THE DEVELOPMENT AND PUBLICATION OF UNIFIED DESIGN CRITERIA FOR CHEMICAL ROCKET PROPULSION, INCLUDING BOTH _LIQUID AND SOLID PROPELLANTS. THE PUBLICATIONS ARE TO BE COMPLETE AND AUTHORITATIVE DOCUMENTS FOR USE BY DESIGNERS AND PROJECT MANAGERS _IN DESIGNING FUTURE SPACE PROPULSION SYSTEMS AND IN IMPROVING PRESENT SYSTEMS. THE DOCUMENTS WILL BE IN THE FORM OF DESIGN CRITERIA MONOGRAPHS RELATING TO PARTICULAR PROPULSION COMPONENTS, SUBSYSTEMS, OR SYSTEMS. EACH MONOGRAPH WILL DISCUSS THE RELATED STATE OF THE ART, ESTABLISH DESIGN CRITERIA, PRESENT RECOMMENDED PRACTICES, AND REFERENCE LITERATURE USED AS THE BASIS FOR THE CRITERIA. THE MONOGRAPHS ARE BEING WRITTEN BY CONTRACTORS SELECTED BY THE NASA ON THE BASIS OF COMPETENCE, ACKNOWLEDGED LEADERSHIP IN THEIR FIELDS, AND ABILITY TO ESTABLISH AUTHORITATIVE AND RELIABLE DESIGN CRITERIA. THE CONTRACTOR ALSO _PREPARES A DOSSIER CONTAINING THE MATERIAL UPON WHICH THE MONOGRAPH _IS BASED, FOR RETENTION BY NASA FOR REFERENCE.

RTOP NO. 113-31-04 TITLE: CRYOGENIC STORAGE TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AUKERMAN, C. A. TEL. 216-433-6538
TECHNICAL SUMMARY

THE GENERAL OBJECTIVES OF THE PROGRAMS UNDER THIS RTOP ARE TO PROVIDE TECHNOLOGY FOR VARIOUS ASPECTS OF CRYOGENIC THERMAL PROTECTION SYSTEMS. THE SPECIFIC AREAS COVERED BY THESE PROGRAMS ARE: (1) SHADOW SHIELDS FOR LIQUID HYDROGEN TANKS, (2) A LIQUID HYDROGEN MIXING UNIT, (3) CRYOGENIC TANK SUPPORTS, AND (4) INTEGRATED THERMAL PROTECTION SYSTEMS. IN EACH AREA, THE OBJECTIVE IS TO DEMONSTRATE THE FEASIBILITY OF A NEW CONCEPT FOR IMPROVING THE CAPABILITY TO STORE LIQUID HYDROGEN IN SPACE VEHICLES. FOR THE CONCEPTS INVOLVING SHADOW SHIELDS, _THE MIXING UNIT AND TANK SUPPORTS, ANALYSIS AND DESIGN IS FOLLOWED BY THE FABRICATION OF COMPONENTS FOR THOROUGH

CRYOGENIC TEST AND EVALUATION. DESIGN INFORMATION AND ANALYTICAL PROGRAMS WILL ALSO BE DEVELOPED. THE PROGRAM ON INTEGRATED THERMAL PROTECTION SYSTEMS IS PRIMARILY A SYSTEM STUDY TO PRODUCE AN INTEGRATED THERMAL/METEOROID PROTECTION DESIGN. ONLY NOMINAL SUPPORT TESTING WILL BE CONDUCTED.

RTOP NO. 113-31-05 TITLE: SPACE STORABLE PROPULSION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CONRAD, E. W. TEL. 216-433-6874
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT, SUBSYSTEM _AND SYSTEM DESIGN CRITERIA FOR PROPULSION SYSTEMS USING MODERATE CRYOGENIC (SPACE STORABLE) AND DEEP CRYOGENIC (HYDROGEN) PROPELLANTS TO _DEMONSTRATE THE PERFORMANCE AND TECHNOLOGY READINESS OF PROPULSION MODULES USING BOTH PROPELLANT TYPES FOR SIMULATED MISSIONS OF UP TO 1200 DAYS. THE PROGRAM OBJECTIVES WILL BE MET THROUGH DESIGN, FABRICATION AND DEMONSTRATION TESTING OF TWO RESEARCH PROPULSION MODULES. NEAR FLIGHT WEIGHT HARDWARE WILL BE USED AND CONSIDERATION GIVEN TO AREAS OF SYSTEM INTERACTION, SPACE ENVIRONMENT AND LAUNCH VEHICLE AND PAYLOAD CONSTRAINTS AND INTERFACES. THE PROGRAM WILL DEVELOP AND DEMONSTRATE TECHNOLOGY IN FOUR AREAS: (1) INVESTIGATION OF A COMPLETE FLUORINE-COMPATIBLE PROPELLANT FEED SYSTEM (INCLUDING PRESSURIZATION) FOR BOTH STEADY STATE AND DYNAMIC OPERATING CHARACTERISTICS; (2) DEMONSTRATION OF THERMAL PERFORMANCE OF TWO INTEGRATED PROPULSION MODULES SUITABLE FOR DEEP SPACE APPLICATION; (3) STUDY AND DEMONSTRATION OF AN ATTITUDE CONTROL PROPULSION SYSTEM, WITHEMPHASIS ON PULSED OPERATION; AND (4)---- MISSION SIMULATION OF EACH MODULE (INCLUDING PERTINENT SUBSYSTEMS) THROUGH GROUND HOLD, LAUNCH, EARTH ORBIT, SPACE COAST AND NONFIRING SYSTEM OPERATION. IN ADDITION, A TECHNOLOGY PROGRAM, WHICH HAS BEEN DIRECTED AT CRITICAL----

RTOP NO. 113-31-06 TITLE: LIQUID PROPULSION SYSTEMS TECHNOLOGY FOR PLANETARY SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE MAJORITY OF THE WORK CONDUCTED UNDER THIS RTOP IS DIRECTED TOWARD THE DEMONSTRATION OF THE PERFORMANCE AND OPERATIONAL CAPABILITY OF A SPACE STORABLE PROPULSION MODULE UNDER SIMULATED ENVIRONMENTAL TEST CONDITIONS, FOR USE ON PLANETARY SPACECRAFT SUCH AS JUPITER OR SATURN ORBITERS. A PROTOTYPE DEMONSTRATION PROGRAM WILL BE CONDUCTED IN ORDER TO GAIN AN UNDERSTANDING OF SUBSYSTEM INTERACTIONS AND TO UNCOVER UNFORESEEN OPERATIONAL AND HANDLING PROBLEMS WHICH WOULD AFFECT SUBSYSTEM DESIGNS. THE DEMONSTRATION SYSTEM INITIALLY WILL USE CURRENTLY AVAILABLE FLIGHTWEIGHT COMPONENTS FROM SPARE MARINER '71 SYSTEMS AS APPROPRIATE. A HEAVYWEIGHT FLOX/MMH ENGINE WILL BE USED IN THE INITIAL TEST SERIES. AN ALUMINUM, TYPE 2219, TANK WILL BE USED FOR THE OXIDIZER. AS HIGHER RELIABILITY, HIGHER PERFORMING COMPONENTS BECOME AVAILABLE FROM

SUPPORTING UNITS, THEY WILL BE SUBSTITUTED FOR THE ORIGINAL COMPONENTS. AFTER THE SYSTEM HAS UNDERGONE THE CHANGE FROM BREADBOARD TO FLIGHTWEIGHT, IT WILL BE CARRIED THROUGH A MODIFIED PREFLIGHT RATING TEST. THE FIRST FIRING OF THE INITIAL CONFIGURATION IS SCHEDULED TO TAKE PLACE IN JUNE, 1972. DURING FY'72, THE DEVELOPMENT OF THE ATTITUDE PROPULSION SYSTEM FOR THE TOPS R/AD ACTIVITY WILL BE COMPLETED; AN ANALYSES WILL BE MADE ON WAYS TO INTEGRATE A SIMILAR ATTITUDE PROPULSION SYSTEM INTO THE SPACE STORABLE PROPULSION MODULE.

RTOP NO. 113-31-08 TITLE: LIQUID ROCKET PROPULSION RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: PRIEM, R. J. TEL. 216-433-6259
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE NEW TECHNOLOGY AND TO ACHIEVE ENGINEERING AND SCIENTIFIC IMPROVEMENTS IN THE PERFORMANCE, RELIABILITY, STABILITY AND COOLING OF LIQUID ROCKET PROPULSION SYSTEMS BY UNDERSTANDING AND CONTROLLING THE PHYSICAL AND CHEMICAL PROCESSES IN SUCH SYSTEMS. THESE OBJECTIVES WILL BE ATTAINED THROUGH: (1) CONTRACTED THEORETICAL STUDIES TO DELINEATE THE IMPORTANT DESIGN PARAMETERS REQUIRED TO ACHIEVE ENGINEERING IMPROVEMENTS; (2) IN-HOUSE AND CONTRACTED EXPERIMENTAL STUDIES TO DEMONSTRATE THE VALIDITY OF SPECIFIC _THEORETICAL APPROACHES AND/OR DESIGN PARAMETERS; AND (3) CONTRACTED EXPLORATORY STUDIES TO INVESTIGATE NEW TECHNIQUES OR THEORETICAL APPROACHES THAT WILL AID IN OBTAINING FURTHER ENGINEERING IMPROVEMENTS IN LIQUID ROCKET ENGINES. AREAS IN WHICH THIS EFFORT WILL BE APPLIED _ARE: 1. STABLE COMBUSTION PROCESSES SUCH AS SUPERCRITICAL BURNING, GAS RECIRCULATION NEAR THE INJECTOR FACE, TURBULENT MIXING, AND GAS-GAS COMBUSTION. 2. COMBUSTION INSTABILITY CONTROL WITH BAFFLES, ACOUSTIC ABSORBERS, DRIVING PROCESSES, FEED SYSTEM HYDRAULICS AND IMPROVEDMATHEMATICAL MODELS.---- WITH FILM OR TRANSPIRATION COOLING. 4. IGNITION DELAYS IN SMALL THRUSTERS UNDER VACUUM START CONDITIONS. 5. STANDARDIZED COMPUTER PROGRAMS FOR PREDICTING ENGINE PERFORMANCE. 6. CONTAMINATION OF SPACECRAFT SURFACES BY EXHAUST GASES, SOLAR AND UV RADIATION, SOLID PARTICLE BOMBARDMENT AND

RTOP NO. 113-31-09 TITLE: ADVANCED LIQUID ROCKET PROPULSION COMPONENT TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: GREGORY, J. W. TEL. 216-433-6860
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF LIQUID ROCKET PROPULSION, INCLUDING (1) TURBOMACHINERY, _(2) FEED SYSTEMS, (3) INJECTORS AND THRUST CHAMBERS, AND (4) ASSOCIATED INSTRUMENTATION. THESE PROGRAMS WILL BE PURSUED LARGELY FOR APPLICATIONS UTILIZING HIGH ENERGY SPACE STORABLE AND CRYOGENIC PROPELLANTS. IN TURBOMACHINERY, THE MAJOR EFFORTS WILL BE DEVOTED TO INVESTIGATION OF AXIAL FLOW PUMPS, INDUCER DESIGN, CAVITATION IN CRYOGENIC PROPELLANTS, TURBOPUMP STABILITY AND POGO SUPPRESSION, AND

FLUORINE-LUBRICATED BEARINGS. IN THE AREA OF PROPELLANT FEED SYSTEMS, EFFORTS WILL BE DEVOTED TO MAIN TANK INJECTION SYSTEMS, POSITIVE EXPULSION DEVICES, A HOT GAS POWERED EJECTOR PUMP, AND TO IMPROVEMENTS IN VALVE DESIGN. INJECTOR TECHNOLOGY WILL CONTINUE WITH THE GOAL OF PROVIDING KNOWLEDGE ON THE EFFECT OF INJECTOR DESIGN VARIABLES ON COMBUSTION EFFICIENCY AND HEAT FLUX. EFFORT ON REGENERATIVELY COOLED THRUST CHAMBERS WILL INVESTIGATE IMPROVED MATERIALS, FABRICATION TECHNIQUES AND NDT _INSPECTION PROCEDURES. RESEARCH WILL ALSO BE CONTINUED TO IMPROVE THE ACCURACY OF FLOW MEASUREMENT TECHNIQUES IN CRYOGENIC FLUIDS.

RTOP NO. 113-31-10 TITLE: SPACECRAFT ENGINE COMBUSTION AND FLUID FLOW
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE CHEMICAL-PHYSICAL PROCESSES THAT ARE THE ESSENCE OF LIQUID PROPELLANT ROCKET ENGINES ARE BEING CHARACTERIZED. THESE PROCESSES INCLUDE IGNITION, COMBUSTION AND DECOMPOSITION, THE FLUID DYNAMICS AND CHEMISTRY OF NOZZLE FLOWS, COMPATIBILITY OF CHAMBER WALLS WITH REACTION PRODUCTS, PLUME EFFECTS ON SPACECRAFT COMPONENTS/STRUCTURE, AND RESONANT COMBUSTION. ONLY WHEN THESE PROCESSES ARE UNDERSTOOD, IS CONTROL AND A'PRIORI PREDICTION OF SPECIFIED CONDITIONS POSSIBLE AND THE PERTINENT EXTRAPOLATION TO THE ENERGETIC SPACE STORABLES JUSTIFIED. FURTHER THE EXPERIMENTAL VERIFICATION OF PROTOTYPE FLIGHT SYSTEMS CAN BE MINIMIZED. THE MIXING EFFECTIVENESS OF VARIOUS LIQUID/LIQUID, GAS/LIQUID, AND GAS/GAS PROPELLANT INJECTION SYSTEMS ARE BEING EVALUATED EXPERIMENTALLY AND THE MECHANISMS THAT CONTROL MIXING ARE BEING CORRELATED WITH INJECTOR DIMENSIONS AND OPERATING CONDITIONS. AN ON-LINE HIGH SPEED MASS SPECTROMETER IN COMBINATION WITH A MOLECULAR BEAM PROBE, IS BEING USED TO RELATE ENGINE CONDITIONS (COMPOSITIONS) AND INJECTOR VARIABLES AND BOUND THE RELEVANCE OF NON-REACTIVE DATA AND PREDICTIONS OF ANALYTICAL/COMPUTER MODELS. THE MARGIN OF STABILITY OF A CANDIDATE SPACECRAFT ENGINE UTILIZING GAS/GAS INJECTION OF SPACE STORABLE PROPELLANTS IS BEING DETERMINED AND MODIFIED AS REQUIRED TO GIVE A HIGH CONFIDENCE LEVEL FOR A SUCCESSFUL MISSION (PROPOSED). CONCURRENTLY, A COMBUSTION MODEL (DISTRIBUTED ENERGY RELEASE) IN CONJUNCTION WITH A 2-DIMENSIONAL NON-LINEAR COMBUSTION INSTABILITY MODEL (COMB AND TRDL) ARE BEING USED TO PREDICT STABILITY MARGINS. DENSITIES AND PRESSURES WITHIN THE EXHAUST PLUME OF A SMALL ROCKET NOZZLEARE BEING DETERMINED. THESE PROPERTIES----

RTOP NO. 113-31-11 TITLE: SPACECRAFT ENGINE COMPONENTS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO DEVELOP THE FEED SYSTEM COMPONENT AND THRUST CHAMBER TECHNOLOGY REQUIRED TO SUPPORT ADVANCED PROPULSION SYSTEMS SUCH AS THE SPACE STORABLE PROPULSION MODULE THAT

WILL BE USED FOR OUTER PLANETARY MISSIONS. THE WORK INCLUDES THE DEVELOPMENT OF COMPONENTS, THRUST CHAMBERS, AND ESTABLISHING CRITERIA AND TECHNIQUES REQUIRED FOR THE INTEGRATION INTO ADVANCED CHEMICAL PROPULSION SYSTEMS FOR THESE LONG DURATION (TEN YEAR) MISSIONS. CURRENT EFFORTS INVOLVE MATERIAL APPLICATION; ENVIRONMENTAL AND PROPELLANT EXPOSURE EFFECTS DETERMINATION; PERFORMANCE VERIFICATION, AND COMPONENT DEVELOPMENT. MAJOR EMPHASIS IS BEING GIVEN TO UNDERSTANDING THE EFFECTS OF EXTENDED FLIGHT ENVIRONMENTAL AND OPERATIONAL CONDITIONS. OF PARTICULAR CONCERN IS THE LACK OF SATISFACTORY QUALIFICATION METHODS FOR ASSURING ACCEPTABLE COMPONENT PERFORMANCE RELATIVE TO THE TEN YEAR MISSION REQUIREMENTS. THE WORK IS DIRECTED TOWARD PROPELLANTS FOR UNMANNED SPACECRAFT. THESE INCLUDE: FLOX, LF2, OF2, MMH, N2H4, B2H6, AND N2H4 MIXES. THE IMPLICATIONS OF SIMULANT FLUIDS ALSO ARE BEING CONSIDERED. WORK WILL ALSO BE DIRECTED TO CONCEPTS ALLOWING A TELEOPERATOR/ROBOT TO PROPEL ITSELF AND OPERATE THROUGH SPACE, THROUGH PLANETARY ATMOSPHERES, AND/OR ON EXTRATERRESTRIAL SURFACES WITH PREDICTABLE VELOCITY. THIS INVESTIGATION WILL EMPHASIZE CHEMICAL PROPULSION FOR CONCEPTS SUCH AS A "FLYING TELEOPERATOR", INCLUDING CONTROL JETS AND OTHER ALLIED AUXILIARY SUBSYSTEMS. CONSIDERATION WILL BE GIVEN TO THE USE OF THE MAIN THRUSTING PROPELLANTS FOR GENERATING PNEUMATIC, HYDRAULIC, AND ELECTRICAL AUXILIARY POWER.

RTOP NO. 113-31-12 TITLE: LAUNCH VEHICLE PROPULSION TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ATTAYA, H. E., JR. TEL. 205-453-1121
TECHNICAL SUMMARY

THE EFFORT OUTLINED IN THIS PLAN IS DIRECTED AT INTEGRATING RECENT RESULTS INTO THE JANNAF'S FORMULATION OF A GENERAL ENGINE PERFORMANCE PREDICTION METHODOLOGY, CONDUCTING ADDITIONAL TESTS TO INVESTIGATE TRANSONIC FLOW PHENOMENA BASED ON INHOMOGENEOUS MASS CONCENTRATION IN ALTITUDE COMPENSATING NOZZLES, INVESTIGATING THE PHYSICAL MECHANISMS THAT CONTRIBUTE TO COMPLEX PUMP TERMINATION IMPENDANCE, AND OBTAINING FLOW FIELD PROPERTIES OF A HYDROGEN-OXYGEN ROCKET EXHAUST PLUME USING OPTICAL TECHNIQUES; AND TO CONTINUE EXPERIMENTAL INVESTIGATIONS OF THE EFFECTS OF LOW GRAVITY LEVELS ON THE NUCLEATE BOILING REGIME IN CRYOGENS, FY-71, RTOP 128-31-62. UTILIZATION OF THE UNIVERSITY OF MICHIGAN DROP TOWER FACILITY USING LIQUID HYDROGEN AS THE TEST LIQUID IS PROPOSED TO INVESTIGATE THE EFFECTS OF NEAR-ZERO GRAVITY. A KNOWLEDGE OF LOW GRAVITY BOILING IS ESSENTIAL FOR THE DESIGN OF CRYOGEN PROPELLANT ACQUISITION AND CONDITIONING SYSTEMS. ORBITAL TESTING IS REQUIRED FOR VERIFICATION OF BOILING HEAT TRANSFER TECHNOLOGY USED TO DESIGN SHUTTLE SYSTEMS.

RTOP NO. 113-31-17 TITLE: SPACE SHUTTLE - CRYOGENIC STORAGE SYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: CHANDLER, W. A. TEL. 713-483-4771
TECHNICAL SUMMARY

THE SPACE SHUTTLE WILL REQUIRE CRYOGENIC STORAGE SYSTEMS FOR BOOST, MANEUVERING AND REACTION CONTROL PROPULSION, FUEL CELL AND

AUXILIARY POWER, AND ENVIRONMENTAL CONTROL/LIFE SUPPORT FUNCTIONS. THE STORAGE SYSTEMS MUST SUPPLY CONDITIONED FLUIDS FOR UP TO 7 DAYS AND SATISFY THE SHUTTLE REQUIREMENTS OF COMPLETE REUSABILITY, LOW COST, MINIMUM MAINTENANCE AND MAXIMUM SAFETY. PRESENT TECHNOLOGY IS INADEQUATE TO MEET THESE REQUIREMENTS. THEREFORE, SELECTED CRITICAL PROGRAMS WERE INITIATED IN FY71 TO SATISFY THESE DEFICIENT TECHNOLOGICAL AREAS AND WILL BE CONTINUED WITH FY72 FUNDS. OTHER CRITICAL PROGRAMS WILL BE INITIATED BY THIS RTOP. THE OVERALL PROGRAM OBJECTIVE IS TO PROVIDE THE CRYOGENIC SYSTEM TECHNOLOGY NECESSARY TO MEET ALL THE OBJECTIVES FOR A LOW COST REUSABLE SHUTTLE VEHICLE.

RTOP NO. 113-31-20 TITLE: PLANETARY EXPLORATION PROPULSION TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS RTOP IS TO EVOLVE A CHEMICAL PROPULSION TECHNOLOGY WHICH IS APPLICABLE TO PLANETARY EXPLORATION MISSIONS CONSISTENT WITH NASA'S FUTURE OBJECTIVES. EMPHASIS WILL BE ON CONCEPTS AND TECHNOLOGY WHICH (A) IS COMPATIBLE WITH AND, IF POSSIBLE, TAKES ADVANTAGE OF PLANETARY ATMOSPHERES, EXTRA-TERRESTRIAL SURFACE CONDITIONS, AND OTHER SPECIAL ENVIRONMENTAL CHARACTERISTICS, AND (B) RECOGNIZES THE EXTENSIVE USE WHICH WILL BE MADE IN THIS WORK OF TELEOPERATOR AND OTHER REMOTELY OPERATED EQUIPMENT AND VEHICLES. APPROACH INCLUDES AN INVESTIGATION AND DEMONSTRATION OF VARIOUS CONCEPTS FOR CONVERTING CHEMICAL ENERGY INTO MOTION TO POWER TELEOPERATORS AND TO PRO VIDE PROPULSION FOR SURFACE ROVERS. "GROUND EFFECT" PROPULSION IN VERY LOW DENSITY ATMOSPHERES WILL BE STUDIED, AS WILL RAM ROCKET PROPULSION FOR LOW DENSITY ATMOSPHERES. AN ANALYTICAL STUDY OF VERY LOW REYNOLDS' NUMBER FLOW IN NOZZLES IS INCLUDED.

RTOP NO. 113-32-01 TITLE: ADVANCED SOLID PROPULSION AND PYROTECHNIC SYSTEMS TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS RTOP IS TO DEVELOP TECHNOLOGY FOR NEW AND IMPROVED EXISTING SOLID PROPULSION SYSTEMS, HYBRID PROPULSION SYSTEMS, AND PYROTECHNIC SYSTEMS FOR USE IN PLANNED AND PROBABLE FUTURE NASA MISSIONS. WORK THIS YEAR IN SOLID PROPULSION SYSTEMS WILL INCLUDE DEMONSTRATION OF A STERILIZABLE ROCKET MOTOR OF USEFUL SIZE, CONTINUED DEVELOPMENT OF AN ADVANCED SOUNDING ROCKET (ASTROBEE F, HEADQUARTERS FUNDING), AND DEMONSTRATION OF IMPROVED LOW-COST MOLDED ROCKET CASE STRENGTH THROUGH SPECIAL MOLDING TECHNIQUES. HYBRID MOTOR TECHNOLOGY WORK WILL INCLUDE STUDIES OF THE APPLICABILITY AND PRELIMINARY DEVELOPMENT WORK ON EARTH STORABLE AND OTHER PROPELLANT FORMULATIONS FOR IMPROVED SCOUT/DELTA UPPER STAGING, A LIMITED DEMONSTRATION OF A WASTE UTILIZATION ROCKET DIRECTED TOWARD

SPACE STATION/SPACE BASE APPLICATION, AND TESTS OF A SUBLIMATION COOLED NOZZLE. PENDING A DECISION ON SPECIFIC APPLICATION OF THE HIGH ENERGY HYBRID TO DELTA AND ADDITIONAL FUNDING, FURTHER NOZZLE TECHNOLOGY WORK AND ALTITUDE PERFORMANCE DEMONSTRATIONS WILL BE INITIATED. PYROTECHNIC SYSTEMS WORK WILL INCLUDE A STUDY OF THE APPLICABILITY OF PYROTECHNIC SYSTEMS TO THE PERFORMANCE OF MANY FUNCTIONS ON SPACE SHUTTLE. POTASSIUM PERCHLORATE TECHNOLOGY FOR PYROTECHNIC AND GAS GENERATOR DEVICES FOR VERY LONG DURATION FLIGHT WILL BE FURTHER DEVELOPED AND EXTENDED, AND THE PROGRAM TO INCREASE THE UNDERSTANDING OF PYROTECHNIC PERFORMANCE MECHANISMS AND THEIR MONITORING AND EVALUATION WILL CONTINUE. IMPROVED TEST AND MEASUREMENT TECHNIQUES WILL INCLUDE DEMONSTRATION OF A LASER HOLOGRAPHIC INTERFEROMETRY NDT METHOD AND A PRELIMINARY STUDY OF GRAIN STRAIN INSTRUMENTATION METHODS.

RTOP NO. 113-32-02 TITLE: SOLID PROPULSION FOR SPACECRAFT AND UPPER STAGES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO CONDUCT RESEARCH, TO DEVELOP TECHNOLOGY, AND TO TEST SOLID PROPELLANT MOTORS AND CRITICAL COMPONENTS, INCLUDING PYROTECHNIC DEVICES, TOWARD THE GOAL OF IMPROVED PROPULSION SYSTEMS FOR NASA SPACECRAFT AND UPPER STAGES. SPECIFIC OBJECTIVES ARE A) TO CONTINUE DEMONSTRATION OF THE HIGH-ENERGY RESTARTABLE SOLID PROPELLANT MOTOR TO PROVE QUENCH, RESTART, AND SECOND QUENCH UNDER SIMULATED ALTITUDE CONDITIONS; B) TO DEVELOP TECHNOLOGY AND CONDUCT PROOF FIRINGS OF A LOW-ACCELERATION MOTOR. ADVANCEMENTS WILL INCLUDE LOW SHOCK IGNITION, A LIGHT-WEIGHT "ALL-CARBON" NOZZLE, VERY FLEXIBLE PROPELLANTS, AND GOOD COMBUSTION EFFICIENCY AT LOW PRESSURE. THE GOAL IS TO CONDUCT ONE 800 POUND SIZE MOTOR TEST PER YEAR AND SUPPORTING 60 POUND MOTOR TESTS. HIGH ENERGY FUEL COMBINATIONS WILL BE CONSIDERED; C) TO CONTINUE THE EFFORT TOWARD A BETTER UNDERSTANDING OF PROPELLANT MECHANICAL BEHAVIOR; TO INTEGRATE THE ROLES OF THE BASIC CONSTITUENTS, VARIABLES OF MANUFACTURE AND THE FINAL CHARACTERISTICS OF PROPELLANT INTO A THEORY WHICH WOULD ALLOW A MOTOR DESIGNER TO "DESIGN" A PROPELLANT CHARGE WITH PREDICTABLE COMBUSTION PROPERTIES IN THE SAME MANNER THAT A CONVENTIONAL STRUCTURE CAN BE DESIGNED TO WITHSTAND SPECIFIED LOADS; AND D) TO ADVANCE MOTOR AND COMPONENT TECHNOLOGY IN PREPARATION OF FUTURE MISSION REQUIREMENTS FOR NEW SYSTEMS WITH ENOUGH POTENTIAL TO BE CONSIDERED FOR MAJOR DEMONSTRATIONS IN FY73 AND BEYOND.

RTOP NO. 113-32-03 TITLE: ASTROBEE F DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HONECKER, H. J. TEL. 301-982-4865
TECHNICAL SUMMARY

NASA IS, AND HAS BEEN FOR MANY YEARS, FLYING BETWEEN 30 AND 50 AEROBEE 150/170 SOUNDING ROCKETS PER YEAR. CURRENT PREDICTIONS INDICATE THAT THIS USAGE RATE WILL CONTINUE AND WOULD PROBABLY

INCREASE IF BUDGETARY RESTRICTIONS WERE TO BE RELAXED. IN ADDITION, OTHER ACTIVITIES, PRINCIPALLY AIR FORCE CAMBRIDGE RESEARCH LABORATORY, KITT PEAK NATIONAL OBSERVATORY, AND THE US NAVY FLY A COMBINED TOTAL OF 15 TO 30 OF THESE VEHICLES PER YEAR. AN AEROBEE 150/170 COSTS ABOUT $40,000 _EXCLUDING PAYLOAD AND ANY SPECIAL EQUIPMENT REQUIRED. AN ADDITIONAL SUBSTANTIAL COST IS INCURRED AT THE LAUNCH SITE SINCE THE VEHICLE MUST BE SERVICED AND ITS LIQUID FUEL LOADED AND PRESSURIZED AFTER IT IS INSTALLED IN THE LAUNCH TOWER. THE OBJECTIVE OF THIS PROGRAM IS TO _COMPLETE THE DEVELOPMENT OF A NEW SOLID FUEL ROCKET MOTOR WHICH WILL SERVE AS THE PROPULSION FOR A VEHICLE WHICH WILL REPLACE THE AEROBEE 150/170. PRELIMINARY DEVELOPMENT OF THIS MOTOR, WHICH INCLUDES SEVERAL NEW CONCEPTS, HAS BEEN COMPLETED AND ITS FEASIBILITY SUPPORTED BY TWO STATIC FIRINGS UNDER CONTRACT NAS 7-774. TARGET PRODUCTION COSTS OF THE COMPLETE SOUNDING ROCKET, DESIGNATED THE ASTROBEE F, ARE IN _THE RANGE OF $23,000 TO $28,000. SUCCESSFUL DEVELOPMENT OF THE ASTROBEE F COULD RESULT IN SAVINGS, TO NASA ALONE, IN EXCESS OF $500,000 _PER YEAR.

RTOP NO. 113-32-04 TITLE: SOLID PROPULSION COMBUSTION AND KINETICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

ONE OBJECTIVE OF THIS PROGRAM IN SOLID PROPULSION COMBUSTION AND KINETICS IS TO ACQUIRE PERTINENT EXPERIMENTAL KNOWLEDGE AND UNDERSTANDING OF (1) CONDENSED-PHASE REACTION AND GASIFICATION MECHANISMS OF AMMONIUM PERCHLORATE-BASED COMPOSITE PROPELLANTS, AND (2) DOMINANT GAS-PHASE REACTION AND HEAT/MASS TRANSFER MECHANISMS JUST ABOVE BURNING PROPELLANT SURFACES. SPECIFIC CONTRACTED AND IN-HOUSE PROGRAM PLANS COVER RESEARCH IN THE FOLLOWING AREAS: EFFECTS OF CONDENSED-PHASE REACTIONS ON PROPELLANT COMBUSTION, CO2 LASER PYROLYSIS - MASS SPECTROMETRY OF PROPELLANT INGREDIENTS, AMMONIUM PERCHLORATE/PROPELLANT STABILIZATION, PROPELLANT FLAME STUDIES, METAL COMBUSTION, SOLID PROPELLANT AND HYBRID INSTANTANEOUS BURNING RATE MEASUREMENTS, DEPRESSURIZATION EXTINCTION OF SOLID PROPELLANTS, WATER QUENCH EXTINCTION, AND IGNITION OF SOLID ROCKETS.

RTOP NO. 113-33-11 TITLE: SOLAR CELL AND ARRAY TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BERNATOWICZ, D. T. TEL. 216-433-4000
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT WILL BE CONDUCTED TO IMPROVE SOLAR CELLS FOR SPACE APPLICATIONS. THE PRINCIPAL OBJECTIVES OF THIS WORK ARE TO RAISE THE EFFICIENCY OF SOLAR CELLS AND REDUCE THE COST OF SOLAR CELL ARRAYS. THE APPROACH TO INCREASING SOLAR CELL EFFICIENCY WILL BE: 1. TO REDUCE THE IMPURITY LEVEL IN HIGHLY DOPED SILICON BULK MATERIAL, 2. TO MODIFY CELL FABRICATION PROCESSES TO ELIMINATE DAMAGE TO _THE BULK PROPERTIES, AND 3. TO DECREASE SURFACE RECOMBINATION LOSSES THROUGH IMPROVED SURFACE PROPERTIES. COST REDUCTION WILL BE PURSUED IN TWO WAYS: 1. CONTINUED DEVELOPMENT EFFORT ON FEP-COVERED SILICON CELL MODULES. TECHNIQUES DEVELOPED ON

INDIVIDUAL CELLS AND SMALL _MODULES WILL BE EXTENDED TO LARGE MODULES AND RELIABLE MEANS TO FABRICATE AND INTERCONNECT MODULES WILL BE DEVELOPED. 2. PURSUIT OF NEW CONCEPTS TO MAKE VERY CHEAP SILICON SOLAR CELLS, SUCH AS BY VAPOR DEPOSITION. THE VOLTAGE BREAKDOWN LIMITS FOR DIFFERENT CELL-COVER COMBINATIONS IN THE NEAR-EARTH PLASMA AND THE RESULTANT CURRENT DRAINAGE _AFTER BREAKDOWN, WILL BE DETERMINED.

RTOP NO. 113-33-13 TITLE: PLANETARY SOLAR POWER TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137
TECHNICAL SUMMARY

THE JPL FY 72 PROGRAM FOR PLANETARY SOLAR ARRAYS AND SOLAR CELL TECHNOLOGY DEVELOPMENT HAS THEFOLLOWING MAJOR OBJECTIVES: 1. INVESTIGATE THE FEASIBILITY OF DEVELOPING LIGHTWEIGHT SOLAR ARRAYS WITH POWER TO WEIGHT EFFICIENCIES GREATER THAN 110 WATTS PER KILOGRAM (50 WATTS PER POUND). 2. INITIATE A PROGRAM TO INVESTIGATE SOLAR ARRAY MATERIAL PROPERTIES, MODELING AND TEST TECHNIQUES. 3. CONTINUE THE PROGRAM TO DEVELOP SOLAR CELL ELECTRICAL DESIGN INFORMATION FOR DEEP SPACE MISSION APPLICATION. 4. CONTINUE SOLAR ARRAY DYNAMIC INTERACTION WITH SPACECRAFT CONTROL STUDIES. 5. CONTINUE LITHIUM SOLAR CELL DEVELOPMENT. 6. INITIATE A PROGRAM TO DEVELOP GALLIUM ARSENIDE SOLAR CELLS. 7. EVALUATE THE DEVELOPMENT OF A SILICON RIBBON GROWTH TECHNIQUE FOR SOLAR CELLS. 8. REVISE AND PUBLISH THE SOLAR CELL SPACE RADIATION HANDBOOK. 9. INITIATE A PROGRAM TO DEVELOP NEW SOLAR ENERGY CONVERSION DEVICES. THIS WORK WILL BE ACCOMPLISHED THROUGH COMBINED IN-HOUSE AND CONTRACTED EFFORTS WITH INDUSTRY AND UNIVERSITIES. SPECIAL CONSIDERATION IN THE APPROACH TO MEETING THESE OBJECTIVES WILL BE GIVEN TO THE MISSION REQUIREMENTS OF THE SOLAR ELECTRIC MULTI-MISSION SPACECRAFT (SEMMS) PROJECT.

RTOP NO. 113-34-10 TITLE: PLANETARY BATTERIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137
TECHNICAL SUMMARY

THIS RTOP IS DIRECTED TOWARD PROVIDING THE TECHNOLOGIES FOR VARIOUS PLANETARY MISSIONS. THE OBJECTIVES ARE: (1) THE DEVELOPMENT OF BATTERIES FOR LONG-LIFE (3 TO 12 YEAR) PLANETARY MISSIONS; (2) THE DEFINITION AND RESOLUTION OF THE INTERFACES CONSEQUENT FROM THE INTEGRATION OF LONG-LIFE BATTERY SYSTEMS IN SPACECRAFT; AND (3) THE CONTINUED INVESTIGATIONS AND DEVELOPMENT OF BATTERIES, WHICH ARE REQUIRED FOR SHORT-LIVED (LESS THAN 3 YEARS) SPACE MISSIONS. THE OBJECTIVES HAVE BEEN DEFINED FROM REALIZATIONS THAT THE TECHNOLOGIES FOR BATTERIES AND INTERFACES REQUIRED FOR LONG-LIFE MISSIONS, SUCH AS JUPITER ORBITER, JUPITER ENTRY PROBE, SEMMS, AND OUTER PLANET MISSIONS, ARE NOT AVAILABLE AND THAT IMPROVEMENTS IN BATTERY ELECTRICAL PERFORMANCE AND RELIABILITY SHOULD BE OBTAINED FOR SHORT-LIFE MISSIONS, SUCH AS THOSE TO MARS AND VENUS. THE ELEMENTS OF THIS TASK WILL BE ACCOMPLISHED BY: (1) THE DEVELOPMENT OF

SUITABLE AND RELIABLE COMPONENTS, DESIGNS, AND FABRICATION TECHNIQUES; (2) THE INVESTIGATIONS OF THE EFFECTS OF PARTICULAR ENVIRONMENTAL CONDITIONS ON BATTERIES; (3) THE SECURING AND EVALUATION OF DATA FROM CHARACTERIZATION TESTS OF THE COMPONENTS, BATTERIES, AND BATTERY SYSTEMS, AND (4) THE ESTABLISHMENT OF THE CONTROLS, TECHNOLOGY LEVELS, AND PROCEDURES REQUIRED FOR FLIGHT TECHNOLOGY READINESS. THE SUBTASKS TITLED DEVELOPMENT OF NONGASSING BATTERIES, PULSE CHARGING TECHNIQUES, MISSION DEPENDENT BATTERY DEVELOPMENTS AND EVALUATIONS, ELECTROCHEMICAL STUDIES, AND HEAT STERILIZABLE BATTERIES ARE STRUCTURED TO ACHIEVE THE PROGRAM OBJECTIVES.

RTOP NO. 113-34-11 TITLE: SATELLITE BATTERIES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HENNIGAN, T. J. TEL. 301-982-5547
TECHNICAL SUMMARY

A. ADVANCE BATTERY MATERIALS DEVELOPMENT B. DEVELOP NEW CELL CONCEPTS C. DEVELOP NEW CELL AND CHARGE CONTROL CONCEPTS D. IMPROVE CELL CHARACTERIZATION METHODS AND CELL FABRICATION PROCESS CONTROL E. MAINTAIN TEST FACILITIES AND PERFORM BATTERY LIFE TESTS AND PERFORM FAILURE ANALYSIS F. INVESTIGATE THERMAL CHARACTERISTICS AND DEVELOP METHOD TO MAINTAIN BATTERY TEMPERATURES AT OPTIMUM LEVELS.

RTOP NO. 113-34-12 TITLE: ELECTROCHEMICAL POWER DEVICES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARTZ, H. J. TEL. 216-433-6910
TECHNICAL SUMMARY

ELECTROCHEMICAL POWER DEVICES HAVE BEEN USED ON VIRTUALLY EVERY LAUNCH VEHICLE AND SPACECRAFT FLOWN TO DATE, AND WILL CONTINUE TO BE USED FOR THE FORESEEABLE FUTURE. THE BROAD SPECTRUM OF MISSION POWER REQUIREMENTS ALREADY KNOWN AND ANTICIPATED DICTATE DEVELOPMENT OF A VARIETY OF ELECTROCHEMICAL POWER SOURCES TO MEET THESE NEEDS. MAJOR EMPHASIS WILL BE PLACED ON TECHNOLOGY LEADING TO AN ADVANCED H2-O2 FUEL CELL SYSTEM FOR SPACE SHUTTLE APPLICATIONS; ON IMPROVED SILVER-ZINC BATTERIES FOR 5 YEAR OPERATION IN SYNCHRONOUS ORBIT; NEW APPROACHES TO NICKEL-CADMIUM AND SILVER-CADMIUM BATTERY CONSTRUCTION FOR LONG-LIFE IN LOW-ALTITUDE ORBIT; AND ON SOLID IONIC CONDUCTORS AS AN APPROACH TO A 150 WATT-HOUR PER POUND SECONDARY BATTERY.

RTOP NO. 113-34-22 TITLE: NICAD BATTERY DEVELOPMENT FOR SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

INITIAL FABRICATION AND TEST OF BALANCED GEOMETRY 100-AH NICAD CELLS HAS SHOWN SIGNIFICANT GAINS IN PERFORMANCE OVER CONVENTIONAL CELLS. INFORMATION GAINED TO DATE INDICATES THAT A 200-AH CELL CAN BE DESIGNED USING SIMILAR TECHNIQUES. SINCE THESE CELLS ARE DESIGNED

FOR SPACE STATION APPLICATIONS, LONG RELIABLE LIFE EXPECTANCIES BECOME A PRIME REQUIREMENT. THIS RTOP WILL COVER THE CONTINUANCE OF 100-AH CELL LIFE TESTS ALREADY IN PROGRESS, AND WILL PROVIDE INITIATION OF 200-AH LIFE TESTS. IT WILL ALSO COVER THE IN-HOUSE DEVELOPMENTAL WORK REQUIRED TO SUPPLEMENT THE CONTRACTS.

RTOP NO. 113-60-01 TITLE: POWER PROCESSING RESEARCH & ADVANCED DEVELOPMENT FOR ELECTRIC PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO ESTABLISH THE TECHNOLOGY FOR _SINGLE MODULE MULTI-KILOWATT ELECTRIC POWER DC TO DC CONVERTERS. THE CONVERTER DESIGN WILL PERMIT PARALLEL OPERATION PROVIDING POWER LEVELS OF UP TO 100 KW. INCLUDED IN THE TECHNOLOGY ARE CONTROL SYSTEMS _PROVIDING POWER SOURCE TRACKING, AND ACCURATE OUTPUT PARAMETER CONTROL. THE PROGRAM WILL PROVIDE CONVERTERS OF MAXIMUM RELIABILITY, MINIMUM WEIGHT AND SIZE AND WITH POWER DENSITIES OF 0.4 TO 1.0 KW/KG AT EFFICIENCIES IN EXCESS OF 90%. ALL PRIMARY ELECTRIC PROPULSION SYSTEMS. PARTICULAR ATTENTION WILL BE DIRECTED TOWARD THE SEMMS CLASS OF ION THRUSTER. RELIABILITY ADVANCEMENT WILL BE ACHIEVED THROUGH DEVELOPMENT OF CIRCUITS AND FUNCTIONAL CONCEPTS WHICH MINIMIZE STRESSES ON _INDIVIDUAL COMPONENTS. WEIGHT REDUCTIONS WILL BE ACHIEVED BY OPERATING AT HIGHER INPUT VOLTAGE LEVELS AND AT SUBSTANTIALLY HIGHER SWITCHING FREQUENCIES THAN PRESENTLY POSSIBLE.

RTOP NO. 113-60-03 TITLE: SPACECRAFT ELECTRICAL POWER PROCESSING AND DISTRIBUTION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO IMPROVE THE STATE-OF-THE-ART _OF SPACECRAFT POWER PROCESSING CIRCUITS AND COMPONENTS. PARTICULAR _ATTENTION WILL BE DIRECTED TO THE PROBLEM OF DYNAMIC LOAD CONDITIONS. GENERAL ADVANCEMENT IN CIRCUITS AND COMPONENTS, REQUIRED FOR ADVANCED CONCEPT ELECTRICAL POWER ELECTRONICS, WILL BE ACHIEVED. FLIGHT MISSIONS WITH DURATION OF TEN YEARS; ACTIVE SPACECRAFT AND SATELLITES _FOR SURVEY, SCIENTIFIC OR COMMUNICATION PURPOSES. CONTRACT AND IN-HOUSE STUDIES AND EXPERIMENTAL INVESTIGATIONS WILL BE UNDERTAKEN TO OBTAIN NEW COMPONENTS AND CIRCUITS FOR IMPROVED SPACECRAFT POWER PROCESSING SYSTEMS TECHNOLOGY.

RTOP NO. 113-60-04 TITLE: ELECTRICAL POWER PROCESSING AND DISTRIBUTION FOR PLANETARY SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137
TECHNICAL SUMMARY

THIS RTOP PROVIDES FOR THE DEVELOPMENT OF POWER PROCESSING AND

DISTRIBUTION SYSTEMS AND RELATED TECHNOLOGY FOR FUTURE PLANETARY SPACECRAFT. IT DEVELOPS THE NECESSARY CAPABILITY, TECHNIQUES AND HARDWARE REQUIRED TO PRODUCE HIGH-RELIABILITY, LONG-LIFE POWER SYSTEMS FOR RTG-POWERED OUTER-PLANET MISSIONS AND FOR ADVANCED PHOTOVOLTAIC POWERED MISSIONS. EXISTING POWER PROCESSING AND DISTRIBUTION SYSTEM TECHNOLOGY CANNOT MEET THE STRINGENT REQUIREMENTS FOR MANY FUTURE MISSIONS SUCH AS THE GRAND TOUR, WHICH REQUIRES 12 YEARS' LIFE, A SPECIFIC WEIGHT OF 25 KG/KW OR LESS, AND IMMUNITY FROM SINGLE PIECE-PART FAILURE. THE WORK TO BE DONE INCLUDES: (1) THE DEVELOPMENT OF HIGH-QUALITY BREADBOARD POWER PROCESSING AND DISTRIBUTION SYSTEM FOR DETAILED EVALUATION AND TESTING IN SUPPORT OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT. THIS EFFORT WILL DEMONSTRATE TECHNOLOGY READINESS FOR AN OUTER-PLANETS MISSION THROUGH THE DEVELOPMENT AND SELECTION OF AN OPTIMIZED POWER PROCESSING AND DISTRIBUTION SYSTEM CONFIGURATION THAT PROVIDES HIGH PERFORMANCE, HIGH RELIABILITY AND LONG LIFE; (2) THE DEVELOPMENT OF NEW TECHNOLOGY CIRCUIT CONFIGURATIONS AND TECHNIQUES TO IMPROVE THE PERFORMANCE, RELIABILITY AND LIFETIMES OF PHOTOVOLTAIC/BATTERY POWER PROCESSING AND DISTRIBUTION SYSTEMS. THESE DEVELOPMENTS ARE NECESSARY TO INSURE THAT TECHNOLOGY IS AVAILABLE TO MEET THE REQUIREMENTS OF ADVANCED SOLAR POWERED MISSIONS SUCH AS SEMMS (SOLAR ELECTRIC MULTIMISSION SPACECRAFT (RTOP 113-26-20); (3) TECHNOLOGY WORK, BOTH ANALYTICAL AND EXPERIMENTAL, TO ADVANCE THE STATE-OF-THE-ART IN POWER AND CONTROL TECHNIQUES FOR ACTUATION OFELECTROMECHANICAL AND ELECTRO EXPLOSIVE----

RTOP NO. 113-60-06 TITLE: POWER PROCESSING AND DISTRIBUTION TECHNOLOGY FOR EARTH ORBITAL SPACE SCIENCE AND APPLICATIONS SATELLITES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: YAGERHOFER, F. TEL. 301-982-4886
TECHNICAL SUMMARY

POWER CONDITIONING DEVELOPMENTS ARE SEEKING TO INCREASE CONVERSION EFFICIENCIES, UTILIZE VERY LOW INPUT VOLTAGES EFFECTIVELY, AND TRA NSFER POWER FROM A STATIONARY OR ORIENTED PLATFORM, SUCH AS A SOLAR ARRAY OR ANTENNA, TO A SPINNING VEHICLE. INVESTIGATIONS OF THICK FILM INTEGRATED CIRCUITS AND THE UTILIZATION OF FERROMAGNETIC AND AIR CORE TRANSFORMERS SO AS TO REDUCE WEIGHT AND SIZE OF POWER CONDITIONING _SUBSYSTEMS IS PROPOSED.

RTOP NO. 113-60-10 TITLE: SPACE SHUTTLE ELECTRICAL POWER PROCESSING AND DISTRIBUTION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO ESTABLISH THE TECHNICAL CRITERIA WHICH WILL PERMIT THE CONCURRENT OPTIMIZATION OF ELECTRICAL SYSTEMS FOR REUSABLE HYBRID AIR AND SPACEBORNE CRAFT. THE SYSTEMS OF INTEREST ARE: 1) THE POWER SOURCE, 2) THE POWER DISTRIBUTION, 3) THE POWER CONVERSION SYSTEM, AND 4) THE POWER UTILIZATION SYSTEM. THE

OPTIMIZATION IS TO BE ACHIEVED OVER THE POWER RANGE OF 10 KW TO MORE THAN 100 KW. DUE CONSIDERATION WILL BE GIVEN IN THE OPTIMIZATION TO THE EFFECT ON THE POWER SYSTEM OF ATMOSPHERIC REENTRY. A SECOND OBJECTIVE IS TO ESTABLISH THE TECHNOLOGY FOR CRITICAL SUBSYSTEMS AND COMPONENTS OF THE ABOVE SYSTEMS WHERE NEW TECHNOLOGY IS REQUIRED. APPLICATIONS INCLUDE REUSABLE SPACE SHUTTLE LAUNCH AND ORBITER CRAFT; AND OTHER AIR AND LARGER SPACECRAFT. THE APPROACH IS TO ACQUIRE KNOWLEDGE ON THE NATURE OF POWER SYSTEM CHARACTERISTICS AND THE ASSOCIATED SUBSYSTEMS UNDER GIVEN CONSTRAINTS AND TRANSLATE THE RESULTS OF COMPARATIVE WEIGHTING OF CONTRIBUTING FACTORS INTO CRITERIA FOR DESIGN. ESTABLISH TECHNOLOGY FOR CRITICAL SUBSYSTEMS, COMPONENTS FOR POWER CONTROL, POWER TRANSFER AND TRANSMISSION, ELECTRIC ENERGY MANAGEMENT AND POWER FAULT DETECTION.

RTOP NO. 113-60-20 TITLE: SPACE STATION/BASE ELECTRICAL POWER PROCESSING AND DISTRIBUTION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

ESTABLISH THE NEEDED TECHNOLOGY FOR THE ELECTRIC POWER PROCESSING AND DISTRIBUTION SYSTEM FOR THE SPACE STATION/BASE WITH AN ESTIMATED TOTAL POWER CAPACITY OF 30 TO 100 KW. ELECTRONIC POWER PROCESSORS WITH POWER HANDLING CAPACITIES OF 10 KW AND BEYOND WILL BE BREADBOARDED. THE PROCESSORS WILL OPERATE WITH INPUT VOLTAGES OF FROM 100 TO 500 VOLTS. ELECTRICAL SWITCHGEAR WILL BE DEVELOPED CAPABLE OF CONTROLLING THE POWER FLOW IN THE POWER DISTRIBUTION LINES OF THE STATION/BASE. CERTAIN GENERAL ASSUMPTIONS CONCERNING THE STATION/BASE/ELECTRICAL SYSTEMS WILL BE MADE TO PERMIT AN EARLY START ON CRITICAL LONG LEAD TIME TECHNOLOGY. THIS WORK WILL ATTACK PROBLEMS WHICH ARE OF SIGNIFICANCE TO THE FORESEEABLE POWER SYSTEM CONFIGURATIONS. THE IMPORTANT ELEMENTS OF THIS WORK SHOULD BE APPLICABLE TO THE TECHNOLOGY REQUIREMENTS AS THEY WILL EMERGE FROM SYSTEM STUDIES.

RTOP NO. 113-60-53 TITLE: A SOLAR ELECTRIC POWER GENERATOR SYSTEM WITH INTEGRATED NONDISSIPATIVE ELECTRONIC CONTROL
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

INVESTIGATE THE FEASIBILITY AND ESTABLISH THE TECHNOLOGY OF SOLAR ELECTRIC POWER GENERATION SYSTEMS WITH APPLICATION OF NONDISSIPATIVE TYPE ELECTRONIC CONTROL MECHANISMS TO INDIVIDUAL ELEMENTS OF THE SOLAR ARRAY. THESE SUPPLIES WILL PROVIDE DC POWER TO ELECTRIC SYSTEMS WHICH REQUIRE CONTROL OF INPUT VOLTAGE AND/OR CURRENT WITHIN SPECIFIED TOLERANCES. INITIAL EMPHASIS IS PLACED ON SUPPLY OF DC POWER FROM TEN (10) TO FIFTEEN THOUSAND (15,000) VOLTS TO GROUPS OF INDIVIDUAL FIXED AND/OR TIME VARYING ELECTRIC LOAD SYSTEMS. APPLICATION AND INTEGRATION OF ELECTRONIC CONTROL TECHNOLOGY WITH SOLAR ARRAY SYSTEMS FOR PURPOSE OF CONTROL OF THE

ELEMENTS AND GROUPS OF ELEMENTS OF THE POWER _GENERATION PROCESS. VERIFICATION OF SHORT AND LONG TERM ELECTRICAL _INTEGRITY OF LARGE AREA STRUCTURES UNDER STRESS OF SIGNIFICANT ELECTRIC FIELDS CAUSED BY POTENTIALS FROM 100 VOLTS TO 15 KV IN A SPACE (PLASMA) ENVIRONMENT BY FLIGHT OF AN EXPERIMENT AS AN AUXILIARY PAYLOAD ON A "PIGGYBACK" SATELLITE ATTACHED TO A FLIGHT MISSION. PLANS FOR _FY '72 INCLUDE THE DEVELOPMENT OF METHODOLOGY FOR SYSTEMS DESIGN OF _CONTROLLED SOLAR POWER GENERATORS WITH MULTIPLE SUPPLY CHANNELS AND _DUAL PURPOSE UTILIZATION TO SUPPLY IN SUCCESSION POWER TO AN ION PROPULSION ENGINE AND TO A MICROWAVE TUBE. THESE PLANS INCLUDE THE EFFORTS FOR STUDY DESIGN AND CONSTRUCTION OF A 3 KW LABORATORY SOLAR POWER SUPPLY SYSTEM AND THE CONTINUATION OF EFFORTS TOWARDS THE STUDY OF _FEASIBILITY OF LARGE AREA SOLAR ARRAYS THAT COULD WITHSTAND THE STRESSES OF THE ASSOCIATED FIELDS.

RTOP NO. 114-03-01 TITLE: SURFACE PHYSICS AND CHEMISTRY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: DALINS, I. TEL. 205-453-5134
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE BEING PERFORMED IN ORDER TO AUGMENT THE UNDERSTANDING OF VARIOUS ATOMIC, IONIC AND ELECTRONIC INTERACTIONS AT OR ON INTERFACES OF SOLIDS. THIS STUDY IS REORIENTED IN ORDER TO BE ABLE TO SPECIALIZE ON STUDIES OF SURFACE INTERACTIONS THAT OCCUR ON CERTAIN SEMICONDUCTOR SURFACES. THE ROLE OF EPITAXY AND ITS RELATIONSHIP TO SURFACE STATES, BARRIER POTENTIAL, ETC., IS BEING INVESTIGATED IN LIGHT OF RECENT SCIENTIFIC DEVELOPMENTS IN THIS TECHNICAL AREA. AMONG THE EXPERIMENTAL METHODS LEED AND AES IN COMBINATION WITH MEASUREMENTS OF WORK FUNCTION, FIELD EFFECT, SURFACE CONDUCTIVITY, RECOMBINATION VELOCITY IS EITHER EMPLOYED OR BEING CAREFULLY EVALUATED FOR FUTURE EFFORTS. THE PREPARATION OF THE TEST SURFACE AND THE METHODS USED IN THIS STUDY ARE CONSISTENT WITH THE SO CALLED "CLEAN SURFACE" APPROACH. COMPLEMENTING THEORETICAL STUDIES PERTAINING TO THE SURFACE STATES PROBLEM IS BEING CONDUCTED IN ORDER TO DEVELOP A BETTER UNDERSTANDING OF THE PHYSICAL ASPECTS OF THE PROBLEM.

RTOP NO. 114-03-01 TITLE: SURFACE PHYSICS AND CHEMISTRY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RESEARCH INCLUDES THEORETICAL AND EXPERIMENTAL STUDIES OF THE PHYSICAL, MECHANICAL AND ELECTRONIC PROPERTIES OF SURFACES. THESE STUDIES RANGE FROM THEORETICAL MODELING OF AN ATOM-SOLID INTERACTION AND SURFACE ENERGY STATES AND CHARACTERIZATION OF THE INTERACTIONS OF GASES AND SURFACES WITH A SURFACE-ION MASS SPECTROMETER TO ATTEMPTS TO GAIN UNDERSTANDING OF THE KINETICS OF NUCLEATION AND GROWTH OF CRYSTAL NUCLEI WITH IN SITU

ULTRA-HIGH-VACUUM ELECTRON MICROSCOPY. RESULTS OF THIS WORK WILL IMPROVE OUR UNDERSTANDING OF STRESS CORROSION OF METALS AND OF NUCLEATION AND GROWTH OF THIN FILMS, AND WILL HAVE APPLICATION IN SUCH AREAS AS CORROSION PREVENTION, MATERIALS PROCESSING, AND ELECTRONICS.

RTOP NO. 114-03-02 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

STUDIES OF THE PHYSICS AND CHEMISTRY OF METALS ARE TO BE CONDUCTED TO GAIN A BETTER UNDERSTANDING OF THE EFFECTS OF THE ENVIRONMENT OF EARTH, PLANETS, AND INTERPLANETARY SPACE ON THEIR STRUCTURAL PERFORMANCE. MECHANICAL, ELECTRICAL, AND OPTICAL PROPERTIES ARE TYPICAL OF THOSE MATERIAL PROPERTIES WHICH CAN BE DEGRADED BY EXPOSURE TO THESE ENVIRONMENTS; THESE PROPERTIES WILL BE STUDIED WITH TENSILE AND FATIGUE TESTING MACHINES, OPTICAL INSTRUMENTS, CRACK DETECTORS, ETC., AFTER (AND DURING IF APPROPRIATE) EXPOSURE TO SIMULATED PLANETARY AND SPACE ENVIRONMENTS. RESULTS OF THIS WORK WILL BE USEFUL IN THE DESIGN OF AIRCRAFT AND SPACECRAFT. THE EFFECTS OF SHOCK WAVES ON NATURAL CRYSTALLINE MATERIALS ARE BEING STUDIED TO DETERMINE THE MECHANISMS OF ATOMIC REARRANGEMENT WHICH LEAD TO THE STRUCTURAL CHANGES OBSERVED FOLLOWING SUCH SHOCK LOADING. RESULTS WILL BE OF VALUE IN LEADING TO A FULLER UNDERSTANDING OF THE MECHANISMS BY WHICH DIFFERENT CRYSTALLINE STRUCTURES DEFORM AND COLLAPSE UNDER SUDDENLY APPLIED LOADS.

RTOP NO. 114-03-02 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LAD, R. A. TEL. 216-433-6601
TECHNICAL SUMMARY

TO OBTAIN AN INCREASED UNDERSTANDING OF THE BASIC PROPERTIES OF THE SOLID STATE, BOTH BULK AND SURFACE, WITH PARTICULAR EMPHASIS ON THE ROLE OF ELECTRONIC AND MAGNETIC PROPERTIES, ATOMIC STRUCTURE AND CHEMICAL REACTIVITY IN THE DETERMINATION OF PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES. THE RESEARCH IS DESIGNED TO APPLY TO MATERIALS PREPARATION AND TO THE CONTROL OF PHYSICAL PHENOMENA IN MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE TO NASA. PROGRAMS IN DIFFUSION: THEORETICAL AND EXPERIMENTAL STUDIES OF DIFFUSION AND DEFECT STRUCTURE IN REFRACTORY BCC METALS AND APPLICATION TO STRAIN AGING AND CREEP, SURFACE DEFECT STUDIES ON INSULATORS USING EPR AND ELECTRON BOMBARDMENT. PROGRAMS ON ELECTRONIC AND MAGNETIC PROPERTIES: THEORY AND EXPERIMENTAL VERIFICATION FOR RARE EARTH ALLOYS, STUDIES OF HIGH COERCIVE FORCE MATERIALS USING MAGNETOSTRICTION AND MOSSBAUER SPECTROSCOPY. PROGRAMS ON CHEMICAL BOND CONTROLLED PROPERTIES: MASS SPECTROMETRIC STUDY OF REFRACTORY COMPOUNDS AT HIGH TEMPERATURES, MECHANICAL PROPERTIES OF THE TIH SYSTEM, HIGH PURITY METAL PREPARATION BY ELECTRON BOMBARDMENT, THEORY AND EXPERIMENTAL STUDIES OF CHEMISORPTION.

RTOP NO. 114-03-02 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE EFFECTS OF HAZARDOUS CONDITIONS ENCOUNTERED BY MAN IN SPACE AND PLANETARY ENVIRONMENTS WILL IMPOSE SERIOUS CONSTRAINTS ON BOTH MISSION AND SPACECRAFT DESIGN FOR ANY LONG TERM MANNED SPACE MISSION. OF PRIMARY CONCERN IS THE PHYSICAL INCAPACITATION AND SUBSEQUENT REDUCED PERFORMANCE LEVEL OF THE ASTRONAUT DUE TO THE MITOGENIC INHIBITION OF SOMATIC CELLS WHICH UNDERLIES CRITICAL SPACE RADIATION SICKNESS. INHIBITION AND OVER-STIMULATION OF MITOSIS BY RADIATION AND WEIGHTLESSNESS, RESPECTIVELY, CAN LEAD TO SEVERE HOMESOTATIC UPSET AND EVEN DEATH. RESEARCH IS PLANNED TO DETERMINE THE BASIC MOLECULAR PROCESSES INVOLVED IN THE REGULATION OF MITOGENESIS IN SOMATIC CELLS, AND THE FUNCTIONAL ALTERATION OF THESE PROCESSES BY ADVERSE ELEMENTS OF SPACE AND PLANETARY ENVIRONMENTS. CURRENT INVESTIGATIONS WILL BE CONCERNED WITH ESTABLISHING THE CORRELATION AND INTERACTIONS BETWEEN STRUCTURAL FORM AND FUNCTION IN BIOLOGICAL SYSTEMS AT THE FUNDAMENTAL MOLECULAR LEVEL. SPECIFIC AREAS OF INTEREST ARE, THE MOLECULAR STRUCTURE OF THE CELL MEMBRANE, THEIONIC PARTITIONING ABILITY OF THE CELL, THE STRUCTURE OF THE HUMAN CHROMOSOME, AND THE EFFECTS OF IONIC ENVIRONMENTS ON THE PHYSICAL STATE OF THE CHROMOSOMAL DNA. THE INFORMATION GAINED WILL PINPOINT THE KEY MOLECULAR PROCESSES UNDERLYING MITOSIS AND PROVIDE A RATIONAL BASIS FOR COUNTERMEASURE DEVELOPMENT.

RTOP NO. 114-03-03 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: URBAN, E. W. TEL. 205-453-5134
TECHNICAL SUMMARY

A WIDE VARIETY OF SUPERCONDUCTING DEVICES HAVE BEEN PROPOSED FOR SPACE APPLICATIONS, INCLUDING MAGNETS AND INSTRUMENTATION. ALL ARE LIMITED IN UTILITY BY EXCESSIVELY LOW OPERATING TEMPERATURE REQUIREMENTS; MAGNETS ARE ADDITIONALLY RESTRICTED BY MAGNETIC-THERMAL INSTABILITIES. IT IS IMPORTANT TO SEEK TECHNIQUES FOR INCREASING SUPERCONDUCTING TRANSITION TEMPERATURES, TO INVESTIGATE NEW SUPERCONDUCTING INSTRUMENTATION CONCEPTS, AND TO IMPROVE THE STABILITY OF MAGNETIC MATERIALS. THEORETICAL AND EXPERIMENTAL STUDIES ARE BEING MADE OF THE PROPERTIES AND PREPARATION OF KNOWN AND NEW SUPERCONDUCTORS TO DETERMINE THOSE PARAMETERS WHICH GOVERN TRANSITION TEMPERATURES AND MAGNETIC FIELD PROPERTIES, WITH AN ULTIMATE GOAL OF BEING ABLE TO SPECIFY THE CHARACTERISTICS OF AND TO PRODUCE MATERIALS OF GREATER UTILITY IN SPACE; ALSO STUDIES ARE MADE TO ENHANCE THE CAPABILITIES OF SUPERCONDUCTING QUANTUM INSTRUMENTATION FOR SPACE EXPERIMENTS AND TECHNOLOGICAL APPLICATIONS. ELECTROMAGNETIC AND PARTICULATE RADIATION ALTER SIGNIFICANTLY THE OPTICAL, ELECTRONIC, AND MAGNETIC PROPERTIES OF INORGANIC SEMICONDUCTORS. IN PARTICULAR, WHEN USED IN THERMAL CONTROL COATINGS FOR SPACECRAFT, SUCH SEMICONDUCTORS ARE DEGRADED, CHIEFLY BY ULTRAVIOLET RADIATION AND SOLAR WIND PROTONS, AND BECOME LESS EFFECTIVE IN CONTROLLING THE TEMPERATURE. MECHANISMS FOR THE

DEGRADATION ARE INCOMPLETELY UNDERSTOOD, AND IT IS THUS IMPOSSIBLE EITHER TO PREDICT METHODS FOR IMPROVING KNOWN MATERIALS OR TO SPECIFY MORE SUITABLE ALTERNATE MATERIALS. THEORETICAL AND EXPERIMENTAL STUDIES ARE IN PROGRESS TO ELUCIDATE THE GENERAL DAMAGE MECHANISMS IN INORGANIC SEMICONDUCTORS. EXPERIMENTAL TECHNIQUES INCLUDEEPR, OPTICAL ABSORPTION AND REFLECTANCE----

RTOP NO. 114-03-03 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE ELECTRONIC AND OPTICAL PROPERTIES OF MATERIALS ARE CRUCIAL FOR ALL SOLID-STATE DEVICES. OF INTEREST FOR THESE DEVICES ARE SEMICONDUCTOR BULK AND SURFACE CARRIER-RECOMBINATION RATES, IMPURITY TYPE AND ENERGY, AND STABILITY OF THESE PARAMETERS TO TEMPERATURE, LIGHT AND ADSORBED GASES. THE PROPERTY STUDIES COVERED BY THIS RTOP ARE FUNDAMENTAL TO IMPROVED SOLAR CELLS, NEW LIGHT-CONTROLLED MICROWAVE MODULATORS AND INFRARED DETECTORS, LIGHT-EMITTING DIODES, HIGH-TEMPERATURE TRANSISTORS, AND OPTICAL MEMORIES FOR ULTRA-HIGH DENSITY COMPUTERS. SOLAR CELLS COULD BE IMPROVED IN EFFICIENCY USING GAAS HAVING LOWERED SURFACE RECOMBINATION RATE, AND IN HIGH TEMPERATURE POWER PRODUCTION, BY EMPLOYING P-N JUNCTIONS IN EITHER GAAS OR CDS. HIGH TEMPERATURE TRANSISTORS, BLUE AND GREEN LIGHT EMITTING DIODES AND DIODE LASERS REQUIRE IMPROVED DOPING AND CHARACTERIZATION OF WIDE BANDGAP SEMICONDUCTORS, SUCH AS GAAS, GAP, CDTE AND ZNSE. AS AN OUTGROWTH FROM STUDIES OF ORGANIC PHOTOCHROMICS, PARAMAGNETIC ORGANIC SOLIDS HAVE RECENTLY BEEN DISCOVERED AND SUGGEST POTENTIAL APPLICATIONS AS MICROWAVE MODULATORS, INFRARED DETECTORS AND IN PARAMAGNETIC, RATHER THAN FERROMAGNETIC, TAPE RECORDING. OPTICAL MEMORIES FOR COMPUTERS BASED ON INDEX OF REFRACTION CHANGE AND PHASE HOLOGRAMS REQUIRE STUDIES OF A RANGE OF FERROELECTRIC, PHOTOELECTRIC AND PHOTOCHEMICAL SYSTEMS.

RTOP NO. 114-03-04 TITLE: ADVANCED FORMING AND PROCESSING
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: BANNISTER, T. C. TEL. 205-453-3090
TECHNICAL SUMMARY

THE PURPOSE OF THIS RTOP IS TO DEVELOP THE TECHNOLOGY AND KNOWLEDGE NECESSARY TO UNDERSTAND THE BASIC EFFECTS OF THE SPACE ENVIRONMENT ON PROCESSES IN NASA'S SPACE PROCESSING PROGRAM INVOLVING CRYSTAL GROWTH AND SOLIDIFICATION. PAST EFFORTS HAVE BEEN DEVOTED PRIMARILY TOWARD DEFINITION OF GRAVITY EFFECTS AND TOWARD DEFINITION OF CANDIDATE PROCESSES HAVING POTENTIAL FOR USAGE IN SPACE. THE PRESENT OBJECTIVE IS TO CONTINUE THIS WORK AND TO FOCUS UPON DEVELOPING AN IN-DEPTH SCIENTIFIC UNDERSTANDING ON METALLIC AND SEMICONDUCTOR CRYSTALS BEING CONSIDERED IN SPACE PROCESSING. THE APPROACH TO BE USED IN THIS EFFORT IS TO USE A BALANCE OF INHOUSE RESEARCH AND CONTRACT RESEARCH IN ORDER TO ACCOMPLISH SPECIFIC TECHNICAL TASKS INCLUDING: 1) DEFINITION OF CONVECTION EFFECTS ON

SOLIDIFICATION; 2) DESCRIPTION OF SOLIDIFICATION IMPERFECTIONS THAT OCCUR DURING CRYSTAL GROWTH; 3) DEVELOPMENT OF CERTAIN GROWTH TECHNIQUES SUITABLE FOR SPACE FLIGHT; 4) DEFINITION AND DEVELOPMENT OF CHARACTIZATION TECHNIQUES CAPABLE OF IMPORTANT CRYSTAL DEFECTS.

RTOP NO. 114-03-05 TITLE: SPACE RADIATION SHIELDING & DOSIMETRY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER,
MONITOR: DECHER, R. TEL. 205-453-5130
TECHNICAL SUMMARY

SPACE RADIATION IS A MAJOR CONSIDERATION IN ALL SPACE MISSIONS, WHETHER MANNED OR UNMANNED. THESE RADIATIONS MAY EMANATE FROM THE SUN (SOLAR PROTONS), INTERGALACTIC SPACE (COSMIC RAYS), EXIST AS TRAPPED PARTICLES (BOTH ELECTRONS AND PROTONS) IN THE EARTH'S MAGNETIC FIELD, OR BE CREATED WITHIN THE SPACECRAFT ITSELF BY ON BOARD SOURCES. THE MARSHALL SPACE FLIGHT CENTER HAS MAINTAINED A CONTINUOUS EFFORT IN THIS FIELD SINCE ITS ORIGINAL ASSOCIATION WITH THE TEAM WHICH DISCOVERED THE VAN ALLEN BELTS. THE PRESENT EFFORTS AT MSFC ARE DIRECTED TOWARD IMPROVING THE USE AND KNOWLEDGE OF THE RADIATION ENVIRONMENT AS REQUIRED FOR SPACE VEHICLE DEVELOPMENT; CALCULATIONS AND MEASUREMENTS TO DETERMINE THE EFFECTIVENESS OF CURRENT PASSIVE SHIELDING TECHNIQUES; RESEARCH TO DEVELOP NEW TECHNIQUES FOR DOSIMETRY, ESPECIALLY FOR HEAVY CHARGED PARTICLES; AND STUDIES TO DETERMINE BASIC CHARGED PARTICLE COLLISION CROSS SECTION DATA. THE MAJOR EFFORT IN FY-72 WILL BE IN THE AREA OF COSMIC RAY TRANSPORT AND DOSIMETRY WITH A LOW LEVEL SUPPORT TO THE ORNL RADIATION SHIELDING INFORMATION CENTER AND THE COMPLETION OF A SPACE RADIATION SHIELDING HANDBOOK.

RTOP NO. 114-03-05 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

INVESTIGATE THE EFFECTS OF INTERMEDIATE ENERGY PROTONS AND ALPHA PARTICLES ON VARIOUS MATERIALS, FOR THE PURPOSE OF IMPROVING CALCULATIONS OF RADIATION SHIELD EFFECTIVENESS AND OF BIOLOGICAL DOSE. DEVELOP AND MAINTAIN THEORETICAL MODELS AND COMPUTATIONAL METHODS TO ANALYTICALLY OBTAIN THE RADIATION COMPONENTS OF THE ENVIRONMENT, TRANSPORT THESE THROUGH ANY GIVEN MATERIAL AND ESTIMATE THE BIOLOGICAL DOSE AT A GIVEN POINT. DEVELOP A PARTICLE IDENTIFICATION SYSTEM AND ENERGY SPECTROMETER TO BE USED AS A REAL TIME REM DOSIMETER FOR FUTURE LONG-DURATION MANNED SPACE FLIGHTS. INVESTIGATE THE EFFECT OF IONIZING RADIATION ON VARIOUS TYPES OF PHOTOGRAPHIC EMULSIONS AND ADVANCE THE STATE OF THE ART TO THE POINT WHERE SPACE RADIATION NO LONGER POSES A SERIOUS THREAT TO THE USE OF PHOTOGRAPHIC EMULSIONS ON REALISTIC SPACE MISSIONS. PERFORM EXPERIMENTS AT PROTON AND ALPHA PARTICLE ACCELERATORS TO MEASURE THE MASS, CHARGE, ENERGY, AND ANGLE OF EMISSION OF NEUTRAL AND CHARGED SECONDARY PARTICLES THAT ARE PRODUCED AS A RESULT OF THE PASSAGE OF INTERMEDIATE ENERGY PROTONS AND ALPHA PARTICLES THROUGH MATTER. USE AN IN-HOUSE COMBINATION OF EMULSION, PROTON EXPOSURE, AND DOSIMETRY

TECHNIQUES AND A STATE-OF-THE-ART FILM EXPOSURE AND PROCESSING LABORATORY TO DETERMINE THE PHOTOGRAPHIC RESPONSE OF DIFFERENT EMULSIONS TO SPACE RADIATION.

RTOP NO. 114-03-06 TITLE: SPACE RADIATION EFFECTS LABORATORY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR THE MANAGEMENT, OPERATION, AND MAINTENANCE OF THE SPACE RADIATION EFFECTS LABORATORY (SREL). THE LABORATORY IS USED JOINTLY BY SCIENTISTS AND ENGINEERS TO PERFORM RESEARCH IN BASIC PHYSICS, RADIOBIOLOGY, AND THE EFFECTS OF RADIATION ON MATERIALS, COMPONENTS, AND SYSTEMS PLANNED FOR USE IN SPACE. THE LABORATORY IS OPERATED BY THE COLLEGE OF WILLIAM AND MARY UNDER CONTRACT TO THE LANGLEY RESEARCH CENTER. THE OPERATING TIME IS SHARED EQUALLY BETWEEN EDUCATIONAL INSTITUTIONS AND GOVERNMENT AGENCIES.

RTOP NO. 114-03-07 TITLE: OPTICAL CONTAMINATION OF SPACECRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO IDENTIFY CONTAMINATION ON SPACECRAFT SURFACES AND TO MEASURE CONTAMINATION IN GROUND FACILITIES AND IN SPACE. CONSIDERATION WILL BE GIVEN TO WAYS OF MONITORING AND CONTROLLING CONTAMINATION AND MEASURING THE CHANGES IN PROPERTIES OF SENSITIVE SURFACES ON SPACECRAFT DUE TO CONTAMINATION. TECHNIQUES WILL BE DEVELOPED FOR DEPOSITING, DETECTING, AND IDENTIFYING CONTAMINANTS ON SOLID SURFACES IN THE SPACE ENVIRONMENT. THESE TECHNIQUES WILL BE USED TO DETERMINE THE EFFECTS OF CONTAMINANTS ON THE SURFACE AND/OR BULK PROPERTIES OF SPACECRAFT MATERIALS.

RTOP NO. 114-03-07 TITLE: OPTICAL CONTAMINATION OF SPACECRAFT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: WEATHERS, H. M. TEL. 205-453-3040
TECHNICAL SUMMARY

THIS STUDY IS DIRECTED TOWARD A BETTER UNDERSTANDING OF THE INDUCED ENVIRONMENT AROUND SPACECRAFT, BOTH MANNED AND UNMANNED AS IT DEGRADES THE RESULTS OF IMPORTANT MEASUREMENTS AND EXPERIMENTS. MOREOVER, THIS RTOP PROVIDES FOR THE STUDY, CONTROL, MONITORING, AND ABATEMENT OF CONTAMINATION AS IT EFFECTS ASTRONOMICAL INSTRUMENTS, THERMAL CONTROL SURFACES, AND OTHER CRITICAL OPTICAL SURFACES SUCH AS FOUND ON SKYLAB, HEAO, SPACE STATION, SPACE SHUTTLE, AND RAM.

RTOP NO. 114-03-08 TITLE: EFFECTS OF VENT AND THRUSTER PLUMES ON VEHICLE SURFACES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MARK, H. TEL. 216-433-6201
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DETERMINE THE EFFECTS OF RELEASING GASES FROM A SPACE VEHICLE OR FROM A NEIGHBORING VEHICLE IN SUCH A WAY AS TO AFFECT THE OPERATION OF THE VEHICLE OR ANY OF ITS COMPONENTS. DETERMINATION OF THE EFFECTS ON SPACE VEHICLE SURFACES OF FIRING CHEMICAL ROCKETS FOR MANEUVERING OR DOCKING IN THE VICINITY OF ANOTHER SPACE VEHICLE WILL BE INCLUDED. CRITICAL LOW TEMPERATURE SURFACES ON WHICH CONDENSATES WILL MOST PROBABLY APPEAR WILL BE STUDIED. EFFECTS FOR HIGHER TEMPERATURE SURFACES ON WHICH UNDESIRABLE REACTIONS COULD OCCUR WILL BE INCLUDED. THE EFFECTS OF ADDITIONAL ENVIRONMENTAL FEATURES WILL BE CONSIDERED AND SOME EFFORT WILL ALSO BE DIRECTED TOWARDS APPLICATION OF PLUME VEHICLE INTERACTIONS FOR REFURBISHMENT OF SURFACES. WHERE POSSIBLE SPECTRAL DATA WILL BE ADDED TO HELP IDENTIFY THE CONTAMINANT AS WELL AS TO PROVIDE THE POSSIBILITY OF CORRECTING MEASUREMENTS MADE BY OPTICAL INSTRUMENTS UNDER THESE CONDITIONS.

RTOP NO. 114-03-20 TITLE: ADVANCED MATERIALS FOR SPACE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVES OF THE RESEARCH PROGRAM ARE: (1) TO EVALUATE THE EFFECTS OF LONG TERM EXPOSURE TO SPACE ENVIRONMENTAL CONDITIONS ON POLYMERIC MATERIALS USED AS ADHESIVES, SEALANTS, AND INSULATORS IN SPACECRAFT STRUCTURES AND COMPONENTS; (2) TO DEVELOP AND EVALUATE COATINGS FOR METALS, CERAMICS, AND PLASTICS EXPOSED TO HIGH TEMPERATURES AND/OR EROSIVE ENVIRONMENTS; AND (3) TO STUDY THE THERMO-PHYSICAL PROPERTIES OF ABLATIVE CHARS. THE THERMAL, MECHANICAL, AND DIELECTRIC PROPERTIES OF POLYMERIC MATERIALS WILL BE EVALUATED EXPERIMENTALLY BEFORE AND FOLLOWING UP TO FOUR MONTHS EXPOSURE TO HIGH VACUUM. TECHNIQUES SUCH AS THERMOGRAVIMETRIC ANALYSIS AND DIFFERENTIAL THERMAL ANALYSIS IN CONJUNCTION WITH GAS CHROMOTOGRAPHY AND RESIDUAL GAS ANALYSIS WILL BE USED TO QUALITATIVELY AND QUANTITATIVELY DETERMINE OUTGASSING PRODUCTS OVER A BROAD TEMPERATURE RANGE. COATED METALLIC AND NON-METALLIC MATERIALS WILL BE EVALUATED IN THERMAL, VACUUM, AND MECHANICAL ENVIRONMENTS. CRYSTALLOGRAPHIC AND CHEMICAL CHANGES IN CERAMIC COATINGS SUBJECTED TO CYCLIC TEMPERATURE WILL BE DETERMINED. THE EFFECTS OF SUCH FACTORS AS HEATING RATE, MAXIMUM TEMPERATURE, AND HEATING HISTORY ON THE CONDUCTIVITY OF ABLATIVE MATERIAL CHARS WILL BE INVESTIGATED.

RTOP NO. 114-03-20 TITLE: ADVANCED MATERIALS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CANTOR, B. R. TEL. 301-982-2309
TECHNICAL SUMMARY

CHEMICAL VAPOR DEPOSITION (CVD) AND ION BEAM POLISHING (IBP) ARE

AMONG THE PROCESSES BEING STUDIED FOR THE PRODUCTION OF STRONG, HIGHLY STABLE AND ACCURATE OPTICAL ELEMENTS. CVD SHOULD PERMIT FABRICATION OF ACCURATE STRESS-FREE COMPONENTS FROM A POLISHED MASTER WHILE IBP WILL PERMIT REMOVING SMALL, CONTROLLED AMOUNTS OF MATERIALS FROM OPTICAL SURFACES BY EROSION WITH AN ACCELERATED BEAM OF IONS TO ACHIEVE THE DESIRED CONFIGURATION. EXPLOSIVE FORMING IS ANOTHER TECHNIQUE WHICH IS BEING STUDIED FOR PRODUCING LARGE REFLECTIVE ELEMENTS. THE FEASIBILITY OF USING A PIEZOELECTRIC POSITIONER TO ACHIEVE MOTION ACCURACIES IN THE ORDER OF 2.54 X 10 TO THE MINUS 8TH POWER METER HAS BEEN DEMONSTRATED. FURTHER DEVELOPMENT OF THIS OR SIMILAR DEVICES FOR THE PURPOSE OF POSITIONING OPTICAL ELEMENTS AS WELL AS FOR GENERATING ACCURATE OPTICAL SURFACES WILL BE CONTINUED.

RTOP NO. 114-03-20 TITLE: ADVANCED MATERIALS FOR SPACE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP IMPROVED REFRACTORY ALLOYS WITH SUPERIOR COMBINATIONS OF MECHANICAL PROPERTIES FOR SPACE POWER SYSTEMS, RE-ENTRY VEHICLES, NUCLEAR REACTORS, AND OTHER SPACE APPLICATIONS. TO ACHIEVE THIS OBJECTIVE, THE HIGH TEMPERATURE STRENGTH PROPERTIES OF REFRACTORY ALLOYS OF W, TA, AND MO ARE BEING ENHANCED THROUGH MECHANISTIC STUDIES OF LONG TIME CREEP BEHAVIOR, PRECIPITATE STRENGTHENING, AND THERMOMECHANICAL PROCESSING RESPONSE. THE SOLUTION SOFTENING BEHAVIOR OR DILUTE REFRACTORY ALLOYS IS BEING STUDIED TO IMPROVE LOW TEMPERATURE DUCTILITY. A SECOND OBJECTIVE OF THIS PROGRAM IS TO PROVIDE MATERIALS RESEARCH TO SUPPORT NUCLEAR THERMIONIC SYSTEMS.

RTOP NO. 114-03-22 TITLE: POLYMERS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO ASCERTAIN THE FEASIBILITY OF SYNTHESIZING A HIGH TEMPERATURE SUPERCONDUCTOR. THE ACHIEVEMENT OF THE OBJECTIVE REQUIRES UNDERSTANDING AND CONTROL OF ELECTRONIC CONDUCTIVITY IN POLYMERIC MATRICES. THE GENERAL APPROACH INVOLVES THEORETICAL CALCULATIONS AND SYNTHESIS OF BOTH NEW AND MODIFIED POLYMERIC AND PROTOTYPE CHEMICAL STRUCTURES, THE CHARACTERIZATION OF THESE MATERIALS AND THE DETERMINATION OF CHEMICAL STRUCTURE AND PROPERTY RELATIONSHIP. THE EMPHASIS IS PLACED ON AN EXPERIMENTAL STUDY OF TWO DIMENSIONAL SUPERCONDUCTIVITY BASED ON THE GINZBURG MODEL. THIS INVOLVES INCORPORATION OF MOLECULAR LAYERS OF METALS INTO LAYERED STRUCTURES (E.G., MOLYBDENUM DISULFIDE, PREFERABLY IN HIGHLY CRYSTALLINE FORM) FOLLOWED BY PHYSICAL AND CHEMICAL ANALYSIS AND THE DETERMINATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE. MONODIMENSIONAL SYSTEMS (E.G. CRYSTALLINE TCNQ STRUCTURES) ARE ALSO UNDER INVESTIGATIONS BY A SIMILAR APPROACH.

RTOP NO. 114-03-23 TITLE: COMPOSITE MATERIALS FOR SPACE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES THE DEVELOPMENT OF CARBON OR GRAPHITE FIBER--ALUMINUM ALLOY MATRIX COMPOSITES FOR STRUCTURAL APPLICATIONS. FABRICATION AND COMPATIBILITY STUDIES ARE A REQUISITE TO THE SUCCESSFUL PRODUCTION OF COMPOSITES AND WILL CONSTITUTE A MAJOR PORTION OF THE PROGRAM. HIGH STRENGTH, LARGE DIAMETER CARBON BASE MONOFILAMENTS HAVE BEEN DEVELOPED UNDER CONTRACT TO NASA. THESE HAVE POTENTIAL AS REINFORCEMENTS OF METAL IN THAT THEY CAN BE HANDLED, COATED, AND RESIST DAMAGE MORE READILY THAN USUAL FINE DIAMETER FIBERS. THE PRIMARY EMPHASIS IN THE PROGRAM WILL INVOLVE THESE LARGE FIBERS. AS BASIS FOR COMPARISON, AND BECAUSE CONVENTIONAL FINE GRAPHITE FIBERS ARE BEING MADE IN LARGE QUANTITIES, THESE FIBERS TOO WILL BE INCORPORATED INTO COMPOSITES FOR STUDY. THE OBJECTIVES OF THE PROGRAM ARE: 1. TO DETERMINE WHICH OF SEVERAL FABRICATION METHODS WILL PERMIT SUCCESSFUL PRODUCTION OF CARBON BASE FIBER-ALUMINUM ALLOY MATRIX COMPOSITES. 2. TO EVALUATE BY TEST AND METALLOGRAPHIC EXAMINATION THE QUALITY OF THE COMPOSITES.

RTOP NO. 114-03-24 TITLE: BEARINGS, SEALS AND LUBRICANTS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: JOHNSON, R. L. TEL. 216-433-4000
TECHNICAL SUMMARY

BASIC MATERIALS AND LUBRICANTS STUDIES AS WELL AS EXPERIMENTS AND ANALYSES WITH ACTUAL COMPONENTS IN VACUUM, CRYOGENIC, INERT GAS, AND LOW VISCOSITY FLUID ENVIRONMENTS WILL BE CONDUCTED. MATERIALS STUDIES INCLUDE ATOMIC, MOLECULAR AND CRYSTALLINE AND SURFACE PHYSICS AND CHEMISTRY CONSIDERATIONS. THE POTENTIALS OF SELF-LUBRICATING MATERIALS AND FILM DEPOSITION METHODS ARE BEING EXPLORED. EXPERIMENTS AND ANALYSES OF PROMISING TYPES OF FLUID FILM BEARINGS AND SEALS FOR GAS AND LOW VISCOSITY LIQUID APPLICATIONS ARE UNDERWAY. SEAL CONCEPTS INCLUDE THOSE WITH SELF-ACTING AND EXTERNALLY PRESSURIZED FILM GENERATION AND SELF-PUMPING VISCOSEALS. PROMISING MATERIALS FROM VACUUM STUDIES WILL BE USED FOR HUMAN HIP PROSTHESIS STUDIES AND POSSIBLE IMPLANTS. RHEOLOGICAL PROPERTIES OF LUBRICATING FLUIDS WILL BE STUDIED AT HIGH PRESSURES (BOTH STEADY AND TRANSIENT) AND RELATED TO CONCENTRATED CONTACT.

RTOP NO. 114-03-25 TITLE: EXTRATERRESTRIAL MATERIALS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILLER, E. R. TEL. 205-453-3103
TECHNICAL SUMMARY

A STUDY OF THE BASIC MODES OF HEAT TRANSFER IN PARTICULATE MATERIALS WILL BE MADE. THE PROPERTIES OF THE LUNAR SURFACE MATERIAL AS REPORTED BY THE PRINCIPAL INVESTIGATORS OF THE APOLLO PROGRAM WILL BE COMPARED TO PROPERTIES OF THE SIMULATED LUNAR STUDIES CONDUCTED IN THE LABORATORY. PHYSICAL PROPERTIES AND ENGINEERING BEHAVIOR OF MATERIALS UNDER VARIOUS SIMULATED LUNAR AND PLANETARY ENVIRONMENTAL

CONDITIONS WILL BE INVESTIGATED. THESE INVESTIGATIONS ARE NEEDED IN ORDER TO DEVELOP AND BUILD SKILL IN INTERPRETATION OF FINDINGS, KNOWLEDGE OF THE UNKNOWN, AND A MODE OF OPERATION AS RELATED TO EXTRATERRESTRIAL SOURCE MATERIALS.

RTOP NO. 114-03-30 TITLE: SPACE SHUTTLE: ENVIRONMENTAL TESTING OF THERMAL-PROTECTION MATERIALS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS PROGRAM WILL ENCOMPASS A NUMBER OF WORK AREAS DEALING WITH THE EFFECTS OF THE ENTRY ENVIRONMENT ON CANDIDATE THERMAL-PROTECTION AND SKIN MATERIALS FOR SPACE SHUTTLE, WITH A COMMON GOAL OF EVALUATING THE OXIDATION SUSCEPTIBILITY AND RESULTING EFFECT ON THE MECHANICAL AND OPTICAL PROPERTIES OF THESE MATERIALS. OXIDATION EXPERIMENTS WILL BE RUN IN HIGH-TEMPERATURE ENVIRONMENTAL CHAMBERS WITH ATOMIC OXYGEN GENERATORS TO PROVIDE REACTIVE SPECIES APPROPRIATE FOR SHUTTLE THERMAL-ENVIRONMENT CONDITIONS. MECHANICAL PROPERTY EXPERIMENTS WILL BE RUN WHICH INCORPORATE ENVIRONMENTAL SIMULATION, TENSILE TESTS, AND APPROPRIATE METALLURGICAL, CHEMICAL AND PHYSICAL PROPERTY MEASUREMENTS.

RTOP NO. 114-03-30 TITLE: HIGH TEMPERATURE METALS FOR SPACE SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES CONTINUED DEVELOPMENT OF METALLIC MATERIALS FOR POSSIBLE USE IN THE HIGH TEMPERATURE REGIONS OF HEAT SHIELDS FOR SPACE SHUTTLE VEHICLES. THE PROGRAM INCLUDES THE DEVELOPMENT OF BOTH DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS (NI-CR-THO) AND COATED REFRACTORY METALS (COLUMBIUM AND TANTALUM ALLOYS). THE MAJOR OBJECTIVES OF THE PROGRAM ARE: 1. TO COMPLETE THE DEVELOPMENT AND SCALE-UP OF FABRICATION PROCESSES FOR AN ADVANCED NI-CR-THO ALLOY. 2. TO COMPLETE THE DEVELOPMENT OF RELIABLE FORMING AND JOINING PROCESSES FOR NI-CR-THO ALLOYS. 3. TO CONTINUE DEVELOPMENT OF IMPROVED OXIDATION-RESISTANT COATINGS AND PRODUCTION PROCESSES FOR BOTH COLUMBIUM AND TANTALUM ALLOY HEAT SHIELDS.

RTOP NO. 114-03-32 TITLE: BEARINGS, LUBRICANTS, AND SEALS FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: DEMOREST, K. E. TEL. 205-453-3536
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO PROVIDE SOLUTIONS TO THE PROBLEMS OF LUBRICATING BEARING SYSTEMS AND OTHER COMPONENTS FOR LONG LIFETIMES IN THE VARIETY OF ENVIRONMENTS WHICH WILL BE ENCOUNTERED BY SHUTTLE SPACECRAFT. EARLY ORBITAL FLIGHTS OF BOTH SATELLITES AND MANNED SPACECRAFT HAVE HAD LUBRICATION SYSTEMS THAT WERE EITHER

COMPLETELY SEALED OR THAT HAD RELATIVELY SHORT LIFE REQUIREMENTS. EVEN SUCH SPACECRAFT AS THE APOLLO TELESCOPE MOUNT AND THE ORBITAL WORKSHOP HAVE LIMITED LIFE REQUIREMENTS WHICH ARE WITHIN THE PRESENT STATE-OF-THE-ART. IT IS INTENDED TO ACCOMPLISH THE ABOVE OBJECTIVE BY THE CONTINUED DEVELOPMENT OF FLUID AND DRY LUBRICANTS AND BY THE DEVELOPMENT OF SPECIAL DESIGNS FOR SLIDING AND ROLLING ELEMENTS WHICH WILL MEET THE LIFE AND ENVIRONMENTAL REQUIREMENTS POSED BY THESE ADVANCED SYSTEMS.

RTOP NO. 114-03-32 TITLE: SHUTTLE LUBRICATION, BEARINGS AND SEALS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: JOHNSON, R. L. TEL. 216-433-4000
TECHNICAL SUMMARY

MATERIALS AND LUBRICANTS SELECTION, DEVELOPMENT, DESIGN, THEORY, ANALYSIS AND EXPERIMENTATION OF BEARINGS AND SEALS WILL BE PERFORMED UNDER EXTREME CONDITIONS ASSOCIATED WITH (A) ENGINE AND (B) VEHICLE COMPONENTS SUBJECT TO LUBRICATION, FRICTION, WEAR AND HYDRAULICS PROBLEMS. COMPONENTS MUST FUNCTION IN CRYOGENICS, AFTER EXPOSURE TO VACUUM, AND IN AIR AT EXTREME TEMPERATURES. ROLLING ELEMENT BEARINGS AND FACE TYPE SEALS FOR HYDROGEN PUMPS OF SHUTTLE ENGINES WILL BE OPERATED UNDER CONDITIONS SIMULATING PROBLEM AREAS. VEHICLE FRAME CONTROL BEARINGS, HYDRAULIC FLUIDS, AND SEALS FOR ACTUATION SYSTEMS OF FLIGHT CONTROL SURFACES WILL BE STUDIED. MINIMUM WEIGHT, EFFICIENCY AND EXTENDED LIFE ARE ESSENTIAL.

RTOP NO. 114-03-33 TITLE: STRUCTURAL COMPOSITE MATERIALS FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: LAIACONA, F. P. TEL. 205-453-5516
TECHNICAL SUMMARY

THE OBJECT OF THIS PROGRAM IS TO DEVELOP TECHNIQUES FOR FABRICATING FIBER REINFORCED ALUMINUM COMPOSITES INTO STRUCTURAL SHAPES (TUBES, I-BEAMS, HAT SECTIONS, "T"-SECTIONS, Z SECTIONS, ETC.) BY MEANS OF A CONTINUOUS PROCESS. THE PRIMARY OBJECTIVE IS THE REDUCTION OF METALLIC COMPOSITE FABRICATION COSTS AS WELL AS DEVELOPING A MORE RELIABLE AND DESIRABLE METHOD OF FABRICATING METALLIC COMPOSITE COMPONENTS. THE APPROACH WILL BE TO EVALUATE PROCESSES FOR PRODUCING BORON-ALUMINUM COMPOSITES WHICH APPEAR ADAPTABLE FOR USE IN A CONTINUOUS PROCESS. NECESSARY PROCESSING PROCEDURES WILL BE INVESTIGATED AND TECHNIQUES DEVELOPED FOR PRODUCING A VARIETY OF STRUCTURAL SHAPES. A MECHANICAL EVALUATION WILL BE MADE OF THE DEVELOPED COMPOSITES SO THAT FINAL FABRICATING TECHNIQUES CAN BE ESTABLISHED AND EXPECTED MECHANICAL PROPERTIES OF THE VARIOUS STRUCTURAL SHAPES CAN BE DEVELOPED. THE TECHNIQUES DEVELOPED SHALL ALSO BE INVESTIGATED FOR APPLICATION TO OTHER TYPE OF FIBER REINFORCED ALUMINUM COMPOSITES.

RTOP NO. 114-03-33 TITLE: STRUCTURAL COMPOSITE MATERIALS FOR SPACE SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRINCIPAL OBJECTIVE IS TO ESTABLISH THE CHARACTERISTICS OF AND TO OBTAIN DESIGN INFORMATION FOR CERTAIN ADVANCED FIBER/POLYMER MATRIX SYSTEMS THAT ARE APPLICABLE TO SPACE SHUTTLE STRUCTURES. THE HIGH STRENGTH TO WEIGHT RATIOS AND THE HIGH MODULUS TO WEIGHT RATIOS OF THESE SYSTEMS OFFER CONSIDERABLE PROMISE FOR REDUCING THE STRUCTURAL WEIGHT OF THE SHUTTLE SYSTEM AND THUS INCREASING THE PAYLOAD. A NEW HIGH STRENGTH, HIGH MODULUS ORGANIC FIBER WILL BE FURTHER INVESTIGATED AS A FILAMENT WINDING MATERIAL IN ADDITION TO A POLYIMIDE/GLASS FIBER SYSTEM FOR INCREASED TEMPERATURE CAPABILITY. IN ADDITION, ADHESIVE SYSTEMS WILL BE INVESTIGATED TO PROVIDE BETTER BOND STRENGTH OVER A WIDER TEMPERATURE RANGE.

RTOP NO. 114-03-34 TITLE: DESIGN PROPERTIES OF MATERIALS (EVALUATION OF SOFTGOODS)
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: WOOD, T. E. TEL. 205-453-1231
TECHNICAL SUMMARY

TO STUDY THE PERFORMANCE OF RUBBER SOFT GOODS WHICH MUST BE USED FOR SEALS, BLADDERS, O-RINGS, DIAPHRAGMS, GASKETS, ADHESIVES, AND RELATED APPLICATIONS AS EFFECTED BY EXTREME CYCLIC VARIATIONS IN THE SHUTTLE VEHICLE FLIGHT ENVIRONMENT, COUPLED WITH THE REUSABILITY, RELIABILITY AND QUICK TURN-AROUND REQUIREMENTS. IT IS PROPOSED TO EXPOSE CANDIDATE RUBBER MATERIALS IN BOTH TYPICAL END-USE CONFIGURATIONS AND STANDARD TEST CONFIGURATIONS TO CYCLIC THERMAL AND PRESSURE ENVIRONMENTS COMPARABLE TO ANTICIPATED SHUTTLE ENVIRONMENTS AND MONITOR SUCHPARAMETERS AS COMPRESSION SET, STRESS RELAXATION, AGING BEHAVIOR, EMBRITTLEMENT, STRENGTH CHANGES, HARDNESS, AND OTHER ATTRIBUTES WHICH DICTATED THE SELECTION AND SUITABILITY OF THE MATERIALS FOR THE GIVEN APPLICATION.

RTOP NO. 114-03-35 TITLE: MATERIALS ENVIRONMENTAL COMPATIBILITY FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: CATALDO, C. E. TEL. 205-453-1278
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY IS TO DETERMINE THE EFFECTS OF VARIOUS ENVIRONMENTS ANTICIPATED DURING FABRICATION, STORAGE AND FLIGHT OF THE SHUTTLE ON STRUCTURAL MATERIALS, BOTH WITH RESPECT TO SHORT TERM EFFECTS AND LONG LIFE EFFECTS. WHILE ALL ANTICIPATED ENVIRONMENTS CANNOT BE INVESTIGATED UNDER THE SCOPE OF THIS PROGRAM, SEVERAL SPECIFIC STUDIES ARE TO BE MADE WHEREIN MATERIALS PROBLEMS HAVE BEEN IDENTIFIED. THE STUDIES COVERED UNDER THIS RTOP INCLUDE THE EFFECTS OF HIGH PRESSURE GASEOUS HYDROGEN ON MATERIALS, THE FLAMMABILITY CHARACTERISTICS OF MATERIALS IN OXYGEN, CORROSION SUSCEPTIBILITY AND OUTGASSING CHARACTERISTICS OF NON-METALLIC

MATERIALS. THREE STUDIES ALREADY UNDERWAY WILL BE CONTINUED WITH DIFFERENT EMPHASIS AND ONE ADDITIONAL TASK WILL BE IMPLEMENTED.

RTOP NO. 114-03-36 TITLE: SPACE SHUTTLE: EXTERNAL INSULATION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROJECT IS TO DETERMINE: (1) THE MATERIAL PROPERTY CHANGES OF THE INGREDIENTS OF THIS CLASS OF MATERIALS AS THEY ARE PROCESSED AND SUBSEQUENTLY EXPOSED TO THE SHUTTLE ASCENT AND ENTRY ENVIRONMENT, AND (2) HOW THESE CHANGES RELATE TO THE THERMAL PERFORMANCE AND RELIABILITY OF THIS CLASS OF THERMAL PROTECTION SYSTEMS. SILICA, MULLITE AND ZIRCONIA SYSTEMS WILL BE STUDIED IN THEIR CURRENT STATUS TO PROVIDE A BASELINE FOR ASSESSING THE EFFECTS OF FUTURE IMPROVEMENTS ON THEIR PERFORMANCE AND RELIABILITY. THIS WILL BE ACCOMPLISHED BY ASSESSING THE CHEMICAL AND MORPHOLOGICAL STATES OF THE MATERIAL INGREDIENTS BEFORE AND AFTER PROCESSING INTO THE INSULATION ITSELF. THE COATING WILL LIKEWISE BE STUDIED. AFTER CYCLIC EXPOSURE TO SIMULATED ENTRY ENVIRONMENTS, CHANGES IN THE MATERIALS WILL BE ASSESSED, RELATED TO THE THERMAL AND MECHANICAL PERFORMANCE OF THE MATERIALS AND RECOMMENDATIONS WILL BE MADE FOR IMPROVING THE MATERIAL COMPOSITION, PROCESSING AND COATING TO ACHIEVE HIGHER PERFORMANCE AND GREATER RELIABILITY.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATIONS FOR SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: KING, H. M. TEL. 205-453-1227
TECHNICAL SUMMARY

THE OBJECTIVE IS TO EVALUATE THE PERFORMANCE OF REUSABLE SURFACE INSULATION (RSI) MATERIALS UNDER THERMAL AND DYNAMIC LOADS SIMULATING THE FLIGHT ENVIRONMENTS TO WHICH THE SHUTTLE BOOSTER IS EXPOSED IN ORDER TO ASSESS THE RELIABILITY OF THIS TYPE OF THERMAL PROTECTION SYSTEM FOR THIS APPLICATION, TO IDENTIFY OPTIMUM MATERIAL PROPERTIES, AND TO DEMONSTRATE ADEQUATE CYCLE LIFE FOR MULTI-FLIGHT REUSE WITH MINIMUM REFURBISHMENT. THE PERFORMANCE OF SEVERAL CURRENTLY AVAILABLE RSI MATERIALS WILL BE EVALUATED IN SUB-SCALE AND FULL SCALE PANEL CONFIGURATIONS USING BOOSTER PANEL DESIGNS AND SIMULATED BOOSTER ENVIRONMENTS. THE SUBSTRATE PANELS WILL BE OBTAINED FROM MARTIN-MARIETTA CORPORATION (MMC) IN THE SHUTTLE PHASE B BASELINE CONFIGURATION AND MATERIALS. THE RSI MATERIALS WILL BE OBTAINED FROM MSC AS A PORTION OF THE MATERIALS DELIVERABLE ON THEIR CONTRACTED DEVELOPMENT EFFORTS. AS IMPROVED RSI MATERIALS BECOME AVAILABLE FROM NASA IN-HOUSE OR SPONSORED CONTRACTUAL PROGRAM, ADDITIONAL MATERIALS WILL BE OBTAINED TO VERIFY IMPROVED MATERIAL RESPONSE TO BOOSTER ENVIRONMENTS. PARTICULAR EMPHASIS WILL BE PLACED ON THE EVALUATION OF REINFORCED RSI MATERIALS AS DEVELOPED UNDER EARLY WORK.

RTOP NO. 114-03-36 TITLE: HIGH TEMPERATURE ADHESIVES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: SPIKER, I. K. TEL. 713-483-5539
TECHNICAL SUMMARY

RESEARCH IS REQUIRED TO: PROVIDE AN ADHESIVE SYSTEM THAT WILL PERFORM IN THE 600 DEG TO 700 DEG F RANGE; IS STRAIN-COMPATIBLE WITH SURFACE INSULATION UNDER THERMAL AND MECHANICAL CYCLING; HAVE MINIMUM DENSITY; AND HAVE REUSE CAPABILITY FOR 100 SHUTTLE MISSIONS. THIS WORK SHOULD INCLUDE STRUCTURAL ADHESIVES AND COMPOSITE RESINS, AND FLEXIBLE ADHESIVES SUCH AS THE SILICONE RUBBER SEALANTS.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATION FOR SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS RESEARCH AND DEVELOPMENT EFFORT IS RELATED TO THE GENERAL CLASS OF MATERIALS THAT MIGHT BE USED IN THE REUSABLE SURFACE INSULATION (RSI) CONCEPT FOR THE SHUTTLE THERMAL PROTECTION SYSTEM. THE OBJECTIVES OF THIS WORK MAY BE BRIEFLY SUMMARIZED AS FOLLOWS: 1) TO FULLY CHARACTERIZE THE RSI MATERIALS; 2) TO IMPROVE THE MECHANICAL BEHAVIOR OF RSI BODIES; 3) TO IMPROVE THE SURFACE CHARACTER OF RSI BODIES; 4) TO OPTIMIZE CURRENTLY USED FIBERS AND TO SEEK NEW AND IMPROVED FIBER COMPOSITIONS. THE FIRST THREE OBJECTIVES WILL BE PURSUED BY OBTAINING CURRENTLY USED RSI MATERIALS FROM NASA CONTRACTORS FOR IN-HOUSE STUDIES. MATERIAL CHARACTERIZATION WILL BE MADE AT ALL STAGES OF PROCESSING. IMPROVEMENTS IN MECHANICAL PROPERTIES AND SURFACE CHARACTERISTICS WILL BE SOUGHT BY THE INTRODUCTION OF OTHER SELECTED MATERIALS INTENDED TO BRING ABOUT THE DESIRED IMPROVEMENTS. THESE MATERIALS WILL BE COMPATIBLE WITH, BUT COMPLETELY INDEPENDENT OF, THE FABRICATION PROCESSING STEPS. OPTIMIZED AND IMPROVED FIBERS WILL BE SOUGHT BY CONTRACTUAL EFFORTS.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATIONS FOR SHUTTLE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE PROPERTIES OF CERAMIC MATERIALS WILL BE EVALUATED TO ESTABLISH THEIR SUITABILITY FOR USE AS SURFACE INSULATION THERMAL PROTECTION SYSTEMS. METHODS FOR IMPROVING THE THERMAL AND MECHANICAL PROPERTIES OF CURRENT LOW-DENSITY MATERIALS WILL BE INVESTIGATED. LOW-DENSITY RIGIDIZED FIBROUS MATERIALS SUCH AS SILICA, MULLITE, ZIRCONIA, AND ALUMINA WILL BE SUBJECTED TO CYCLIC HEATING. THERMAL AND MECHANICAL STABILITY WILL BE DETERMINED THROUGH MECHANICAL TESTS AND MICROSCOPIC EXAMINATION. IMPROVEMENTS IN PROPERTIES WILL BE PURSUED BY VARYING PROCESSING METHODS AND MATERIALS. COATINGS REQUIRED TO SEAL FIBROUS MATERIALS AGAINST EXCESSIVE MOISTURE ABSORPTION AND TO PROVIDE SUITABLE SURFACE EMITTANCE PROPERTIES WILL BE EVALUATED IN COMBINATION WITH THE VARIOUS FIBER SYSTEMS. THE THERMO-CHEMICAL INTERACTION OF COATINGS WITH FIBERS WILL BE STUDIED. THE STRUCTURAL BEHAVIOR OF THE COATING, FIBER, SUBSTRATE SYSTEM WILL

BE STUDIED ANALYTICALLY AND THROUGH STRUCTURAL TESTS OF REPRESENTATIVE PANELS.

RTOP NO. 114-03-37 TITLE: ADVANCED INSPECTION AND REPAIR TECHNIQUES
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER
MONITOR: CATALDO, C. E. TEL. 205-453-1278
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ESTABLISH THE RE-USABILITY OF THERMAL PROTECTIONSYSTEM MATERIALS, INVESTIGATE METHODS OF INSPECTION OF SUCH SYSTEMS, AND STUDY METHODS OF REPAIR OF VARIOUS TYPES OF DEFECTS. A STUDY TO GAIN KNOWLEDGE OF MATERIALS DEGRADATION PHENOMENA UNDER LOW AND HIGH MASS FLOW CONDITIONS RELATIVE TO THE EFFECTS OF FLAWS WILL BE MADE. STUDIES WILL BE MADE OF THE EFFECTS OF SUCH DEGRADATION UPON THE STRUCTURAL OR FUNCTIONAL RELIABILITY OF THE COMPONENT OR SYSTEM. PERTINENT NDE EVALUATION WILL BE DEVELOPED FOR MONITORING AND EVALUATING THE INTEGRITY OF MATERIALS AND STRUCTURES, BOTH DURING GROUND TURN-AROUND AND WHERE FEASIBLE, ON-BOARD THE VEHICLE. MAJOR EMPHASIS WILL BE GIVEN TO THE TPS AND TO THE CRYOGENIC SYSTEM. IN THE PROPOSED STUDY TWO SEPARATE TASKS WILL BE INCLUDED.

RTOP NO. 114-03-37 TITLE: SPACE SHUTTLE: NONDESTRUCTIVE EVALUATION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, GLEN TEL. 415-961-2265
TECHNICAL SUMMARY

EXISTING MICROWAVE CRACK-DETECTION TECHNOLOGY WILL BE USED TO DEVELOP DESIGN CRITERIA FOR CRACK-DETECTION SYSTEMS APPROPRIATE TO HIGH-SPEED NONDESTRUCTIVE EVALUATION OF SHUTTLE VEHICLES. IN THIS TECHNOLOGY, METAL SURFACES ARE EXAMINED FOR FLAWS BY USING MICROWAVES AS THE SCANNING MEDIUM. THE METAL SURFACE BEING EXAMINED ACTS AS A PARTIALLY REFLECTING PLANE TO INCIDENT MICROWAVE ENERGY AND, THEREFORE, HAS A CHARACTERISTIC REFLECTING SIGNATURE. WHEN THE MICROWAVE SIGNAL ENCOUNTERS A FLAW OR CRACK ON THE METAL SURFACE, THE SIGNAL IS DISTORTED OR CHANGED AND THIS CHANGE CAN BE USED AS AN INDICATION OF THE EXISTENCE OF AND, WITH PROPER CALIBRATION, THE SIZE OF THE FLAW OR CRACK. MICROWAVE CRACK-DETECTORS ARE NON-CONTACTING AND CAN BE USED TO LOCATE FLAWS BENEATH OR HIDDEN BY NON-METALLIC PAINTS AND FILMS. TESTS WILL BE CONDUCTED TO ADAPT EXISTING TECHNOLOGY TO PROPOSED SPACE SHUTTLE SKIN AND STRUCTURE CONFIGURATIONS AND TO OBTAIN HIGH-SPEED NONDESTRUCTIVE EVALUATION CAPABILITY NECESSARY TO SPACE SHUTTLE MISSIONS.

RTOP NO. 114-03-45 TITLE: METEORS AND METEOROIDS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-8_7-2893
TECHNICAL SUMMARY

TO DETERMINE THE NATURE OF METEOROIDS IN SPACE FROM GROUND-BASED RADAR AND OPTICAL MEASUREMENTS. TO STUDY THE EFFECTS OF IONIZATION, DIFFUSION, RECOMBINATION, LUMINOSITY AND FRAGMENTATION (THE CRITICAL

PHYSICAL PROCESSES) ON THE MEASUREMENT BIAS OF METEORS. DEFINE THE METEORIC PROCESSES SUFFICIENTLY TO REDUCE BASIC UNCERTAINTIES IN THE FLUX, MASS, COMPOSITION, DENSITY AND ABLATION OF METEOROIDS THAT INTERCEPT THE EARTH'S ATMOSPHERE. INVESTIGATE THE ORBITAL DISTRIBUTION, ORIGIN, AND ECOLOGY OF METEOROIDS IN SPACE. THE VAST QUANTITIES OF UNREDUCED RADAR AND OPTICAL METEOR DATA WHICH HAVE BEEN GATHERED BY SAO OVER THE PAST DECADE WILL BE REDUCED AND STATISTICALLY ANALYZED. PARTICULAR ATTENTION WILL BE DIRECTED TO ANALYSIS OF METEORS WHICH HAVE BEEN OBSERVED SIMULTANEOUSLY BY RADAR AND OPTICAL TECHNIQUES. DATA REPORTS WILL BE PREPARED TO MAKE THE DATA AVAILABLE TO ANYONE INTERESTED IN METEOR ANALYSIS. THEORETICAL STUDIES OF METEOR PHENOMENA WILL BE PERFORMED TO AID ANALYSIS OF THE METEOR DATA.

RTOP NO. 114-03-45 TITLE: METEORS AND METEOROIDS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE UNDERSTANDING OF HYPERVELOCITY IMPACT REQUIRED TO DESIGN FUTURE SPACECRAFT HAVING ADEQUATE METEOROID PROTECTION. EFFECTS OF MATERIAL, PROJECTILE DENSITY, SIZE, AND SHAPE, AND PROJECTILE VELOCITY ON PENETRATION AND CRATERING PHENOMENA WILL BE STUDIED EXPERIMENTALLY AND ANALYTICALLY. IMPROVEMENTS IN LAUNCHER PERFORMANCE RESULTING FROM HIGH-EXPLOSIVE DRIVER DEVELOPMENT CARRIED OUT UNDER RTOP 114-03-46 WILL BE EXPLOITED TO THE MAXIMUM POSSIBLE EXTENT. RESULTS OF THIS WORK WILL BE NEEDED FOR THE DESIGN OF METEOROID BUMPERS FOR LONG-LIVED SPACECRAFT AND PARTICULARLY FOR SPACECRAFT TRAVERSING THE ASTROID BELT.

RTOP NO. 114-03-46 TITLE: METEOROIDS (SPACE STATION)
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

STUDIES AIMED AT MAXIMIZING THE EFFECTIVENESS OF MULTIPLE-WALL STRUCTURES IN PROVIDING METEOROID PROTECTION OF SPACE STATION/SPACE BASE ARE IN PROGRESS. STRESS CONCENTRATIONS IN PANELS, RESULTING FROM PARTIAL-PENETRATION IMPACTS, ARE BEING STUDIED TO DETERMINE THE DEGRADATION IN STRUCTURAL INTEGRITY AND EFFICIENCY, AND THE IMPLICATIONS WITH RESPECT TO DESIGN CRITERIA. HIGH-EXPLOSIVE DRIVER TECHNIQUES ARE _BEING DEVELOPED FOR ACCELERATING LABORATORY PROJECTILES TO METEORIC SPEEDS. THE OVERALL OBJECTIVE IS TO DEVELOP COMPREHENSIVE DESIGN CRITERIA WHICH CAN BE USED BOTH TO DESIGN IMPACT-RESISTANT STRUCTURES FOR PROTECTION OF THE SPACE STATION/BASE, AND TO ASSESS THE LONG-TERM _PERFORMANCE OF IMPACTED STRUCTURAL ELEMENTS.

RTOP NO. 114-03-46 TITLE: METEOROIDS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CLIFTON, K. S. TEL. 205-453-0943
TECHNICAL SUMMARY

(A) LOW LIGHT LEVEL TELEVISION SYSTEMS WILL BE USED IN GROUND-BASED OBSERVATIONS OF METEORS IN ORDER TO DEFINE THE MASS DISTRIBUTION OF THE NEAR-EARTH METEOROID ENVIRONMENT. SPECIFICALLY, DATA WILL BE RECORDED TO DETERMINE THE SLOPE OF THE MASS-FLUX CURVE IN THE MASS RANGE BETWEEN THAT DEFINED PHOTOGRAPHICALLY AND THAT MEASURED BY THE PEGASUS SATELLITES, A REGION OF CRITICAL IMPORTANCE TO LONG-TERM ORBITING SPACECRAFT. IN ADDITION, THE TEMPORAL AND OTHER VARIATIONS IN METEOR INFLUX RATES WILL ALSO BE INVESTIGATED. WITH THE USE OF VIDEO PROCESSORS, FILTERS, AND SPECTRAL GRATINGS METEOR PARAMETERS SUCH AS LUMINOSITY, COLOR, AND SPECTRA WILL ALSO BE EXAMINED. FURTHERMORE, TWO STATION OBSERVATIONS CAN ALLOW THE CALCULATION OF METEOR HEIGHTS, VELOCITIES, AND ORBITAL PARAMETERS. (B) THE METEOROID SIMULATION PROGRAM IS CONDUCTED USING LIGHT GAS AND PLASMA ACCELERATORS. AT THE PRESENT TIME THEY ARE UTILIZED IN SUPPORT OF FOUR OBJECTIVES: (1) TO VERIFY AND SUPPORT AN ACCURATE THEORETICAL MODEL OF THE HYPERVELOCITY IMPACT PHENOMENA. (2) TO DEFINE DAMAGE TO SUCH STRUCTURES AS SKYLAB BUMPER AND HULL, MDA INSTRUMENTATION CABLES, PROPOSED LUNAR TUG FUEL TANKS, SOLAR CELLS, IU PANELS, ETC., FROM HYPERVELOCITY IMPACT. (3) TO SIMULATE METEOR PHENOMENA IN SUPPORT OF THE GROUND-BASED WORK. (4) INCREASE THE ACCELERATION VELOCITY OF PROJECTILES.

RTOP NO. 114-03-47 TITLE: ASTEROID/METEOROID ENVIRONMENT MEASUREMENTS IN SPACE
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

EXPERIMENTS ARE BEING DEVELOPED FOR THE PIONEER F/G JUPITER MISSIONS TO DETERMINE THE METEOROID AND ASTEROID ENVIRONMENT IN THE REGION BETWEEN EARTH AND JUPITER AND TO PROVIDE REQUIRED DATA ON THE METEOROID AND ASTEROID HAZARD FOR THE PROPER ENGINEERING DESIGN OF SPACE VEHICLES ON LONG DURATION FLIGHTS TO THE OUTER PLANETS. ONE EXPERIMENT UTILIZES A REFLECTED LIGHT TECHNIQUE, AND HAS THE POTENTIAL OF YIELDING DATA ON SPEED, DIRECTION (HENCE, PARTICLE ORBITS), AND PARTICLE SIZE OVER THE RANGE OF PARTICLE MASSES FROM 10 TO THE MINUS 8TH POWER TO .001 GRAMS. A COMPLEMENTARY EXPERIMENT EMPLOYS THE PRESSURIZED CELL TECHNIQUE USED ON EXPLORERS 13, 16, AND 23 AND ON THE LUNAR ORBITERS, AND IS RESPONSIVE TO PARTICLE MASSES ON THE ORDER OF .0000001 GRAMS.

RTOP NO. 114-03-50 TITLE: SPACE THERMAL CONTROL DEVELOPMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: RICHARD, B. E. TEL. 205-453-3090
TECHNICAL SUMMARY

THE FIELD OF THERMAL CONTROL OF SPACECRAFT IS BROAD AND INCLUDES SUCH AREAS AS COATINGS, HEAT PIPES, FUSIBLE MATERIALS, FLUID LOOPS

AND RADIATING FINS. THIS RTOP IS DIRECTED PRIMARILY AT THERMAL CONTROL BY FUSIBLE MATERIALS. SPECTRAL REFLECTANCE AND INFRARED DETECTION _UNDER CRYOGENIC CONDITIONING IS ALSO INCLUDED. IDENTIFICATION OF NEW FUSIBLE MATERIALS AND THEIR PROPERTIES IS A CONTINUING EFFORT IN ORDER TO INCREASE THE RANGE OF TEMPERATURES OVER WHICH THIS TECHNIQUE CAN BE USED. THE EFFECT OF FILLERS (INTERNAL FINS, HONEYCOMB, ETC), ADDED TO INCREASE THE THERMAL CONDUCTIVITY AND DIFFUSIVITY OF PHASE CHANGE MATERIALS (PCM), UPON PCM SYSTEM OPERATION IS UNDER INVESTIGATION. RESEARCH IN THE AREA OF PCM SYSTEM PERFORMANCE IN THE SPACE ENVIRONMENT WILL BE CONTINUED. STUDIES OF CLOSE SPACING ON THE RADIATIVE _TRANSPORT OF ENERGY BETWEEN METAL OR DIELECTRIC PLATES AT TEMPERATURES APPROACHING THAT OF LIQUID HELIUM WILL ALSO BE CONTINUED.

RTOP NO. 114-03-50 TITLE: SPACECRAFT THERMAL CONTROL
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEVELOP A FUNDAMENTAL UNDERSTANDING OF HEAT PIPE PHENOMENA; TO DEVELOP INTO USEFUL COMPONENTS DIFFERENT TYPES OF HEAT PIPES, EACH CAPABLE OF PERFORMING A UNIQUE THERMAL CONTROL FUNCTION; AND TO PROVIDE BASIC HEAT PIPE DESIGN DATA AND COMPUTER ROUTINES, NOT AVAILABLE FROM OTHER SOURCES, AS DESIGN AIDS FOR THE THERMAL ENGINEER. TO ACCOMPLISH THESE OBJECTIVES FUNDAMENTAL STUDIES WILL BE _CONTINUED AND/OR INITIATED TO INVESTIGATE THE FOLLOWING BASIC HEAT PIPE PHENOMENA: THE INTERACTION BETWEEN NON-CONDENSING GAS AND THE WORKING FLUID IN GAS-LOADED PIPES; VAPOR MODULATION EFFECTS ON PIPE TEMPERATURE; MATERIALS COMPATIBILITY AND LIFE TESTING; ARTERIAL DYNAMICS; TRANSIENT PERFORMANCE; WICK HYDRODYNAMICS; AND ELECTROHYDRODYNAMIC _WICKING. DEVELOPMENT WILL CONTINUE ON THE FOLLOWING TYPES OF HEAT PIPES: VARIABLE CONDUCTANCE; FEEDBACK-CONTROLLED; ONE-WAY; THERMAL ACCUMULATOR; AND HIGH PERFORMANCE/FIXED CONDUCTANCE. THE AMES HEAT PIPE EXPERIMENT (AHPE) ON OAO-C AND THE ADVANCED THERMAL CONTROL FLIGHT _EXPERIMENT (ATFE) ON ATS-F WILL BE CONDUCTED. SUPPORT WILL BE GIVEN GSFC FOR THE DEVELOPMENT OF HIGH PERFORMANCE/FIXED CONDUCTANCE HEAT _PIPES; MSFC FOR THE DEVELOPMENT OF LARGE, LONG LIFE HEAT PIPES; JPL _AND MSFC FOR THE INTEGRATION OF HEAT PIPES WITH ELECTRONIC COMPONENTS; AND MSC IN THE DEVELOPMENT OF A HEAT PIPE DESIGN HANDBOOK.

RTOP NO. 114-03-50 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE TECHNOLOGY NECESSARY TO INSURE THAT ADEQUATE TEMPERATURE CONTROL OF THE SPACECRAFT PLANNED FOR THE NEW MISSIONS NOW BEING CONSIDERED CAN BE ACCOMPLISHED. THESE MISSIONS, _TRAVELING IN TOWARDS THE SUN, AND OUTWARD AWAY FROM THE SUN TO THE OUTER PLANETS, POSE SOME NEW AND SEVERE THERMAL PROBLEMS. MISSION LIFETIMES ARE BECOMING MUCH LONGER. THE SPACECRAFT ARE

EXPECTED TO BE OPERATIONALLY MORE FLEXIBLE AND TO PERFORM CLOSER TO DESIGN LIMITS. THIS IMPLIES THAT ALL SUBSYSTEMS OF THE SPACECRAFT MUST BE BETTER DEFINED, THE LIMITS OF OPERATION BETTER UNDERSTOOD, AND INTERACTIONS BETWEEN SUBSYSTEMS BETTER UNDERSTOOD. THESE INCREASING DEMANDS FOR UNDERSTANDING ARE ACCOMPANIED BY TIGHTER FINANCIAL RESTRICTIONS. THUS, THE THERMAL CONTROL ENGINEER IS FACED ON THE ONE HAND WITH GREATER DEMANDS FOR KNOWLEDGE AND ON THE OTHER HAND WITH LESS ABILITY TO OBTAIN THAT KNOWLEDGE. THIS TECHNOLOGY WILL BE PROVIDED BY A PROGRAM OF RESEARCH IN FOUR BROAD AREAS: (1) DEFINITION OF THERMAL CONTROL REQUIREMENTS AND IDENTIFICATION OF NECESSARY ADVANCES. (2) DEVELOPMENT OF _ADVANCED ANALYTICAL AND DESIGN TECHNIQUES WHICH WILL ALLOW BETTER PREDICTION OF SPACECRAFT HEAT TRANSFER. (3) DEVELOPMENT OF SELECTED TEMPERATURE CONTROL DEVICES WHICH CAN BE USED FOR MORE EFFECTIVE SPACECRAFT TEMPERATURE CONTROL DESIGN. THESE DEVICES WILL TYPICALLY BE AIMED AT CONTROLLING OR MODIFYING THE FLOW OF HEAT BETWEEN VARIOUS PARTS OF THE SPACECRAFT, BETWEEN THE SPACECRAFT AND SPACE, OR TO MEASURE SOME PARTICULAR HEAT TRANSFER PARAMETER. (4) IMPROVEMENTS IN THE TECHNOLOGY OF MATERIALS SELECTION, UTILIZATION AND PERFORMANCE OF TEMPERATURE CONTROL INSULATIONS, DEVICES, AND

RTOP NO. 114-03-50 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SCHACH, M. TEL. 301-982-5115
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROPOSAL IS TO IMPROVE THE ART OF SPACECRAFT TEMPERATURE CONTROL BY DEVELOPING HIGHER PERFORMANCE HEAT PIPES AND STABLE THERMAL CONTROL COATINGS. THE APPROACHES ARE: (1) TO DEVELOP IMPROVED WICK AND ARTERY DESIGNS, AND (2) TO DEVELOP STABLE THIN FILM VACUUM DEPOSITED COATINGS.

RTOP NO. 114-03-50 TITLE: SPACE VEHICLE THERMAL CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

A COMPREHENSIVE EXPERIMENTAL AND THEORETICAL PROGRAM IS IN PROGRESS TO DEFINE, STUDY, AND SOLVE ADVANCED TECHNOLOGY PROBLEMS ASSOCIATED WITH PASSIVE THERMAL CONTROL OF UNMANNED SPACECRAFT. THE DEVELOPMENT OF FLEXIBLE, SECOND-SURFACE MIRROR COATINGS WILL CONTINUE WITH EMPHASIS ON THE UTILIZATION OF NEW, EXPERIMENTAL POLYMERIC MATERIALS. RESEARCH IN ADVANCED THERMAL CONTROL TECHNIQUES (E.G., PASSIVE ENCLOSURES, VAPOR CHAMBERS) WILL CONTINUE WITH EMPHASIS ON APPLICATION OF THESE TECHNIQUES TO A LARGE ORBITING OBSERVATORY. THIS RESEARCH IS DIRECTED AT PROVIDING THE TECHNOLOGY FOR FUTURE LONG-LIFE EARTH ORBITAL _AND INTERPLANETARY MISSIONS. THE POLYMERIC COATING MATERIALS WILL BE EVALUATED TO DETERMINE THE EFFECTS OF VACUUM, TEMPERATURE, ULTRAVIOLET RADIATION, AND SOLAR WIND PLASMA RADIATION ON THEIR OPTICAL PROPERTIES. THESE DATA WILL BE UTILIZED TO PROVIDE SELECTION CRITERIA FOR DEVELOPMENT OF SPACE-STABLE, TRANSPARENT POLYMERIC FILMS FOR SECOND-SURFACE MIRROR COATINGS.

SEVERAL DIFFERENT PASSIVE ENCLOSURES FOR THE ORBITING TELESCOPE WILL BE DESIGNED AND EVALUATED IN A SIMULATED ORBITAL THERMAL ENVIRONMENT. THESE RESULTS WILL BE USED WITH ANALYTICAL STUDIES TO PROVIDE THE BASIC DESIGN FOR THERMAL CONTROL OF THE LARGE ORBITING TELESCOPE STRUCTURE AND PRIMARY MIRROR.

RTOP NO. 114-03-51 TITLE: SPACE STATION - VEHICLE THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GUY, W. W. TEL. 713-483-2351
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO DEVELOP GENERALIZED RADIATOR/FLUID SYSTEM THERMAL ANALYSIS TECHNIQUES FOR: (1) RADIATOR/FLUID SYSTEM THERMAL SCALE MODELING, (2) AUTOMATICALLY GENERATING AND CORRECTING LARGE THERMAL NETWORKS, AND (3) CHARACTERIZATION OF ADVANCED ACTIVE THERMAL CONTROL COMPONENTS (I.E., HEAT PIPE-RADIATORS, HEAT PIPE-THERMAL TRANSPORT SYSTEMS, ETC. IN ADDITION, THE FEASIBILITY OF USING HEAT PIPES FOR ADVANCED THERMAL CONTROL CONCEPTS WILL BE EXPERIMENTALLY DEMONSTRATED. THE APPROACH WILL EXTEND WORK INITIATED IN FY 1970-71. ANALYTICAL TECHNIQUES WILL BE FORMULATED INTO COMPUTER PROGRAMS FOR THERMAL SCALE MODELING, ERROR CORRECTION AND CHARACTERIZATION OF THERMAL CONTROL COMPONENTS. VALIDATION OF THESE ANALYTICAL TECHNIQUES WILL BE ACCOMPLISHED WITH THERMAL-VACUUM TESTING. THE SPACE STATION HEAT PIPE APPLICATIONS ACTIVITY WILL INVOLVE SOME INITIAL CONCEPTUAL DESIGN OF PROMISING SYSTEMS, COMPONENT TESTING, AND THERMAL VACUUM TESTING OF A COMPOSITE SYSTEM WITH MULTIPLE HEAT SOURCES. ANALYTICAL TRADE STUDIES WILL ALSO BE CONDUCTED TO EVALUATE RELATIVE DIFFERENCES BETWEEN A HEAT PIPE APPROACH AND MORE CONVENTIONAL SYSTEMS.

RTOP NO. 114-03-51 TITLE: SPACE STATION THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GATES, D. W. TEL. 205-453-3100
TECHNICAL SUMMARY

AS A CONTINUATION OF OUR WORK IN THE THERMAL CONTROL FIELD, OUR EFFORTS WILL BE DIRECTED TOWARD SEVERAL METHODS OF IMPROVING NASA'S CAPABILITIES OF CONTROLLING SPACECRAFT TEMPERATURES. ONE EFFORT WILL _BE DIRECTED TOWARD IMPROVEMENT OF THE WHITE PAINTS AND THEIR RELIABILITY FOR EXTENDED MISSION REQUIREMENTS. WHILE MAINTAINING THE 0.9 REQUIRED IN THE PRESENT THERMAL DESIGNS FOR SPACE STATION, THE DELTA A _SUB S MUST BE A MINIMUM TO OBTAIN THE REQUIRED TOTAL LIFE OR THE LEAST EVA REQUIRED TO RESTORE THE THERMAL-CONTROL SURFACES. THIS IS BEING DONE BY IMPROVING THE BINDERS AND PIGMENTS, AND PROTECTION OF THE _COATING AFTER APPLICATION, TO ITS EVENTUAL MISSION REQUIREMENT. INTEGRATION OF EFFICIENT HEAT PIPES INTO ELECTRONIC AND ELECTROMECHANICAL HARDWARE IS BEING DEVELOPED FOR THERMAL CONTROL NECESSARY FOR EXTENDED LIFE OF THESE COMPONENTS. THIS IS NOT BROAD COVERAGE OF HEAT PIPE APPLICATIONS, ONLY THE SPECIFIC USE. DEVELOPMENT OF LARGE SCALE THIN FILM SEMICONDUCTORS IS PROPOSED FOR THERMAL CONTROL DEVICES WITH LONG LIFE AND FLEXIBLE CONTROL OF SURFACE AND INTERIOR SURFACES. IN ORDER TO PROVIDE NECESSARY BACKUP

KNOWLEDGE FOR THESE DEVELOPMENT EFFORTS, LABORATORY STUDIES OF COATINGS, HEAT PIPES AND SEMICONDUCTORS WILL CONTINUE, AND SPECIAL EFFORT IS NOW DIRECTED TOWARD MEASUREMENT DESIGN PARAMETER DATA (THERMAL CONDUCTIVITY, RESISTIVITY AND RADIATION _FIELD VARIATION FOR THE SEMICONDUCTORS), MINIATURE HEAT PIPE ANALYSIS, AND PROPERTIES AND LONG LIFE TIMES OF COATINGS AND THEIR SUBSTRATES AT CRYOGENIC TEMPERATURES.

RTOP NO. 114-03-55 TITLE: ENVIRONMENTAL SPACE VEHICLE DESIGN CRITERIA
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PREPARE SPACE VEHICLE ENVIRONMENTAL DESIGN CRITERIA FOR INTERPLANETARY AND PLANETARY ENVIRONMENTS. THE EFFORT DURING FY-'72 IS DIRECTED TOWARD COMPLETING SPACE VEHICLE DESIGN CRITERIA DOCUMENTS FOR THE PLANETS JUPITER, SATURN, MERCURY, AND THE OUTER PLANETS URANUS, NEPTUNE, AND PLUTO. IN ADDITION, AN INTERPLANETARY NUCLEAR RADIATION ENVIRONMENTAL DESIGN CRITERIA DOCUMENT WILL BE INITIATED AT A VERY LOW LEVEL OF EFFORT. TOGETHER WITH KNOWLEDGEABLE SCIENTISTS, ENGINEERS, AND DESIGNERS IMPORTANT ENVIRONMENTAL PARAMETERS WILL BE IDENTIFIED. BASED ON THE CURRENT STATE-OF-THE-ART KNOWLEDGE OF THE SPECIFIED ENVIRONMENT, ENGINEERING DESCRIPTIONS, AND/OR MODELS WILL BE DEVELOPED AND SPACE VEHICLE DESIGN CRITERIA FOR THE IMPORTANT PARAMETERS ESTABLISHED. AN ENVIRONMENTAL DESIGN CRITERIA DOCUMENT WILL BE COMPOSED, EDITED, AND WRITTEN IN THE ESTABLISHED STYLE. THE DOCUMENTS PASS THROUGH THE REGULAR REVIEW CYCLE AND THEN THE FINAL DRAFT SENT TO GSFC FOR PUBLICATION. THE DESIGN CRITERIA _PROVIDED BY THE DOCUMENT ON URANUS, NEPTUNE, AND PLUTO ARE DIRECTLY APPLICABLE TO THE OUTER PLANETS PROGRAM WHILE THE JUPITER AND SATURN DOCUMENTS ARE APPLICABLE NOT ONLY TO THE OUTER PLANETS PROGRAM, BUT _ALSO TO POTENTIAL SATURN FLY-BY AND ORBITER MISSIONS TO THESE PLANETS. THE MERCURY DESIGN CRITERIA DOCUMENT SUPPORTS THE VENUS-MERCURY PROGRAM SCHEDULED FOR 1973 AS WELL AS ANY FLY-BY OR ORBITER MISSIONS TO MERCURY AND FINALLY, THE INTERPLANETARY NUCLEAR RADIATION CRITERIA _DOCUMENT PROVIDES CRITERIA FOR ALL THE FUTURE INTERPLANETARY AND PLANETARY SPACE PROGRAM FOR WHICH INTERPLANETARY RADIATION DAMAGE TO THE SPACECRAFT SYSTEMS IS AN IMPORTANT CONSIDERATION.

RTOP NO. 114-03-55 TITLE: ENVIRONMENTAL DESIGN CRITERIA
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: VAUGHAN, W. W. TEL. 205-453-3106
TECHNICAL SUMMARY

TO MEET THE SCIENTISTS', ENGINEERS', AND DESIGNERS' REQUIREMENT FOR DOCUMENTS, SUCH AS GUIDELINES AND MONOGRAMS OF ENVIRONMENT PARAMETERS, THE FOLLOWING WORK HAS BEEN UNDERTAKEN TO DEVELOP SPACE AND TERRESTRIAL ENVIRONMENT CRITERIA, GROUND WIND, INFLIGHT, LUNAR SURFACE, SURFACE EXTREMES, EARTH ORBITAL, PLANETARY, AND OTHERS WHICH ARE REQUIRED. THESE MODELS OR MONOGRAMS ARE BEING PUT TOGETHER BY

KNOWLEDGEABLE SCIENTISTS BASED ON DATA OBTAINED IN THE PAST, AS WELL AS DATA PRESENTLY BEING RECORDED. THESE DOCUMENTS ARE NECESSARY IN THE OVERALL _DESIGN, DEVELOPMENT, AND OPERATIONAL REQUIREMENTS OF PRESENT AND FUTURE SPACE VEHICLE AND SYSTEMS. DUE TO THE CHANGING REQUIREMENTS OF NASA PROJECTS AND INCREASE IN DATA RECORDS, IT IS NECESSARY TO MAINTAIN A CONTINUOUS EFFORT TO ANALYZE THESE DATA AND POTENTIAL ENGINEERING APPLICATIONS. THIS PERMITS THE DEVELOPMENT OF TIMELY GUIDELINE AND _MONOGRAPHS FOR ENVIRONMENTAL CRITERIA. THIS WORK WAS COVERED UNDER CODE 124-12-11 WITH THE SAME TITLE OF THIS RTOP. IN FY71 AND PRIOR YEARS.

RTOP NO. 114-03-55 TITLE: ENVIRONMENTAL DESIGN CRITERIA
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MILLS, S. A. TEL. 301-982-4246
TECHNICAL SUMMARY

TO DEVELOP AND PUBLISH (1) NASA DESIGN CRITERIA FOR TERRESTRIAL, EXTRATERRESTRIAL, AND SPACE SYSTEM ENVIRONMENTS AND (2) GSFC ENVIRONMENTAL TEST SPECIFICATIONS. FOR THIS TASK, WE ASSESS DATA FROM THREE SOURCES: SPACE AND TERRESTRIAL RESEARCH, SPACE SYSTEM OPERATIONAL _PERFORMANCE, AND ENVIRONMENTAL TEST EXPERIENCE. THE OBJECTIVE, WHICH IS TO IMPROVE DESIGN AND PERFORMANCE OF SPACE SYSTEMS, IS CARRIED OUT IN THREE COMPLEMENTARY WAYS: (1) DEVELOPMENT OF SOME 30 NASA DESIGN CRITERIA MONOGRAPHS, EACH OF WHICH PRESENTS AN ENGINEERING DESCRIPTION OR MODEL OF AN ENVIRONMENT WHICH CAN AFFECT THE DESIGN OF SPACE SYSTEMS AND THE PLANNING OF SPACE MISSIONS. AS LEAD CENTER, GSFC INITIATES, COORDINATES, AND REVIEWS EFFORTS OF PARTICIPATING NASA CENTERS, CONTRIBUTING SCIENTISTS, ENGINEERS AND CONTRACTORS; (2) FORMULATION OF GSFC GENERAL SPECIFICATIONS FOR TESTING SPACECRAFT AND SOUNDING ROCKET PAYLOADS. REVISIONS ARE MADE IN RESPONSE TO NEW ENVIRONMENTAL KNOWLEDGE OR WHEN NASA ADOPTS NEW LAUNCH VEHICLES; (3) THE PAST _EXPERIENCE AND PERFORMANCE (PEP) EFFORT COMPARES ACTUAL SPACECRAFT OPERATIONAL RESULTS WITH PRIOR RESULTS.

RTOP NO. 114-03-58 TITLE: THERMAL-VACUUM TESTING TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ADVANCE THE STATE OF THE ART IN SPACE ENVIRONMENT SIMULATION TECHNOLOGY. PRINCIPAL EMPHASIS WILL BE PLACED ON MOLSINK TECHNOLOGY AND WILL CONSIST OF THREE CLOSELY RELATED TASKS: 1) _CONTINUED STUDY AND CHARACTERIZATION OF THE MOLSINK ENVIRONMENT; 2) FURTHER DEVELOPMENT OF SPECIALIZED INSTRUMENTATION SUCH AS THE QUARTZ CRYSTAL MICROBALANCE SYSTEM TO ASSIST IN EVALUATION OF TEST DATA AND OF ANCILLARY SYSTEMS SUCH AS RADIATION PRODUCING SYSTEMS TO ENABLE ANALYSIS OF NON-LINEAR, COMBINED SPACE ENVIRONMENT EFFECTS; AND 3) DEVELOPMENT OF SPECIAL TEST TECHNIQUES TO ASSIST IN THE EVALUATION OF SPACECRAFT MATERIALS AND INSTRUMENT CONTAMINATION.

RTOP NO. 114-03-58 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: KRUGER, R. TEL. 301-982-5034
TECHNICAL SUMMARY

THE PURPOSE OF THIS RTOP IS TO IMPROVE OUR KNOWLEDGE OF THE SPACE VACUUM AND THERMAL RADIATION ENVIRONMENT AND ITS EFFECTS TO PERFORM _MORE MEANINGFUL TESTS AND ANALYSES TO INCREASE SPACECRAFT RELIABILITY. MAJOR AREAS OF INVESTIGATION INCLUDE ANALYSES AND TESTS TO DEFINE THE MOLECULAR FLUX IN THE VICINITY OF SPACECRAFT, IN-TEST MONITORING IMPROVEMENTS, AND CONTAMINATION STUDIES. EFFORTS ARE ALSO DIRECTED _TOWARD THE CREATION OF ULTRA-HIGH, CLEAN VACUUM SYSTEMS INCLUDING THE CAPABILITY FOR UNINTERRUPTED OPERATION OVER A PERIOD IN EXCESS OF ONE YEAR. WORK ON THE ESTABLISHMENT OF AN ENGINEERING STANDARD VALUE OF THE SOLAR TOTAL AND SPECTRAL IRRADIANCE WILL BE COMPLETED. THE DEVELOPMENT OF RADIOMETER AND OTHER DETECTOR SYSTEMS WHICH ARE COMPATIBLE WITH SPACE SIMULATOR OPERATION AND THEIR CALIBRATION WILL BE CONTINUED.

RTOP NO. 114-03-58 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP ACCELERATED TESTING _TECHNIQUES FOR PREDICTING LONG-TERM THERMAL/VACUUM EFFECTS ON MATERIALS FROM SHORT-TERM MEASUREMENTS. TECHNIQUES FOR MAKING IN SITU MEASUREMENTS OF THE MECHANICAL AND THERMAL PROPERTIES OF SPACECRAFT MATERIALS WILL BE DEVELOPED. VACUUM DEGRADATION PHENOMENA IN GENERAL CLASSES OF MATERIALS WILL BE STUDIED TO IDENTIFY PARAMETERS FOR ACCELERATING THE TESTS. ACCELERATED TESTING TECHNIQUES WILL BE DEVELOPED AND _VALIDATED.

RTOP NO. 114-08-01 TITLE: SPACE SHUTTLE STRUCTURAL DESIGN TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE GOAL IS IDENTIFICATION OF CRITICAL STRUCTURAL PROBLEMS OF THE SPACE SHUTTLE, AND EXPERIMENTAL AND ANALYTICAL RESEARCH THAT WILL PROVIDE EFFICIENT SOLUTIONS TO THESE PROBLEMS AND AN ADEQUATE TECHNOLOGICAL BASE FOR STRUCTURAL DESIGN OF THE LEAST WEIGHT OR COST SHUTTLE VEHICLE. THE WORK WILL BE ACCOMPLISHED INHOUSE AND THROUGH NUMEROUS CONTRACTS PRIMARILY WITH THE AEROSPACE COMPANIES ACTIVELY ENGAGED IN DEVELOPMENT OF THE SHUTTLE. A MAJOR EFFORT IS THE PURCHASE OF SURFACE STRUCTURE PANELS FOR TESTING UNDER AERODYNAMIC, ACOUSTIC, AND VIBRATORY ENVIRONMENTS. DEVELOPMENT OF MORE EFFICIENT STRUCTURAL PANELS THAT SHOW PROMISE OF REDUCING PRIMARY STRUCTURE WEIGHT WILL BE CONTINUED. STUDIES OF THE MOST EFFICIENT STRUCTURAL ARRANGEMENTS WILL BE MADE. TESTING OF LIGHT WEIGHT COMPOSITE REINFORCED METAL STRUCTURES WILL BEGIN. EFFORTS IN IDENTIFYING MAJOR PROBLEM AREAS WITH SUCH SECONDARY STRUCTURES AS DOORS AND WINDOWS WILL CONTINUE AND WORKABLE DESIGN SOLUTIONS WILL BE DEVELOPED.

STUDIES WILL CONTINUE ON DESIGN CRITERIA AREAS THAT PRESENT SPECIAL PROBLEMS TO THE SHUTTLE SUCH AS STRUCTURAL TEST REQUIREMENTS, ON BOARD PURGE SYSTEM REQUIREMENTS, AND STRUCTURAL INTERFACE COMPATIBILITY.

RTOP NO. 114-08-02 TITLE: SPACE SHUTTLE COMPOSITE TANK TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE THE TECHNOLOGY FOR APPLICATION OF FILAMENT WOUND COMPOSITES TO SPACE SHUTTLE VEHICLE TANKAGE. APPLICATIONS FOR THIS TECHNOLOGY WILL INCLUDE LARGE, LOW-PRESSURE, LOAD-CARRYING LIQUID PROPELLANT TANKS; NON-INTEGRAL (NON-LOAD CARRYING) LIQUID TANKS; AND SMALL, HIGH-PRESSURE GAS STORAGE VESSELS. FILAMENTS OF GLASS, BORON, GRAPHITE, AND HIGH MODULUS POLYMER WHICH OFFER SIGNIFICANT WEIGHT OR COST SAVINGS, WHILE MAINTAINING OR IMPROVING THE RELIABILITY ATTAINABLE WITH CONVENTIONAL METAL VESSELS, WILL BE EVALUATED. THE DEVELOPMENT OF THE ADVANCED CONCEPTS FOR FILAMENT-WOUND PRESSURE VESSELS ALREADY IN PROGRESS WILL BE CONTINUED. IN FY '72, ADDITIONAL ACTIVITIES WILL BE SPECIFICALLY DIRECTED TOWARD SPACE SHUTTLE SYSTEM COMPONENT DESIGN AND DEVELOPMENT.

RTOP NO. 114-08-03 TITLE: SPACE SHUTTLE FRACTURE CONTROL METHODS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE TECHNOLOGY REQUIRED FOR ESTABLISHING EFFECTIVE FRACTURE CONTROL DESIGN AND OPERATIONAL METHODS FOR THE SPACE SHUTTLE VEHICLE STRUCTURES. TECHNOLOGY BENEFITS FOR OTHER SPACE VEHICLE AND SPACE STATION APPLICATIONS WILL ALSO RESULT. SPECIFIC AREAS OF CURRENT WORK INCLUDE: (1) DEVELOPMENT OF FRACTURE DATA ON MATERIALS USING FLAW GEOMETRIES AND LOADING CONDITIONS OF SPECIFIC INTEREST TO THE SPACE SHUTTLE VEHICLE INTEGRAL PROPELLANT TANKS; (2) DEVELOPMENT OF ANALYTICAL EVALUATIONS OF CRACK TIP STRESS INTENSITY FOR SPECIFIC SPACE SHUTTLE VEHICLE FLAW GEOMETRIES AND LOADING CONDITIONS; AND (3) DEFINITION OF FRACTURE CONTROL DESIGN APPROACHES SPECIFICALLY SUITED TO THE SPACE SHUTTLE VEHICLE STRUCTURES.FY '72 EFFORTS WILL CONTINUE IN THESE AREAS, WITH INCREASED EMPHASIS ON THE EFFECTS OF ENVIRONMENT ON FLAW PROPAGATION.

RTOP NO. 114-08-04 TITLE: SPACE SHUTTLE COMPOSITES FOR PRIMARY STRUCTURE
ORGANIZATION: GEORGE C. MARSHALL SPACE
MONITOR: ENGLER, E. E. TEL. 205-453-3958
TECHNICAL SUMMARY

THE OBJECTIVES OF THE STUDY ARE: TO INDICATE AREAS OF GROWTH POTENTIAL FOR THE SPACE SHUTTLE VEHICLE THROUGH THE USE OF ADVANCED

FILAMENTARY COMPOSITE MATERIALS WHICH WOULD PROVIDE MAXIMUM STRENGTH TO WEIGHT CAPABILITIES AND RESULT IN INCREASED PAYLOAD; AND TO DEVELOP THRUST STRUCTURE CONCEPTS, INCLUDING MAJOR STRUCTURAL COMPONENTS, APPLICABLE FOR VARIOUS ENGINE ARRANGEMENTS BY NUMBER AND SIZE. EXISTING TECHNOLOGY COMPOSITE SYSTEMS WILL BE UTILIZED TO OBTAIN MINIMUM WEIGHT STRUCTURE. THE APPROACH UTILIZED IS TO PERFORM TECHNOLOGY INVESTIGATIONS IN THE AREAS OF STRUCTURAL DESIGN, STRUCTURAL ANALYSIS, MATERIALS EVALUATION, FABRICATION, QUALITY ASSURANCE, AND TESTING. THESE INVESTIGATIONS WILL INCLUDE BOTH IN-HOUSE AND CONTRACTED EFFORT. MAJOR STRUCTURAL COMPONENTS WILL BE DESIGNED, FABRICATED, AND TESTED. THESE MAJOR STRUCTURAL TEST COMPONENTS, APPLICABLE TO A SPACE SHUTTLE VEHICLE, WILL INCLUDE A SCALED THRUST STRUCTURE, SKIN PANELS, ENGINE SUPPORT BEAMS AND MINOR COMPONENTS SUCH AS BEAM CAPS, STRINGERS, JOINTS, AND SHEAR WEBS. DESIGN CRITERIA STUDIES WILL ALSO BE CONDUCTED. THE MATERIALS TO BE EVALUATED WILL INCLUDE BORON/EPOXY, GRAPHITE/EPOXY, BORON/ALUMINUM, AND POLYIMIDE COMPOSITES. THE STUDY WAS INITIATED IN FY 1970 AND WILL EXTEND THROUGH FY 1975. THE MANPOWER REQUIREMENTS AVERAGE ABOUT 19 MAN-YEARS PER YEAR.

RTOP NO. 114-08-05 TITLE: SPACE SHUTTLE DYNAMICS AND AEROELASTICITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP THE LOADS, STRUCTURAL DYNAMICS, LIQUID DYNAMICS, AND AEROELASTICITY TECHNOLOGY OF SPACE SHUTTLE VEHICLES. SPECIFICALLY TECHNOLOGY TO SOLVE PROBLEMS SUCH AS BUFFET; FLUTTER; PANEL FLUTTER, GROUND WIND LOADS; PROPELLANT SLOSH; WIND, GUST, AND CONTROL LOADS; POGO; BOUNDARY LAYER NOISE; AND SHOCK LOADS WILL BE DEVELOPED. PROPOSED SPACE SHUTTLE CONFIGURATIONS AND OPERATING REQUIREMENTS INTRODUCE THE NEW FACTORS OF ASYMMETRY, PARALLEL-STAGED MULTIBODIES, AND HIGH TEMPERATURE INTO THESE DYNAMICS PROBLEMS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES ARE REQUIRED TO DETERMINE CRITICAL LOADING CONDITIONS, VEHICLE CHARACTERISTICS, VEHICLE RESPONSES, AND STABILITY BOUNDARIES. DYNAMIC MODELS AND WIND TUNNELS WILL BE USED EXTENSIVELY FOR THIS IN-HOUSE AND CONTRACT EFFORT. THE RESULTS WILL INFLUENCE CONFIGURATION SELECTION AND LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN THE FINAL CONFIGURATION.

RTOP NO. 114-08-06 TITLE: SPACE SHUTTLE: DYNAMICS AND AEROELASTICITY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

WIND TUNNEL TESTS AND ANALYSIS WILL BE CONDUCTED TO INVESTIGATE SEVERAL DYNAMIC AND AEROELASTIC PROBLEMS THAT MUST BE CONFRONTED IN THE EVALUATION OF CONFIGURATIONS AND THE DEVELOPMENT OF A SPACE SHUTTLE VEHICLE. THE PRIMARY EMPHASIS WILL BE ON TRANSONIC BUFFET (INCLUDING AEROELASTIC EFFECTS), AERODYNAMIC NOISE INPUTS AND RESPONSE, FLUTTER, MODE ALLEVIATION, AND FAILURE DETECTION. MOST OF

THE WORK WILL BE EXPERIMENTAL. BOTH LIGHT-WEIGHT RIGID AND ELASTICALLY SCALED MODELS WILL BE TESTED IN WIND TUNNELS TO INVESTIGATE BUFFETING AND FLUTTER. FLOW VISUALIZATION TESTS OF CANDIDATE CONFIGURATIONS WILL BE CONDUCTED TO IDENTIFY AND LOCATE REGIONS OF HIGH INTENSITY TURBULENCE, AND THEN PRESSURE FLUCTUATIONS WILL BE MEASURED IN THESE REGIONS TO EVALUATE AERODYNAMIC NOISE INPUTS. IT IS INTENDED THAT FULL-SCALE PANELS WILL EVENTUALLY BE TESTED TO STUDY RESPONSE AND FATIGUE CHARACTERISTICS. A TECHNIQUE BEING DEVELOPED FOR SIMULATING, ON LARGE-SCALE MODELS, THE LATERAL FORCES PRODUCED BY THRUST VECTOR CONTROL OF LAUNCH VEHICLES WILL BE USED TO STUDY CRITICAL VIBRATION MODES OF SPACE SHUTTLE STRUCTURES AND ACTIVE AND PASSIVE SYSTEMS FOR MODE ALLEVIATION. AN INSTRUMENT DEVELOPED AT AMES FOR ON-LINE ANALYSIS OF DAMPING WILL BE FURTHER DEVELOPED AND EVALUATED AS A STRUCTURAL FAILURE-DETECTION DEVICE.

RTOP NO. 114-08-07 TITLE: SPACE STATION DAMAGE CONTROL AND DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE RESEARCH CONDUCTED UNDER THIS RTOP WILL BE DIRECTED INTO 2 AREAS. FIRST AREA DEALS WITH METHODS TO PROVIDE AND MAINTAIN LARGE ENCLOSED VOLUMES FOR MANNED SPACE STATIONS. RESEARCH WILL BE DIRECTED TOWARD THE DEVELOPMENT OF A DAMAGE CONTROL SYSTEM THAT WILL DETECT, LOCATE, AND REPAIR HOLES OR LEAKS IN THE PRESSURIZED CABINS OF SPACE STATIONS. THE SECOND AREA DEALS WITH THE DEVELOPMENT OF ANALYTICAL AND EXPERIMENTAL TECHNIQUES FOR PREDICTING THE DYNAMIC RESPONSE AND RESULTING STRESSES OF FLEXIBLE MODULAR AND ROTATING SPACE STATIONS. COMPUTER SIMULATIONS OF A STATION CONSISTING OF SEVERAL MODULES AND A STATION WITH A COUNTERWEIGHT CONNECTED BY CABLES OR OTHER EXTENDIBLE MEMBERS WILL BE DEVELOPED. THE ANALYSIS WILL BE USED TO DETERMINE THE THREE-DIMENSIONAL STATION DYNAMICS AND ELASTIC RESPONSE DURING NORMAL OPERATION, EXTENSION, STEADY SPIN, AND RETRACTION.

RTOP NO. 114-08-08 TITLE: ADVANCED CONCEPTS FOR SPACECRAFT ANTENNA STRUCTURES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

OUTER PLANET AND PLANETARY ORBIT MISSIONS IN THE 1975-1985 PERIOD WILL REQUIRE SUBSTANTIALLY INCREASED COMMUNICATION CAPABILITIES. JPL STUDIES INDICATE THAT OPTIMUM TELECOMMUNICATION DESIGN FOR THESE MISSIONS IS REALIZED WITH ANTENNAS HAVING MUCH HIGHER GAIN THAN THOSE NOW USED ON MARINER SPACECRAFT; HOWEVER, THE ASSUMED GAIN VS. WEIGHT USED IN THESE STUDIES HAS NOT BEEN VERIFIED, NOR IS THE TECHNOLOGY SUFFICIENTLY WELL DEVELOPED. THE PRINCIPAL OBJECTIVE OF THIS FIVE-YEAR EFFORT IS TO FULFILL THE NEED TO DEVELOP AND MAKE AVAILABLE THE KNOWLEDGE REQUIRED BY FLIGHT PROJECT TO BE ABLE TO UTILIZE NEW LARGE ANTENNAS. A NUMBER OF FURLABLE ANTENNA CONFIGURATIONS HAVE BEEN CONSIDERED FROM 15 TO 100 FEET IN DIAMETER

FOR OPERATING RADIO FREQUENCIES UP TO X-BAND. FEASIBILITY IS BEING DEMONSTRATED BY DESIGN AND FABRICATION OF A 15-FOOT DIAMETER FURLABLE CONICAL ANTENNA MODEL. THE TECHNOLOGY WILL THEN BE INVESTIGATED FOR EXTRAPOLATION TO LARGER SIZES. CRITERIA WHICH WILL CONTINUE TO BE CONSIDERED INCLUDE: WEIGHT (GOAL IS 0.25 LB/FT SQUARED OR BETTER), SURFACE ACCURACY IN THE OPERATING ENVIRONMENT, RELIABILITY OF DEPLOYMENT, LONG LIFE, AVOIDANCE OF ADVERSE INTERACTION BETWEEN STRUCTURE AND THE ATTITUDE CONTROL SUBSYSTEM, AND AMENABILITY TO PREFLIGHT VERIFICATION BY ANALYSIS AND TESTS. THIS _EFFORT WILL BE COORDINATED WITH "MICROWAVE DEEP SPACE COMMUNICATION S & TRACKING," RTOP CODE 115-21-20. THIS TASK DOES NOT DUPLICATE BUT RATHER COMPLEMENTS WORK BEING DONE FOR TOPS. ANOTHER OBJECTIVE OF _THIS TASK IS TO PERFORM INVESTIGATIONS IN SELECTED AREAS OF STRUCTURES, DYNAMICS, AND MATERIALS RELEVANT TO FUTURE FLIGHT PROJECTS. THE _RESULTS OF THESE INVESTIGATIONS----

RTOP NO. 114-08-09 TITLE: STRUCTURES FOR ORBITING RADIO TELESCOPES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HIBBARD, W. D. TEL. 301-982-4278
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP STRUCTURE TECHNOLOGY NEEDED FOR AN ORBITING RADIO TELESCOPE THAT OPERATES IN THE FREQUENCY RANGE OF 1-10 MHZ; AN ACCURATE PARABOLOIDAL REFLECTOR APPROXIMATELY ONEKILOMETER IN DIAMETER IS REQUIRED; PLUS SUPPORTING STRUCTURE FOR THE RF FEED AND ELECTRONICS. A CENTRIFUGUALLY DEPLOYED FILAMENTARY NET WITH FORE AND AFT STAYS IS THE MOST PROMISING APPROACH. A FIVE METER DIAMETER MODEL HAS BEEN DEVELOPED AND SUCCESSFULLY TESTED IN VACUUM ENVIRONMENT. ADDITIONAL TESTING, INCLUDING AN AEROBEE FLIGHT, IS PLANNED. PRELIMINARY STUDIES OF A 50 METER MODEL ARE UNDER WAY, AND A CONTINUING EFFORT IS DEVOTED TO DEFINING AND ANALYZING THE ULTIMATE TELESCOPE REQUIREMENTS.

RTOP NO. 114-08-10 TITLE: ADVANCED CONCEPTS FOR FUTURE SPACECRAFT STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP NEW STRUCTURAL CONCEPTS AND ADVANCED _MATERIAL INCLUDING COMPOSITES, FABRICS, AND MEMBRANE MATERIALS FOR FLEXIBLE OR RIGID SPACE STRUCTURAL APPLICATION. THE WORK CONSISTS OF _ANALYTICAL AND EXPERIMENTAL STUDIES OF NEW AND ADVANCED CONCEPTS FOR STRUCTURES WHICH EMPLOY NOVEL IDEAS, UNIQUE GEOMETRIES AND APPLICATION OF NEW MATERIALS.

RTOP NO. 114-08-13 TITLE: SPACE VEHICLE LOADS AND DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO PROVIDE FOR MORE EFFICIENT, YET SAFE, SPACE VEHICLE STRUCTURES THROUGH BETTER UNDERSTANDING OF THE LOADS IMPOSED ON THE STRUCTURE AND THE DYNAMIC RESPONSE OF THE STRUCTURE TO APPLIED LOADS. THE PRIME OBJECTIVES INVOLVE IMPROVEMENTS IN THE METHODS OF VIBRATION ANALYSIS OF COMPLEX SPACE VEHICLE STRUCTURES. TYPICAL OF THE IMPOSED LOADS THAT ARE CONSIDERED ARE THOSE DUE TO FLUID MOTIONS; GROUND WINDS AND WINDS ALOFT; IMPULSIVE LOADINGS DUE TO PYROTECHNIC SHOCK, BLAST TYPE LOADS AND PLANETARY LANDING IMPACT; NOISE, BUFFETING AND ENGINE INDUCED VIBRATIONS; AND RELATED DYNAMIC ENVIRONMENTS.

RTOP NO. 114-08-14 TITLE: SPACE VEHICLE LOADS AND DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP METHODS OF PREDICTING STRUCTURAL LOADS ON SPACECRAFT AND THE DYNAMIC RESPONSE OF THE STRUCTURE TO THE IMPOSED LOADS. THE SPECIFIC PROBLEM TO BE INVESTIGATED IS THERMAL LOADING AND THE RESULTANT BUCKLING OR THERMAL FLUTTER. THE CONVERSION OF THERMAL RADIATION TO USEFUL WORK UTILIZING THE THERMAL FLUTTER PHENOMENA WILL ALSO BE STUDIED.

RTOP NO. 114-08-15 TITLE: SPACE VEHICLE DESIGN CRITERIA (STRUCTURES AND STRUCTURAL DYNAMICS)
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

TO DEVELOP, DOCUMENT, AND PROMOTE THE GENERAL ACCEPTANCE OF SOUNDLY CONCEIVED AND AUTHORITATIVE GUIDELINES TO BE USED BY NASA FLIGHT PROGRAMS AND CONTRACTORS IN FORMULATING DESIGN REQUIREMENTS FOR FLIGHTWORTHY SPACE VEHICLE STRUCTURE (NASA POLICY DIRECTIVE 8070.1). TO PROMOTE THE APPLICATION OF THESE RESULTS TO FUTURE NASA MISSIONS, UPDATE THIS INFORMATION WHEN NECESSARY, AND IDENTIFY TECHNOLOGY DEFICIENCIES THAT REQUIRE FURTHER RESEARCH STUDY. THE PROGRAM IS MANAGED BY THE DESIGN CRITERIA OFFICE (DCO), STRUCTURES DIVISION, AND DRAWS ITS INFORMATION FROM SHORT TERM, BROAD DISCIPLINARY SUPPORT PROVIDED BY NATIONALLY RECOGNIZED AUTHORITIES IN THE GOVERNMENT, INDUSTRY, AND ACADEMIC COMMUNITIES. A PRIME CONTRACTOR (MCDONNELL DOUGLAS CORPORATION) ENGAGES ALL NONGOVERNMENT SUPPORT WHO, IN CONJUNCTION WITH GOVERNMENT EXPERTS, EXAMINE AND EVALUATE THE RESEARCH, DEVELOPMENT, AND FLIGHT EXPERIENCE IN MANY PROGRAM AREAS AND TRANSLATE THEIR RESULTS INTO AUTHORITATIVE DESIGN GUIDES. THE INFORMATION IS RELEASED AS NASA SPECIAL PUBLICATIONS (SP-8000 SERIES) IN THE FORM OF DESIGN CRITERIA MONOGRAPHS, DESIGN METHOD DOCUMENTS, OR HANDBOOKS AS APPROPRIATE. MAJOR ATTENTION IS GIVEN TO THE DEVELOPMENT OF DESIGN CRITERIA MONOGRAPHS HAVING DIRECT

APPLICATION TO FUTURE NASA MISSIONS. APPROXIMATELY 38 CRITERIA MONOGRAPHS WILL BE COMPLETED THROUGH FY 1971; 19 OTHERS ARE IN VARIOUS STAGES OF DEVELOPMENT; 19 OTHERS ARE PLANNED.

RTOP NO. 114-08-17 TITLE: IMPULSE TESTING TECHNIQUES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MODLIN, C. T., JR. TEL. 713-483-2076
TECHNICAL SUMMARY

INVESTIGATE AND DEVELOP IMPULSE TRANSFER FUNCTION TESTING TECHNIQUES FOR APPLICATION IN DETERMINING THE STRUCTURAL DYNAMIC CHARACTERISTICS OF THE SPACE SHUTTLE VEHICLE AND SPACE SHUTTLE STRUCTURAL COMPONENTS. AN ANALYTICAL METHOD FOR PREDICTING THE DYNAMIC CHARACTERISTICS AND DYNAMIC RESPONSE OF A STRUCTURE FROM EXPERIMENTALLY DETERMINED IMPULSE TRANSFER FUNCTIONS. THE METHOD WILL BE VERIFIED BY COMPARING RESPONSES DETERMINED BY THE IMPULSE METHOD TO THOSE MEASURED ON A TYPICAL SPACECRAFT STRUCTURE DURING APPLICATION OF IMPACT AND SUSTAINED VIBRATION TYPE LOADINGS.

RTOP NO. 114-08-21 TITLE: SPACECRAFT LAUNCH DYNAMICS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: YOUNG, J. P. TEL. 301-982-4964
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS TO IMPROVE SPACECRAFT AND SUBSYSTEM DYNAMIC TEST SPECIFICATIONS (ACCELERATION, VIBRATION, SHOCK, AND ACOUSTIC NOISE) AND TEST TECHNIQUES SO AS TO PROVIDE A BETTER BALANCE BETWEEN CONSERVATISM IN SEVERITY, RISKS ASSOCIATED WITH INSUFFICIENT TESTING, AND ECONOMY. IN ADDITION, IMPROVEMENT WILL BE SOUGHT IN THE ABILITY TO PREDICT THE ENERGY DISSIPATION OF SPINNING SPACECRAFT UNDERGOING FREE BODY MOTION IN SPACE AND THE RESULTANT EFFECT ON SPACECRAFT STABILITY. A RELATIVELY SMALL EFFORT WILL BE DEVOTED TO THE COORDINATION OF GODDARD NASTRAN USERS WITH HEADQUARTERS AND THE NASTRAN SYSTEMS MANAGEMENT OFFICE AT LANGLEY AND UPDATING THE NASTRAN PROGRAM AT GODDARD. PROGRAM OBJECTIVES WILL BE MET BY PERFORMING A SERIES OF RESEARCH TASKS IN THE AREAS OF DEVELOPMENT OF AN IMPROVED SUBASSEMBLY TEST SPECIFICATION; INVESTIGATION OF ALTERNATIVES TO THE USE OF A UNIFORM TEST FACTOR; GENERATION OF GENERAL GUIDELINES FOR COMBINED ENVIRONMENT TESTING; DEVELOPMENT OF MORE ECONOMICAL ACOUSTIC, AND SHOCK/TRANSIENT TEST TECHNIQUES; AND GENERATION OF PARAMETRIC INFORMATION ON THE INTERRELATIONSHIP BETWEEN DAMPING, MASS PROPERTIES, AND NUTATION RATE OF SPIN-STABILIZED SPACECRAFT.

RTOP NO. 114-08-22 TITLE: STOP (STRUCTURAL-THERMAL-OPTICAL-PROGRAM)
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: LEE, H. P. TEL. 301-982-5275
TECHNICAL SUMMARY

THIS RTOP IS INTENDED TO IMPROVE ANALYSIS CAPABILITY WHERE THE THERMAL DISTORTIONS OF ELEMENTS OF A STRUCTURE RESULT IN THE

DEGRADATION OF ITS PERFORMANCE. THIS, FOR EXAMPLE, WOULD INCLUDE THE DEGRADATION IN THE PERFORMANCE OF A SPACE TELESCOPE BECAUSE OF VARYING THERMAL LOADS IN ORBIT. THESE LOADS RESULT IN THE DEFORMATION OF THE STRUCTURE SUPPORTING THE OPTICAL ELEMENTS AND ALSO DISTORTIONS IN THE ELEMENTS THEMSELVES. APPLICATIONS EXIST IN AREAS SUCH AS THE LARGE SPACE TELESCOPE, SMALL ASTRONOMY SATELLITE, RF ANTENNAS, AND ANY COMPLEX SYSTEM WHERE ALIGNMENTS ARE CRITICAL. THE APPROACH IS TO UTILIZE THE NASTRAN PROGRAM FOR THE STRUCTURAL ANALYSIS OF COMPLEX SYSTEMS AND TO APPLY THE SAME TECHNOLOGY - THE FINITE ELEMENT METHOD - TO THERMAL ANALYSIS. RESULTS ARE THEN USED AS AN INPUT THROUGH AN INTERFACE COMPUTER PROGRAM TO BE DEVELOPED UNDER STOP, TO RAY TRACE PROGRAMS FOR OPTICAL PERFORMANCE ANALYSIS.

RTOP NO. 746-03-47 TITLE: METEOROID TECHNOLOGY SATELLITE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DETERMINE THE METEOROID ENVIRONMENT IN SPACE AND TO DETERMINE THE EFFECTIVENESS OF METEOROID PROTECTION STRUCTURES FOR FUTURE SPACE FLIGHTS. THE WORK INCLUDES THE FOLLOWING AREAS: THE METEOROID TECHNOLOGY SATELLITE (MTS) IS A SCOUT LAUNCHED NEAR-EARTH EXPERIMENT TO OBTAIN BASELINE DATA ON THE EFFECTIVENESS OF BUMPERS OR MULTI-WALL STRUCTURES AND THE VELOCITY DISTRIBUTIONS OF METEOROIDS. MEASUREMENT WILL ALSO BE MADE OF THE FLUX OF VERY SMALL MASS METEOROIDS. THE VELOCITY MEASUREMENT IS A JOINT LANGLEY RESEARCH CENTER/MANNED SPACECRAFT CENTER EXPERIMENT. THE INTERPLANETARY METEOROID PENETRATION EXPERIMENT WILL BE FLOWN ON THE PIONEER F AND ON THE PIONEER G FLIGHTS THROUGH THE ASTEROID BELT TO OBTAIN METEOROID FLUX DATA IN INTERPLANETARY SPACE ENVIRONMENT. AN EARTH ORBITAL SISYPHUS EXPERIMENT WILL BE STUDIED. THE SISYPHUS SYSTEM IS AN OPTICAL METEOROID DETECTOR WHICH UTILIZES THREE OVERLAPPING REFLECTIVE TELESCOPES TO DETERMINE THE MASS, VECTOR VELOCITY, AND RANGE FROM SPACECRAFT OF METEOROIDS.

RTOP NO. 746-03-48 TITLE: RADIATION TECHNOLOGY SATELLITE
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MCALLUM, W. E. TEL. 713-483-3734
TECHNICAL SUMMARY

A SCIENTIFIC INSTRUMENT PACKAGE WAS LAUNCHED SIMULTANEOUSLY WITH THE ORBITING FROG OTOLITH SPACECRAFT ON NOVEMBER 7, 1970. THE INSTRUMENT PACKAGE CONSISTED OF TWO EXPERIMENTS: (1) A RADIATION EXPERIMENT COMPOSED OF THREE SOLID-STATE SPECTROMETERS, A REAL-TIME SPECTRUM-TO-DOSE CONVERTER, AND THREE IONIZATION CHAMBERS, AND (2) A METEOROID EXPERIMENT CAPABLE OF MEASURING PARTICLE FLUX AND PARTICLE VELOCITY WITH THIN FILM CAPACITOR SENSORS. THE WORK TO BE ACCOMPLISHED IS THE REDUCTION, ANALYSIS, AND PUBLICATION OF 90 DAYS OF FLIGHT DATA FROM THE RADIATION AND METEOROID EXPERIMENTS. THE

EXISTING MAGNETIC TAPES WILL BE PROCESSED TO STRIP THE APPROPRIATE DATA AND CORRELATE THE EXPERIMENT DATA WITH SPACECRAFT POSITION OBTAINED FROM THE STADAN EPHEMERIS DATA. THE RESULTING INFORMATION WILL PROVIDE EVALUATION OF SPECTRUM-TO-DOSE CONVERSION PERFORMANCE; DOSE AND POSSIBLE SPECTRUM MAPS OF THE SOUTH ATLANTIC ANOMALY; EVALUATION OF METEOROID INSTRUMENT PERFORMANCE; AND METEOROID FLUX AND VELOCITY DATA POINTS.

RTOP NO. 115-04-20 TITLE: ARTIFICIAL INTELLIGENCE FOR INTEGRATED ROBOT SYSTEMS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS PLAN ENCOMPASSES RESEARCH LEADING TOWARD THE DEVELOPMENT OF "INTELLIGENT" ROBOTS THAT CAN AUGMENT OR, WHEN NECESSARY, REPLACE CERTAIN HUMAN PERCEPTUAL, INTELLECTUAL, AND MOTOR FUNCTIONS. THE WORK WILL BE CARRIED ON IN CONCERT WITH OTHER INVESTIGATORS IN THE FIELD OF ARTIFICIAL INTELLIGENCE; HOWEVER, OUR APPROACH WILL BE CONDITIONED BY AND DIRECTED TO CLASSES OF REQUIREMENTS THAT ARE GERMANE TO FUTURE NASA MISSIONS. POSSIBLE APPLICATIONS OF ROBOTS IN SPACE EXPLORATION DURING THE NEXT FIFTEEN YEARS HAVE BEEN EXPLORED AND DOCUMENTED BY THE NASA TELEOPERATOR/ROBOT DEVELOPMENT TASK TEAM. PRIMARY EMPHASIS OF THE RESEARCH WILL BE ON IMPROVING THE INTELLECTUAL QUALITIES OF MACHINES; HOWEVER, SENSORY AND MOTOR CHARACTERISTICS NECESSARY FOR THE ROBOT TO CONSTRUCT VALID MODELS OF THE ENVIRONMENT AND TO INTERACT WITH IT SUCCESSFULLY WILL BE STUDIED AND THE RESULTS USED TO CONFIGURE AND SIZE THE TOTAL ROBOT SYSTEM. INITIAL SUBJECTS FOR STUDY WILL INCLUDE MACHINE PERCEPTION, PROBLEM-SOLVING AND DECISION-MAKING, MOTOR CONTROL AND COORDINATION, MACHINE STRUCTURE INSOFAR AS IT LIMITS OR DETERMINES ROBOT CAPABILITIES IN THE ABOVE AREAS, MAN-MACHINE COMMUNICATION, AND OVERALL EVALUATION OF ROBOT PERFORMANCE. RELATED WORK ON THE THEORY OF PROGRAMS BEGUN IN FY'71 UNDER ANOTHER RTOP (129-04-21) WILL BE CONTINUED AS A PART OF THIS ONE. PRODUCTS OF THE WORK WILL BE MATHEMATICAL ANALYSES AND MODELS, AND COMPUTER PROGRAMS RELATING TO ROBOT FUNCTIONS. THE FOCUS OF THE RESEARCH WILL BE "BREADBOARDS" OF ROBOT SYSTEMS THAT WILL PERMIT CHANGE AND EXPANSION AS KNOWLEDGE OF MACHINE INTELLIGENCE IMPROVES. THE PRIME ACTIVITY DURING FY'72 WILL BE TO STUDYSUITABLE STRUCTURES FOR THE----

RTOP NO. 115-12-01 TITLE: SPACE VEHICLE DESIGN CRITERIA (GUIDANCE & CONTROL)
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PREPARE AND PUBLISH GUIDANCE AND CONTROL DESIGN CRITERIA MONOGRAPHS FOR SPACE VEHICLE DESIGN.

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EACH MONOGRAPH WILL BE CONCERNED WITH ONE TOPIC IN THE AREA OF GUIDANCE AND CONTROL. IN ACCORDANCE WITH THE POLICY OF THE NASA DESIGN CRITERIA PROGRAM, THESE MONOGRAPHS WILL SERVE TO PROMOTE THE DEVELOPMENT OF RELIABLE AND EFFICIENT SPACE VEHICLES. AS SUCH, EACH DOCUMENT WILL ASSESS THE STATE-OF-THE-ART WITHIN THE SELECTED TOPIC, ESTABLISH A SET OF CRITERIA TO PROVIDE GUIDELINES, PROVIDE AN OUTLINE OF PREVIOUS SUCCESSFUL DESIGN TECHNIQUES AND SET FORTH A COMPREHENSIVE LIST OF REFERENCES. EACH MONOGRAPH WILL DEAL WITH A SINGLE TOPIC SELECTED ON THE BASIS OF NASA'S NEED AND THE AVAILABILITY OF A TECHNICAL BACKGROUND IN THE TOPIC AREA. THE PREPARATION OF THE MONOGRAPHS WILL BE GUIDED BY AN ADVISORY PANEL CONSISTING OF EXPERIENCED NASA PERSONNEL, INDUSTRIAL EXPERTS AND UNIVERSITY PERSONNEL. THIS WILL INSURE A TECHNICALLY SOUND DOCUMENT WITH ALL THE VARIOUS VIEWPOINTS REPRESENTED. THE PRIMARY EMPHASIS IS TO PRODUCE MONOGRAPHS IN THE AREA OF SYSTEMS DESIGN. SPECIFIC MONOGRAPH TOPICS WHICH WILL BE COMPLETED DURING FISCAL YEAR 1972 WILL BE SPACECRAFT DISPLAY SYSTEMS, GYROSCOPE APPLICATIONS, ACCELEROMETER APPLICATION AND EFFECTS OF FLEXIBILITY ON ENTRY VEHICLE CONTROL SYSTEMS. THIS SEQUENCE OF MONOGRAPHS WILL BE DIRECTLY APPLICABLE TO THE DEVELOPMENT OF CONTROL SYSTEMS FOR LOW COST SATELLITES AS WELL AS LARGER PROJECTS SUCH AS THE SPACE SHUTTLE OR PLANETARY EXPLORATION.

RTOP NO. 115-17-01 TITLE: SPACE SHUTTLE: SYSTEMS FOR NAVIGATION, GUIDANCE AND CONTROL DURING APPROACH AND LANDING

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBERTS, L. TEL. 415-961-2280

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP A TECHNOLOGY BASE FOR THE DESIGN OF THE SYSTEMS FOR NAVIGATION, GUIDANCE AND CONTROL OF THE SPACE SHUTTLE VEHICLE (SSV) DURING THE APPROACH AND LANDING. THE PROGRAM INCLUDES ANALYSIS, PILOTED FLIGHT SIMULATION, AND FINALLY, FLIGHT TESTS TO DEVELOP AND EVALUATE SYSTEM CONCEPTS. DURING FY'71 ANALYSIS AND SIMULATION WERE EMPHASIZED ON BOTH IN-HOUSE AND CONTRACT STUDIES. IN FY'72 ANALYSIS AND SIMULATION WILL CONTINUE IN-HOUSE BUT EMPHASIS WILL SHIFT TO FLIGHT EVALUATION OF THE CONCEPTS DEVELOPED. ANALYSIS AND SIMULATION FOR FY'72 INCLUDE: 1. DETAILED EXAMINATION OF THE AUTOMATIC/MANUAL CONTROL SYSTEM INTERFACE 2. EXAMINATION OF PERFORMANCE OF CANDIDATE SYSTEMS CONCEPTS 3. EVALUATION OF HANDLING QUALITIES OF CANDIDATE VEHICLE CONFIGURATIONS. THE FLIGHT PROGRAMS FOR FY'72 ARE: 1. FLIGHT TESTS USING THE CONVAIR 340 TO CONFIRM NAVIGATION PERFORMANCE OBTAINED FROM IN-HOUSE ANALYSIS AND SIMULATION OF BLENDED INERTIAL/RADIO NAVIGATION SYSTEMS. 2. A MORE EXTENSIVE FLIGHT TEST PROGRAM USING THE CONVAIR 990 TO STUDY AUTOMATIC AND PILOTED LANDING SYSTEM CONCEPTS AND TO CONFIRM NAVIGATION, GUIDANCE AND CONTROL SYSTEM PERFORMANCE OBTAINED FROM ANALYSIS AND SIMULATIONS CONDUCTED IN-HOUSE AND ON CONTRACT. THESE FLIGHT TESTS WILL DUPLICATE, AS NEARLY AS POSSIBLE THE SHUTTLE TRAJECTORY AND PERFORMANCE FROM ABOUT 40,000 FEET TO TOUCHDOWN.

RTOP NO. 115-17-02 TITLE: TERMINAL AREA NAVIGATION, GUIDANCE, AND DISPLAY CONCEPTS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: GEE, S. W. TEL. 805-258-3311
TECHNICAL SUMMARY

AN ANALYTICAL STUDY WILL BE CONDUCTED USING AN IBM 360 COMPUTER TO INVESTIGATE THE ENERGY MANAGEMENT AND GUIDANCE EQUATIONS FOR A CURVED, UNPOWERED, INSTRUMENT APPROACH TO A RUNWAY IN A VEHICLE OF LOW LIFT AND HIGH DRAG CONFIGURATION. A COMPUTER SIMULATION USING THE VEHICLE EQUATIONS OF MOTION AND A COCKPIT WITH CHANGEABLE DISPLAYS WILL BE USED TO EVALUATE THE GUIDANCE SYSTEM AND PILOT WORK LOAD. SIMULATION RESULTS WILL BE VALIDATED BY FLIGHT TESTS USING A DATA LINK WITH AN F-104 AIRCRAFT.

RTOP NO. 115-17-04 TITLE: SHUTTLE GUIDANCE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: INGRAM, H. L. TEL. 205-453-0445
TECHNICAL SUMMARY

IN RECENT YEARS A SERIES OF ALGORITHMS FOR TRAJECTORY OPTIMIZATION AND GUIDANCE HAVE BEEN DEVELOPED WHICH SHOW THE FEASIBILITY OF USING GENUINE OPTIMIZATION TECHNIQUES FOR REAL TIME GUIDANCE AND MISSION PLANNING. THESE ALGORITHMS ARE MODIFIED SHOOTING METHODS WHICH ARE CAPABLE OF REPETITIVE ON-BOARD OPTIMIZATION OF MULTIPLE BURN ORBIT TRANSFERS. USING THESE ALGORITHMS, AN OPTIMAL GUIDANCE SCHEME HAS ALREADY BEEN DEVELOPED FOR POWERED VACUUM MANEUVERS; AND, IN A PARALLEL EFFORT TO THIS STUDY (UNDER 908-52-10 FY'71 FUNDING), THE FINISHING TOUCHES ARE BEING PUT ON AN OPTIMAL GUIDANCE SCHEME FOR USE DURING POWERED ASCENT THROUGH THE ATMOSPHERE. UNDER THE CONTRACTUAL EFFORT PRESENTLY FUNDED UNDER THIS RTOP, A LIMITED REENTRY OPTIMIZATION CAPABILITY WILL BE DEVELOPED - AGAIN USING THE ALGORITHMS PREVIOUSLY MENTIONED. UNDER FY '72 FUNDING OF THIS RTOP, THIS EFFORT WILL BE EXTENDED TO THE DEVELOPMENT OF A FULLY REALISTIC OPTIMAL REENTRY GUIDANCE SCHEME FOR THE SPACE SHUTTLE, CAPABLE OF OPTIMIZING THERMAL PERFORMANCE SUBJECT TO THERMAL AND STRUCTURAL CONSTRAINTS. UNDER ANTICIPATED FOLLOW-ON FUNDING UNDER THIS RTOP (FY'73 AND BEYOND), THE THREE APPLICATIONS OF THE DEVELOPED ALGORITHMS (ASCENT, RENDEZVOUS AND REENTRY) WILL BE BROUGHT TOGETHER TO FORM A UNIFIED GUIDANCE SCHEME WHICH TAKES ADVANTAGE OF THE COMMONALITY THAT EXISTS IN THE EQUATIONS AND TECHNIQUES EMPLOYED TO PROVIDE OPTIMAL GUIDANCE DURING ALL THREE SPACE SHUTTLE FLIGHT PHASES. THE ADVANTAGES OF SUCH A UNIFIED SYSTEM WILL INCLUDE MINIMUM COMPUTER STORAGE REQUIREMENTS, MINIMUM SOFTWARE DEVELOPMENT, MINIMUM PROPELLANT REQUIREMENTS, AND MAXIMUM RELIABILITY.

RTOP NO. 115-17-05 TITLE: INERTIAL COMPONENTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: WALLS, B. F. TEL. 205-453-0793
TECHNICAL SUMMARY

THE OBJECTIVE IS: (A) TO PRODUCE A THREE-AXIS STRAPDOWN INERTIAL NAVIGATION SYSTEM WITH PERFORMANCE THAT EXCEEDS THE

PRESENTLY AVAILABLE HIGH QUALITY INERTIAL SYSTEMS IN ACCURACY AND RELIABILITY WITH A CONSIDERABLE REDUCTION IN WEIGHT, SIZE AND COST. (B) TO PRODUCE AN OPERATIONAL LASER GYRO WITH HIGH ACCURACY AND RELIABILITY THAT CAN BE USED IN FUTURE SYSTEMS OF PRECISE RATE AND POSITION SENSING. THE UNIT CAN BE EASILY ADAPTED TO NAVIGATION SYSTEMS AS WELL AS RATE AND POSITION SENSORS AND POSITION TRACKERS. THE APPROACH IS: (A) CONTINUE THE TESTS OF THE PRESENT 5-INCH PER SIDE GYRO FOR LONG-TERM STABILITY AND LONG-TERM REPEATABILITY AND ENVIRONMENTAL RESPONSE. (B) TEST THE UPDATE THREE-AXIS LASER GYRO CONFIGURATION AND NEW ELECTRONICS THAT WILL BE DELIVERED IN MAY 1971. THESE TESTS WILL INCLUDE LABORATORY AND FIELD TESTS FOR ACCURACY AND ENVIRONMENTAL RESPONSE. (C) CONTINUE DEVELOPMENT TESTING OF THE NEW BIAS CELL. (D) CONTINUE THE DEVELOPMENT AND TESTING OF THE NEW DISCHARGE TUBE TO INCREASE THE LIFE OF THE LASER BEYOND THE PRESENTLY PROVEN 2100 HOURS PLUS.

RTOP NO. 115-19-02 TITLE: CONTROL AND STABILIZATION SYSTEMS AND COMPONENTS FOR SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: TEL. 703-827-3745
TECHNICAL SUMMARY

TECHNOLOGY WILL BE DEVELOPED TO PERMIT THE DESIGN OF SPACE STATION ATTITUDE CONTROL AND STABILIZATION SYSTEMS FOR AN 8-10 YEAR OPERATIONAL LIFETIME. SIMULATIONS WILL BE MADE CONSIDERING FLEXIBLE, VARIABLE-INERTIA, MULTIBODY, SPINNING AND NON-SPINNING MODULAR CONFIGURATIONS IN ORDER TO DETERMINE THE REQUIRED SYSTEM AND COMPONENT PERFORMANCE. CONTROL SOFTWARE AND HARDWARE NEEDS BEYOND THE PRESENT STATE-OF-THE-ART WILL BE DEFINED AND DEVELOPMENT EFFORTS UNDERTAKEN TO PROVIDE SOLUTIONS. CRITICAL HARDWARE ELEMENTS WILL BE CARRIED THROUGH PROTOTYPE DEVELOPMENT TO ESTABLISH FEASIBILITY. THIS EFFORT IS DIRECTLY COORDINATED WITH MSFC AND GSFC, AND GSFC-DEVELOPED COMPONENTS WILL BE INTEGRATED INTO SIMULATIONS AT LANGLEY. TECHNOLOGY FOR SEPARATE EXPERIMENT-ISOLATION AND FINE-POINTING SYSTEMS WILL BE DEVELOPED IN A SIMILAR MANNER.

RTOP NO. 115-19-06 TITLE: EXTENDED LIFE ATTITUDE CONTROL SYSTEMS (ELACS) FOR UNMANNED PLANETARY VEHICLES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

A COORDINATED APPROACH TO THE DESIGN OF CONTROL SYSTEMS FOR FUTURE PLANETARY SPACECRAFT IS REQUIRED IN ORDER TO MEET RELIABILITY AND LIFETIME REQUIREMENTS. IN RECOGNITION OF THESE REQUIREMENTS, JPL HAS DEVELOPED A PROGRAM ENTITLED: EXTENDED LIFE ATTITUDE CONTROL SYSTEMS (ELAS), TO PROVIDE THE REQUIRED DESIGN TECHNIQUES, HARDWARE DEVELOPMENTS, AND SYSTEM TECHNOLOGY. THE PROGRAM IS FOCUSED ON GRAND TOUR MISSIONS TO DEFINE IMMEDIATE OBJECTIVES. MISSIONS BEYOND THE PRESENT GRAND TOUR CONCEPT WILL INCLUDE SUCH VARIATIONS AS COMET RENDEZVOUS, ASTEROID FLYBYS AND LANDERS, NATURAL SATELLITE ORBITERS AND LANDERS AND A MULTITUDE OF OUTER PLANETARY ORBITER/LANDER SETS.

SUCH MISSIONS WILL PRESENT A MYRIAD OF REQUIREMENTS AND CONSTRAINTS ON FUTURE SPACECRAFT CONTROL SYSTEMS. EARLY INVESTIGATIONS INTO THE ATTITUDE CONTROL AND THRUST VECTOR CONTROL REQUIREMENTS, CONCEPTS AND ANALYTICAL TECHNIQUES ARE REQUIRED TO ASSURE A REASONABLE TECHNOLOGY READINESS FOR THE 1970'S AND BEYOND.

RTOP NO. 115-21-01 TITLE: MANNED SPACE SHUTTLE - DEVELOPMENT OF ANTENNA TECHNIQUES AND MATERIALS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

CRITICAL ANTENNA TECHNOLOGY WILL BE DEVELOPED TO MEET THE REQUIREMENTS IMPOSED BY STRUCTURAL DESIGN CONSIDERATIONS, THERMAL CONDITIONS, AND THE OVERALL REENTRY ENVIRONMENT OF THE SPACE SHUTTLE. THE REUSE CAPABILITY OF ANTENNA WINDOW AND THERMAL PROTECTION MATERIALS WILL BE DETERMINED BY MEASURING THE DIELECTRIC PROPERTIES OF THESE MATERIALS AFTER REPEATED THERMAL CYCLING. ANTENNA DESIGNS WILL BE DEVELOPED WHICH USE THESE MATERIALS IN LAYERS TO REDUCE ANTENNA TEMPERATURES. COMPUTERIZED DESIGN TECHNIQUES WILL BE DEVELOPED TO DETERMINE THE IMPEDANCE AND PATTERNS OF ANTENNAS ON SPACE SHUTTLE VEHICLES.

RTOP NO. 115-21-02 TITLE: MANNED SPACE SHUTTLE - MICROWAVE AMPLIFIERS FOR SPACE SHUTTLE VEHICLE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

C-BAND MICROWAVE POWER AMPLIFIERS WILL BE DEVELOPED FOR THE COMMUNICATION SUBSYSTEM OF THE SPACE SHUTTLE. PRESENTLY AVAILABLE DESIGN TECHNIQUES WILL BE USED WITH SLIGHT MODIFICATION OF CONVENTIONAL TRAVELING WAVE TUBE CONFIGURATIONS. EMPHASIS WILL BE PLACED ON INCREASED POWER OUTPUT, IMPROVED EFFICIENCY, AND HIGH RELIABILITY. THE NOMINAL POWER OUTPUT WILL BE 100 WATTS WITH SATISFACTORY OPERATION THROUGH THE 20 TO 100-WATT RANGE. THE POWER AMPLIFIERS WILL BE DESIGNED FOR COMPATIBLE OPERATION THROUGH THE INTELSAT IV SATELLITE RELAY COMMUNICATIONS SYSTEM. ENGINEERING MODELS WILL BE CONSTRUCTED WHICH CAN BE USED IN THE INITIAL PHASE OF FLIGHT QUALIFICATION AND LIFE TEST PROGRAMS. IN ADDITION, EFFORTS WILL BE UNDERTAKEN TO EXTEND THE C-BAND TECHNOLOGY TO K SUB U BAND. PARALLEL EFFORT WILL ALSO ASSESS FEASIBILITY OF SOLID STATE TECHNIQUES AT THESE POWER LEVELS.

RTOP NO. 115-21-10 TITLE: MICROWAVE NEAR EARTH COMMUNICATIONS AND TRACKING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SIMAS, V. R. TEL. 301-982-4936
TECHNICAL SUMMARY

THE OBJECTIVE OF THE WORK UNDER THIS RTOP IS TO ACHIEVE

TECHNOLOGICAL ADVANCES IN COMMUNICATION AND TRACKING SYSTEMS IN ORDER TO SATISFY THE DEMANDING COMMUNICATION REQUIREMENTS FOR FUTURE SPACE FLIGHT PROJECTS, SUCH AS SPACE STATION, EARTH OBSERVATION SATELLITE (EOS) PROGRAM AND TDRS. THE CAPABILITY AND PERFORMANCE REQUIREMENTS ON THE COMMUNICATION LINKS FOR THESE ADVANCED PROJECTS ARE CHARACTERIZED BY HIGH DATA RATES (100 MHZ BANDWIDTH), SIMULTANEOUS MULTI-LINK OPERATION AND RELIABLE LONG LIFE OPERATION. THE ATTAINMENT OF THESE PARAMETERS WILL REQUIRE TECHNOLOGICAL ADVANCES IN BOTH SPACECRAFT AND GROUND TERMINAL TECHNIQUES AND HARDWARE. 1) HIGH POWER (10 WATT) EFFICIENT SOLID STATE SIGNAL SOURCES AT K SUB U BAND WILL BE DEVELOPED. THIS WILL CIRCUMVENT THE LIABILITIES ASSOCIATED WITH VACUUM TUBE TWTS, NAMELY LIMITED LIFE, SIZE AND WEIGHT, AND HIGH VOLTAGES. 2) INCREASED ACCURACY AND SENSITIVITY OF TRACKING AND DATA SYSTEMS WILL BE ATTAINED BY IMPROVING SPACECRAFT AND NETWORK PRIMARY FREQUENCY STANDARDS. THE WORK HERE INVOLVES THE DEVELOPMENT OF RUBIDIUM FREQUENCY STANDARDS AND A MINIATURE, ULTRA-STABLE, FREQUENCY/PHASE STANDARD ATOMICALLY CONTROLLED USING ADVANCED CONCEPTS OF ELECTRO DYNAMIC STORAGE OF REFERENCE IONS. 3) THE PRESENTLY ENVISIONED SPACE STATION COMMUNICATIONS SYSTEM HAS ANTENNA REQUIREMENTS THAT MAY BE BEST FILLED BY THE USE OF PHASED ARRAYS. THESE ANTENNA REQUIREMENTS WILL BE DETERMINED THROUGH TRADE-OFF STUDIES AND AN APPROPRIATE PHASED ARRAY TECHNIQUE DEVELOPED WHICH BEST SUITS THE STATION-TO-MODULE AND STATION-TO-GROUND COMMUNICATION LINKS.

RTOP NO. 115-21-11 TITLE: SPACE SHUTTLE LOW NOISE RECEIVER
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: DALLE MURA, P. H. TEL. 301-983-5036
TECHNICAL SUMMARY

THE SPACE SHUTTLE COMMUNICATION THROUGH SYNCHRONOUS SATELLITES WILL REQUIRE INCREASED ANTENNA SIZES OR MORE SENSITIVE RECEIVING SYSTEMS. SINCE RE-ENTRY IS A FACTOR, IT IS OBVIOUS THAT THE LATTER AREA OF CONCERN SHOULD BE DEVELOPED. THIS RTOP WILL DEVELOP A SPACE QUALIFIED PARAMP TECHNOLOGY AT C-BAND, K SUB U BAND AND S-BAND. THE C-BAND PARAMP WILL HAVE A NOISE FIGURE OF LESS THAN 2DB AND THEREBY SIGNIFICANTLY REDUCE THE SIZE REQUIREMENT OF THE ANTENNA. THIS EFFORT WILL BE PRIMARILY CONTRACTURAL WITH SOME EFFORT PERFORMED IN-HOUSE. THE C-BAND UNIT MUST BE DEVELOPED COMPLETELY, WHEREAS THE PROTOTYPE K SUB U BAND UNIT WILL BE DEVELOPED FOR THE TDRS PROGRAM. THIS PROTOTYPE MUST THEN BE DEVELOPED THROUGH THE SPACE QUALIFICATION SEGMENT. THE S-BAND UNIT HAS BEEN DEVELOPED THROUGH THE PROTOTYPE STAGE FOR THE TDRS PROGRAM. THIS PROTOTYPE WILL BE EXTENDED THROUGH A SPACE QUALIFICATION DEVELOPMENT PHASE.

RTOP NO. 115-21-20 TITLE: MICROWAVE DEEP SPACE COMMUNICATION AND TRACKING
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE PURPOSE OF THIS ACTIVITY IS TO INCREASE THE COMMUNICATION

CAPABILITY AND RELIABILITY OF MICROWAVE LINKS BETWEEN PLANETARY SPACECRAFT AND EARTH DURING THE 1976-1986 PERIOD. AN ADDITIONAL GOAL IS TO DECREASE THE COST AND LEAD TIME OF PLANETARY TELECOMMUNICATIONS BY DEVELOPING MULTIPLE-MISSION SUBSYSTEMS USEABLE FOR A WIDE VARIETY OF PLANETARY AND INDEED OTHER NASA MISSIONS. IN FY'72, 60% OF THE FUNDING OF THIS RTOP WILL BE EXPENDED ON THE VENUS-MERCURY S-X EXPERIMENT. THIS EXPERIMENT, A JOINT EFFORT WITH OTDA, WILL DEMONSTRATE THE IMPROVEMENTS IN RADIO TRACKING PROVIDED BY HAVING TWO MICROWAVE FREQUENCIES FROM SPACECRAFT TO EARTH WITH SIMULTANEOUS COHERENT RANGE-DOPPLER ON BOTH LINKS. THE SIMULTANEOUS OPERATION OF TWO FREQUENCIES ALLOWS THE EFFECT OF CHARGED PARTICLES IN THE INTERVENING MEDIUM TO BE PRECISELY CALIBRATED, THUS ALLOWING THE MORE PRECISE SPACECRAFT TRACKING NECESSARY IN PLANETARY ORBITERS AND GRAVITY-ASSIST FLY-BYS SUCH AS THE GRAND TOUR. THE S-X EXPERIMENT WILL BE THE FIRST DEMONSTRATION OF THE UNIFIED DUAL-FREQUENCY (UDF) TELECOMMUNICATION SYSTEM. A FEATURE OF THIS SYSTEM WHICH WILL NOT BE DEMONSTRATED IN THE S-X EXPERIMENT IS THE USE OF X-BAND TELEMETRY TO INCREASE DATA RATES. MUCH OF THE REMAINING WORK IN FY'72 ON THIS RTOP IS CONCERNED WITH PROVIDING A STABLE, RELIABLE, LONG-LASTING UNIFIED DUAL FREQUENCY RADIO DESIGN, EXCEPT FOR THE X-BAND TUBE, AND WITH ACCOMMODATING THE HIGH DATA RATES SO PROVIDED. IN PARTICULAR, A MULTICATHODE ELECTRON GUN IS BEING DEVELOPED JOINTLY WITH RTOP 115-21-21 TO PROVIDE LONG-LIFE TRANSMITTER CAPABILITY.

RTOP NO. 115-21-21 TITLE: MICROWAVE COMMUNICATION FOR THE SPACE STATION BASE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO DEVISE A TECHNOLOGY TO SATISFY THE REQUIREMENTS OF THE MANNED SPACE STATION UNIFIED MICROWAVE COMMUNICATION SYSTEM. THE REQUIREMENTS ARE PRIMARILY LONG TERM RELIABILITY (10 YEARS OR MORE) WITH A CAPABILITY OF EFFICIENTLY HANDLING 100 MEGABITS/SECOND OF DATA COMING TO AND FROM MANY DIFFERENT SOURCES, INCLUDING EARTH RESOURCES MODULES AND THE TRACKING DATA RELAY SATELLITE NETWORK (TDRSN). WORK IS BEING DONE TO DEVELOP AN EXTENSIVE TECHNOLOGY FOR THE K SUB U BAND REGION OF THE FREQUENCY SPECTRUM WHICH IS A MAJOR NASA SPACE STATION FREQUENCY. THIS INCLUDES THE DEVELOPMENT AND TESTING OF HIGH GAIN FURLABLE CONICAL K SUB U BAND ANTENNAS, AS WELL AS THE INVESTIGATION OF OTHER K SUB U BAND ANTENNA CONCEPTS. ALSO, RELIABLE LONG-LIFE WIDEBAND TRANSMITTERS WITH CATHODE REPLACEMENT ARE BEING DEVELOPED. THE TRANSMITTER WORK INCLUDES THE MULTIPLE ELECTRON GUN (MEG) CONCEPT FOR HIGH-POWER HIGH-RATE COMMUNICATION TO EARTH VIA THE TDRSN. NEW MODULATION/DEMODULATION/DETECTION TECHNIQUES SUCH AS INTERPLEX FOR EFFICIENT MULTIPLE SUBCARRIER TELEMETRY SYSTEMS ARE BEING DEVELOPED AND EVALUATED IN THE LIGHT OF THE VERY HIGH DATA RATE REQUIREMENTS. OPTIMUM MODULATION INDEX SELECTION RULES TO MINIMIZE CROSS-MODULATION AND WAVEFORM DISTORTION LOSS ARE UNDER INVESTIGATION. INCLUDED ARE STUDIES OF MULTIPLE SUBCARRIER SCHEMES FOR SUPPRESSED CARRIER SYSTEMS AND DEVELOPMENT OF METHODS OF EXTRACTING THE SUBCARRIER FROM THE MODULATION SIDEBANDS.

RTOP NO. 115-21-50 TITLE: CODING FOR SPACE COMMUNICATIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

DEVELOP ERROR DETECTION AND CORRECTION CODING TECHNIQUES APPLICABLE TO TELEMETRY LINKS FOR A SPACE STATION/BASE, WITH REQUIREMENTS FOR DATA RATES GREATER THAN 15 MBPS. INVESTIGATE METHODS FOR EXTENDING THESE TECHNIQUES TO DATA RATES OF 50 MBPS. STUDY THE APPLICABILITY OF CODING METHODS FOR COMMAND LINKS ASSOCIATED WITH A SPACE STATION. INVESTIGATE HYBRID CODING TECHNIQUES TO EXTEND PRESENT CODING GAINS FOR LOW DATA RATE PLANETARY MISSIONS. THEORETICAL STUDIES OF HIGH DATA RATE CODING HAVE BEEN COMPLETED. DESIGN AND DEVELOPMENT OF PHOTOTYPE DECODING, ENCODING, AND DATA SIMULATION EQUIPMENT, WITH AN OPERATIONAL CAPABILITY OF AT LEAST 20 MBPS, IS UNDERWAY. DETAILED DESIGN OF PROMISING HYBRID CODING TECHNIQUES WILL BE UNDERTAKEN FOR EVALUATION OF MOST EFFECTIVE APPROACH.

RTOP NO. 115-22-04 TITLE: LARGE TELESCOPE TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MANGUS, J. D. TEL. 301-982-4532
TECHNICAL SUMMARY

A TELESCOPE TECHNOLOGY PROGRAM IS TO BE CONDUCTED USING IN-HOUSE AND CONTRACT RESOURCES TO DEVELOP THE TECHNOLOGY REQUIRED TO CONSTRUCT LARGE (ON THE ORDER OF 3-METER DIAMETER APERTURE) SPACE BORNE OPTICAL TELESCOPES, THE PERFORMANCE OF WHICH ARE LIMITED ONLY BY DIFFRACTION AND/OR THE STATISTICAL NOISE OF THE RADIATION RECEIVERS IN THE ACCESSORY EQUIPMENT. TECHNOLOGICAL PROBLEMS STUDIED ARE THE SPECIFICATION OF LIMITS ON OPTICAL-MECHANICAL DESIGN PARAMETERS AND THE DEVELOPMENT OF TECHNIQUES RELATED TO THE DESIGN, FABRICATION AND CONSTRUCTION OF A LARGE TELESCOPE IN A ONE "G" GROUND BASED ENVIRONMENT, SUBSEQUENTLY SUBJECTING IT TO A SEVERAL "G" LAUNCH ENVIRONMENT AND FINALLY OPERATING IT IN A DIFFRACTION LIMITED MODE IN A ZERO "G" SPACE ENVIRONMENT. THE WIDE VARIETY OF FACTORS ASSOCIATED WITH EACH ENVIRONMENT THAT COULD ADVERSELY EFFECT TELESCOPE PERFORMANCE ARE CONSIDERED AS COMPREHENSIVELY AS POSSIBLE THROUGHOUT THE RESEARCH PROGRAM. SPECIFIC PROBLEMS TO BE STUDIED BY THIS TASK INCLUDE: THE ANALYSIS OF CANDIDATE MIRROR STRUCTURE CONFIGURATIONS (LIGHTWEIGHT MONOLITHIC, ACTIVE THIN DEFORMABLE AND ACTIVE SEGMENTED) ON AN ANALYTICAL AND EXPERIMENTAL BASIS; DEVELOPMENT OF A FOCAL PLANE IMAGE ERROR SENSOR; DEVELOPMENT OF TELESCOPE CONFIGURATION CONSTRAINTS; DEVELOPMENT OF OPTICAL ERROR BUDGETS; EVALUATION OF OPTICAL SURFACE GENERATION AND POLISHING TECHNIQUES; DEVELOPMENT OF A PRIMARY-SECONDARY MIRROR ALINEMENT SENSOR; INVESTIGATION OF ZERO "G" AIRBORNE TESTING TECHNIQUES. COMPLETION OF THE VERTICAL TEST FACILITY IS NOW PROJECTED TO BE IN JANUARY 1972.

RTOP NO. 115-22-05 TITLE: (AIRBORNE VISIBLE LASER OPTICAL COMMUNICATIONS (AVLOC))
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: RANDALL, J. L.TES TEL. 205-453-3770
TECHNICAL SUMMARY

THE PURPOSE OF THE EXPERIMENT IS TO ESTABLISH ATWO-WAY LASER COMMUNICATIONS LINK WITH ONE ENDLOCATED AT THE MSFC MADKIN MOUNTAIN OPTICALTRACKING STATION, WHILE THE OTHER END OF THE LINKWILL BE PACKAGED IN THE BELLY OF AN RB-57FAIRCRAFT ORBITING OVER MADKIN MOUNTAIN AT50,000-70,000 FEET. INITIAL ACQUISITION OF THECORRESPONDING LASER BEAMS (BLUE-GREEN ARGON LASERBEAM UPLINK, RED HELIUM-NEON LASER BEAM DOWNLINK)AND CONTINUOUS, CLOSED LOOP TRACKING OF THE SAMEIS REQUIRED WITHIN THE EXPERIMENTAL PROCEDURE.THE OPTIONAL COMMUNICATION MODES WILL INCLUDE A30-MEGABIT PSUDEO-RANDOM CODED DATA LINK. THEOBJECTIVES OF THE EXPERIMENT ARE: (1) EVALUATIONOF OPTICAL ACQUISITION AND TRACKING TECHNIQUES, ASWELL AS OPTICAL COMMUNICATIONS SYSTEMS PERFORMANCEIN AN AEROSPACE ENVIRONMENT, AND (2) DETERMININGTURBULENCE EFFECTS ON LASER BEAMS PROPAGATINGVERTICALLY THROUGH THE ATMOSPHERE.----

RTOP NO. 115-22-06 TITLE: OPTICAL COMMUNICATION FLIGHT EXPERIMENT (ATS-G)
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: RANDALL, J. L. TEL. 205-453-3770
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO DEVELOP AND IMPLEMENT A FLIGHT PROGRAM TO PROVE THE CONCEPT OF OPTICAL COMMUNICATION (OP/COM) IN SPACE USING SYNCHRONOUS AND LOW EARTH ORBITING SATELLITES. THIS WILL ALSO INCLUDE THE DEVELOPMENT OF COMPONENTS AND TECHNIQUES NECESSARY TO CARRY OUT THE FLIGHT EXPERIMENT PROGRAM. THE APPROACH WILL BE TO USE THE RESULTS OF PREVIOUS STUDIES (OCEP) ON OP/COM AND THE CURRENT AIRCRAFT OP/COM FLIGHT PROJECT TO DEVELOP AN INTEGRATED AND WELL PLANNED SATELLITE FLIGHT PROGRAM. FOREMOST IN FY72 IS THE INITIATION OF AN OP/COM EXPERIMENT FOR THE ATS-G SATELLITE. INCLUDED IN THE ATS-G OP/COM EXPERIMENT MUST BE THE EARLY DEVELOPMENT OF SPACE QUALIFIED HARDWARE NECESSARY TO IMPLEMENT THE PROGRAM. PLANNING FOR A LOW EARTH ORBIT OP/COM EXPERIMENT TO COMMUNICATE WITH THE ATS-G WILL BEGIN IN FY72.

RTOP NO. 115-22-08 TITLE: OPTICAL COMMUNICATIONS AND TRACKING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CARRION, W. J. TEL. 301-982-4942
TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS TECHNOLOGY OF COMPONENTS, SYSTEMS, AND OPERATIONAL TECHNIQUES FOR SPACECRAFT COMMUNICATION AND TRACKING WITH LASERS. OPTICAL TECHNOLOGY IS DIRECTED TOWARD SATISFYING NASA'S NEEDS FOR PRECISION TRACKING AND HIGH DATA RATE COMMUNICATION IN THE 1970 TO 1985 ERA. USING LATEST DEVELOPMENTS FROM CONTINUOUSLY CHANGING STATE-OF-THE-ART, PROOF-OF-CONCEPT MODELS OF LASER TRANSMITTERS, RECEIVERS, MODULATORS, AND TELESCOPES, ARE

DESIGNED AND CONSTRUCTED. PERFORMANCE OF COMPONENTS AND SYSTEMS IS MEASURED IN LABORATORY AND FIELD STATIONS UNDER CONDITIONS IN WHICH EFFECTS OF ENVIRONMENTAL PERTURBATIONS SUCH AS ATMOSPHERIC PROPAGATION, ACOUSTIC VIBRATION, AND SOLAR RADIATION BACKGROUND CAN BE STUDIED, LEADING TO THEORETICAL SYSTEMS ANALYSIS AND SELECTION OF OPTIMUM COMPONENTS AND PARAMETERS. PROTOTYPE TRACKING AND COMMUNICATION TERMINALS ARE DEVELOPED AND EMPLOYED IN EXPERIMENTS WITH SATELLITE EQUIPMENT SUCH AS PASSIVE REFLECTORS, LASER DETECTORS, AND RADIATING SOURCES, IN ORDER TO PROVE CONCEPTS AND PROVIDE BASELINE DATA FOR SPECIFIC APPLICATION DESIGNS. GSFC EMPHASIS IS ON DEVELOPMENT AND EVALUATION OF COMPLETE OPERATIONAL SYSTEMS NEEDED FOR SPACE LASER APPLICATIONS. FUNDAMENTAL RESEARCH IN DEVICES, COMPONENT OPERATION, CONTROL SYSTEMS, AND ENVIRONMENTAL PROPERTIES ARE PERFORMED WHEN NECESSARY FOR DIRECT SUPPORT OF SYSTEM DEVELOPMENT, TEST, AND ANALYSIS.

RTOP NO. 115-22-09 TITLE: FLIGHT TEST OF LARGE TELESCOPE (LARGE TELESCOPE TECHNOLOGY)
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: RANDALL, J. L. TEL. 205-453-3770
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM WILL DEVELOP A FLIGHT PROJECT TO PROVE THE TECHNOLOGY NEEDED FOR A THREE METER DIFFRACTION LIMITED OPTICAL SPACECONCEPT OF THE TELESCOPE AND TO PROVIDE AN OBSERVATIONAL TELESCOPE FOR SCIENTIFIC STUDY. LARGE DIFFRACTION LIMITED OPTICAL TELESCOPES REQUIRE MIRROR SURFACE ERRORS OF LESS THAN LAMBDA/50 RMS AND POINTING ERRORS OF LESS THAN 1/100 ARC SEC. SUCH EXTREME ACCURACY REQUIRES ACTIVE CONTROL OF THE PRIMARY MIRROR SURFACE AS WELL AS ACTIVE CONTROL OF OTHER OPTICAL COMPONENTS WITHIN THE TELESCOPE. THE FEASIBILITY OF CORRECTING TELESCOPE ERRORS THROUGH ACTIVE CONTROL HAS BEEN DEMONSTRATED IN THE LABORATORY. THE FOLLOWING AREAS OF TECHNOLOGY REQUIRE FURTHER DEVELOPMENT: FULLY AUTOMATIC OPERATION INTEGRATED POINTING AND ACTIVE OPTICS CONTROL RELIABILITY AND OPERATIONAL CONSIDERATIONS PROCEDURES FOR DESIGNING AND PREDICTING PERFORMANCE OF FULL-SCALE FLIGHT TELESCOPES. IT IS PLANNED IN THE COMING YEAR TO CONTINUE ANALYTICAL AND LABORATORY INVESTIGATIONS OF ACTIVE FIGURE CONTROL USING SEGMENTED AND FLEXIBLE MIRRORS INCLUDING THE DEVELOPMENT OF CONTROL SCHEMES, FIGURE SENSING TECHNIQUES, COMPUTER ALGORITHMS. THE OBJECTIVE IS TO IDENTIFY MAJOR DESIGN PARAMETERS AND SYSTEM SENSITIVITY TO THESE PARAMETERS.

RTOP NO. 115-23-10 TITLE: AUTOMATED DATA HANDLING TECHNIQUES AND COMPONENTS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SCHAEFER, D. H. TEL. 301-982-5184
TECHNICAL SUMMARY

OPERATIONAL EARTH RESOURCE MISSIONS WILL SENSE A VERY LARGE NUMBER OF IMAGES IN MANY SPECTRAL REGIONS. IT HAS BEEN ESTIMATED THAT SENSORS MAY BE RECEIVING INPUTS AT A TOTAL RATE EQUIVALENT TO 10 TO THE 12TH POWER BITS PER SECOND. IN ORDER TO EFFECTIVELY UTILIZE

THIS AVALANCHE OF INFORMATION, DATA REDUCTION ON-BOARD THE ANALYSIS OF DATA GENERATED IN EARTH RESOURCE MISSIONS. THE DEVELOPMENT OF THESE METHODS SHOULD ALSO ASSIST OTHER NASA MISSIONS INCLUDING MISSIONS AROUND PLANETS OTHER THAN THE EARTH. THREE PRINCIPAL AREAS WILL BE INVESTIGATED. THE FIRST AREA IS THE DEVELOPMENT OF HYBRID OPTICAL-DIGITAL METHODS OF PERFORMING DATA ANALYSIS. THIS WILL ALLOW THE ANALYSIS OF IMAGES IN A "PARALLEL" MANNER (I.E., WHERE NO SCANNING IS INVOLVED). THE SECOND AREA IS THE DEVELOPMENT OF ADVANCED DIGITAL METHODS OF PROCESSING DATA. THIS INCLUDES THE DEVELOPMENT OF MINIMAL PROGRAMMABLE COMPUTING DEVICES AS WELL AS THE DEVELOPMENT OF A MICRO-PROCESSOR COMPUTER.

RTOP NO. 115-23-20 TITLE: ADVANCED DIGITAL DATA SYSTEMS FOR DEEP SPACE
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE GOAL OF THE WORK IN THIS PLAN IS TO DEVELOP THE CONCEPTS AND TECHNOLOGY TO DESIGN AND BUILD CENTRALIZED SPACECRAFT DATA SYSTEMS TO PERFORM THE FUNCTIONS OF TIMING, SEQUENCING, CONTROL AND AUTOMATIC MAINTENANCE OF SPACECRAFT AS WELL AS ACQUISITION AND PROCESSING OF SCIENTIFIC AND ENGINEERING DATA. WORK IS PRIMARILY AIMED TOWARD PROJECTED MISSIONS TO THE OUTER PLANETS; FOR EXAMPLE, PREVIOUS WORK WILL BE EXTENSIVELY USED IN THE GRAND TOUR, ALTHOUGH IT WILL BENEFIT OTHER NASA PROGRAMS IN SPACE AND AERONAUTICS AND FIND APPLICATIONS ANYWHERE WHERE ADAPTABILITY AND UNATTENDED FAULT-FREE OPERATIONS ARE REQUIRED. MAJOR PROBLEMS ARE TO PROVIDE SUFFICIENT RELIABILITY TO GUARANTEE ALL CRITICAL FUNCTIONS FOR 10-20 YEAR LIFETIME AND TO PROVIDE FLEXIBILITY FOR AUTOMATIC ADAPTATION TO CHANGES IN ENVIRONMENT AND GROUND CONTROL OF RECONFIGURATION IN CASE OF CHANGES IN MISSION STRATEGY. THE OVERALL RATIONALE IS DESCRIBED IN JPL DIVISION 36 DOCUMENT "PLAN FOR SPACECRAFT-DATA-SYSTEM DEVELOPMENT" (REF. 1). FOR FY 72 THE TECHNICAL PLAN IS A CONTINUATION OF WORK NOW IN PROGRESS AND CONSISTS OF: (1) CONTINUED DEVELOPMENT OF FAULT-TOLERANT COMPUTER TECHNIQUES AND THE SELF-TESTING-AND-REPAIRING (STAR) COMPUTER AND IN TURN ITS USE TO MAKE THE OTHER SPACECRAFT SUBSYSTEMS FAULT-TOLERANT; (2) DEVELOPMENT OF SPACECRAFT DATA-PROCESSING AND COMPRESSION ALGORITHMS AND FURTHER DEVELOPMENT OF THE COMPUTER AIDED TELEMETRY SYSTEM; (3) FURTHER DEVELOPMENT OF LARGE SCALE INTEGRATION TECHNOLOGY USING CHARGE STORAGE TRANSISTORS FOR MEMORY AND ADAPTIVE LOGIC TOGETHER WITH HIGH DENSITY STORAGE USING THIN MANGANESE-BISMUTH FILMS; AND (4) DEVELOPMENT OF MATHEMATICAL SYNTHESIS TECHNIQUESFOR OPTIMUM SPACECRAFT DATA SYSTEMS----

RTOP NO. 115-23-30 TITLE: CENTRAL MULTIPROCESSOR AND MAN/MACHINE TECHNIQUES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: WELDON, J. W. TEL. 713-483-4065
TECHNICAL SUMMARY

THE PRESENT CONCEPT OF A SPACE STATION/BASE AS A PERMANENT

FACILITY (10 YEAR LIFE) IMPLIES SELF-CONTAINED AUTONOMOUS OPERATIONS. THIS REQUIRES PERFORMING ONBOARD FUNCTIONS WHICH WERE PREVIOUSLY PERFORMED ON THE GROUND SUCH AS STATUSING OPERATIONS, INTEGRATED SUBSYSTEM CHECKOUT, PROCESS CONTROL, AND SCIENTIFIC DATA EDITING AND PROCESSING. THE ONBOARD COMPUTATIONAL CAPABILITY REQUIRED TO ACCOMPLISH THESE FUNCTIONS ONBOARD GREATLY EXCEEDS ANY PREVIOUS FLIGHT COMPUTATIONAL REQUIREMENTS. THE DESIGN AND DEVELOPMENT OF A HIGH CAPACITY, HIGH SPEED, FAULT TOLERANT, SPACE FLIGHT MULTIPROCESSOR COMPUTER SYSTEM TO PERFORM THE ONBOARD COMPUTATIONS IS RECOGNIZED AS A CRITICAL TECHNOLOGY AREA. TO ASSURE THE AVAILABILITY OF THIS CRITICAL TECHNOLOGY, THIS EFFORT WILL RESULT IN THE DEVELOPMENT OF MAN/MACHINE M/P COMMUNICATIONS TECHNIQUES, THE DESIGN OF AN AEROSPACE MULTIPROCESSOR, AND THE AVAILABILITY OF MULTICOMPUTER SYSTEM FOR IN-HOUSE EVALUATION OF PRELIMINARY MULTIPROCESSOR CONCEPTS AND APPLICATIONS. THIS RTOP (115-23-30) IS A CONTINUATION OF RTOP (125-23-15) ACTIVITY STARTED IN FY-71. THE MAN/MACHINE COMMUNICATIONS TECHNIQUES STUDY WILL PROVIDE A DISPLAY DEVICE CAPABLE OF PRESENTING THE WIDE VARIETY OF ALPHANUMERIC/GRAPHIC DATA REQUIRED ON A SPACE STATION. THE ADDITIONAL MEMORY REQUIRED FOR FULL GRAPHIC CAPABILITIES AND THE SOFTWARE NECESSARY TO COMMUNICATE WITH THE CENTRAL MULTIPROCESSOR. THE BUFFER I/O SYSTEM WHICH WILL INTERFACE WITH EXTERNAL MEMORY OF THE MULTIPROCESSOR/MULTICOMPUTER SYSTEM IS TO BE EVALUATED IN ITS ABILITY TO DETECT ERROR, RECOVER FROM FAULTS AND HANDLE SYNCHRONOUS/ASYNCHRONOUS COMPUTER I/O OPERATIONS.

RTOP NO. 115-23-31 TITLE: ADVANCED COMPUTER SYSTEM TECHNIQUES FOR DATA MANAGEMENT SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: MARLOWE, G. D. TEL. 713-483-6196

TECHNICAL SUMMARY

THE INCREASED AUTONOMY REQUIREMENTS FOR THE SPACE SHUTTLE HAVE SIGNIFICANTLY INCREASED THE ROLE OF ONBOARD COMPUTERS. THE RESULTANT INCREASED COMPLEXITY OF THE ONBOARD SYSTEMS REQUIRES THAT ADDITIONAL EMPHASIS BE PLACED UPON THE COMPUTER OPERATING SYSTEM DESIGN AND VERIFICATION TO ASSURE DELIVERY WITHIN SHUTTLE SCHEDULES AND COST OBJECTIVES. THIS OBJECTIVE CAN ONLY BE ACHIEVED BY RECOGNIZING THE INTER-DEPENDENCE OF HARDWARE, THE COMPUTER SYSTEM AND FUNCTIONAL SYSTEM APPLICATIONS. THE OBJECTIVE OF THIS EFFORT IS TO PROVIDE THE NECESSARY EMPHASIS ON THE TOTAL SYSTEM DESIGN AND VERIFICATION TO ASSURE THAT THIS INTER-DEPENDENCE IS ACCOUNTED FOR IN THE FINAL SHUTTLE SYSTEM. THE STUDY APPROACH INCLUDES THE UTILIZATION OF FY-70 AND FY-71 TECHNOLOGY EFFORTS. THIS WILL BE ACCOMPLISHED BY EVALUATING THE TWO EXECUTIVE DESIGNS PROVIDED UNDER FY-71 FUNDING AND SELECTING THE OPTIMUM APPROACH WHICH IS CONSISTENT WITH THE AVIONICS HARDWARE CONFIGURATION AT THE TIME OF CONTRACT AWARD. DETAILED SPECIFICATIONS WILL BE ESTABLISHED. USING THE FY-71 VERIFICATION STUDIES AS A BASELINE, A MASTER VERIFICATION PLAN WILL BE GENERATED WHICH WILL INCLUDE VERIFICATION PHASES, HARDWARE, FACILITIES AND CONFIGURATION MANAGEMENT PLANNING.

RTOP NO. 115-23-40 TITLE: SPACE STATION OPTICAL MASS MEMORY SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER,
MONITOR: BAILEY, G. A. TEL. 205-453-3770
TECHNICAL SUMMARY

A MASS MEMORY SYSTEM IS REQUIRED FOR THE SPACE STATION/SPACE BASE SYSTEM OF 1976 THAT COMPLETELY DWARFS EXISTING SYSTEMS IN TERMS OF CAPACITY, SPEED, POWER REQUIREMENTS, SIZE, ETC. IT WOULD BE A RANDOM ACCESS, READ-WRITE MEMORY OF 10 TO THE 12TH POWER BITS CAPACITY WITH NO MOVING PARTS. IT HAS LONG BEEN KNOWN THAT FOR MEMORIES OF THIS CAPACITY, TO KEEP OTHER PARAMETERS REASONABLE, EITHER SOME OPTICAL OR ELECTRON BEAM TECHNIQUE WOULD BE EMPLOYED. THE READ-WRITE REQUIREMENT OBVIATES THE USE OF E-BEAM TECHNOLOGY SINCE THERE IS NO KNOWN MEANS OF STORING BY E-BEAMS IN AN ERASABLE MEDIUM. ADDITIONALLY, THE SUCCESS OF AN OPTICAL SYSTEM WOULD DEPEND UPON THE EFFICIENT INTERACTION OF THE LIGHT SOURCE, THE ACCESSION SYSTEM, THE INPUT-OUTPUT SYSTEM, AND THE STORAGE MEDIUM. OPTICAL MEMORY SYSTEMS IN THE PAST HAVE FAILED DUE TO ONE OR MORE OF THE ABOVE FACTORS. FOR INSTANCE, THE STORAGE MEDIUM MUST HAVE VERY HIGH DATA STORAGE DENSITY IF VERY LARGE CAPACITIES ARE STORED WITHIN REASONABLE DIMENSIONS. PAST SYSTEMS HAVE REQUIRED A PERFECT STORAGE MEDIUM TO KEEP BIT ERROR RATES LOW. HOWEVER, IF STORAGE IS IMPLEMENTED BY HOLOGRAPHIC MEANS, A PERFECT MEDIUM IS NOT REQUIRED. IN ADDITION, BY STORING THE INFORMATION IN TWO STEPS (COMPOUND ADDRESSING) THE HIGH RESOLUTION OF HOLOGRAPHIC RECORDING CAN BE MAINTAINED. SEVERAL YEARS OF EFFORT HAVE BEEN DEVOTED BY INDUSTRY ON THE DEVELOPMENT OF LASER SYSTEMS, BEAM DEFLECTION SYSTEMS, HOLOGRAPHIC TECHNIQUES, RECORDING MATERIALS, LARGE PHOTODETECTOR ARRAYS, AND LIGHT MODULATORS. MOST OF THIS WORK WAS DONE INDEPENDENTLY ON EACH OF THESE COMPONENTS AND ONLY RECENTLY HAS IT BEEN POSSIBLE TO DISCUSS THE FEASIBILITY OF COMBINING TECHNIQUES TO OBTAIN ALARGE STORAGE/FAST ACCESSION SYSTEM----

RTOP NO. 115-24-01 TITLE: HIGH TEMPERATURE SENSORS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP MEASUREMENT TECHNIQUES AND INSTRUMENTATION TO DETERMINE THE EFFECT OF THE REENTRY ENVIRONMENT ON STRUCTURES USED IN THE SPACE SHUTTLE. SPECIFIC EFFORTS WILL BE MADE TO DEVELOP HEAT TRANSFER SENSORS, STRAIN MEASUREMENTS WITH EXTENDED UPPER TEMPERATURE PERFORMANCE, AND DYNAMIC DISPLACEMENT MEASUREMENT TECHNIQUES FOR ANALYZING THE PERFORMANCE OF VARIOUS PANEL DESIGNS UNDER BOTH VIBRATION AND THERMAL LOADS. THIS WORK IS ESSENTIAL TO THE DEVELOPMENT OF EFFICIENT LOAD BEARING STRUCTURES WHICH MEET AERODYNAMIC REQUIREMENTS AND CAN WITHSTAND REPEATED HIGH-TEMPERATURE EXPOSURE WITHOUT IMPOSING SEVERE WEIGHT PENALTIES ON THE VEHICLE.

RTOP NO. 115-24-02 TITLE: SPACE SHUTTLE: HIGH SPECIFICITY GAS ANALYSIS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L.TES TEL. 415-961-2286
TECHNICAL SUMMARY

INSTRUMENTATION WILL BE DEVELOPED TO DETECTGASEOUS CONTAMINATS IN SPACE SHUTTLE CABINATMOSPHERES WITH THE REQUIRED SENSITIVITY ANDSPECIFICITY. A PROGRAM HAS BEEN UNDERWAY AT AMESBOTH IN-HOUSE AND THROUGH A CONTRACTOR, TODEVELOP ONE TYPE OF SUCH INSTRUMENTATION BASED ONNEW CONCEPTS IN THE AREA OF NON-DISPERSIVEINFRARED ANALYSIS (NDIR). IN ADDITION TODEVELOPING A FLIGHT-QUALIFIED INSTRUMENT,FUNDAMENTAL STUDIES OF THE TECHNIQUE WILLCONTINUE WITH THE AIM OF INCREASING SENSITIVITYAND APPLICABILITY. THE SPACE SHUTTLE WILL INVOLVEA CLOSED SYSTEM IN WHICH HUMAN BEINGS MUST LIVE ININTIMATE CONTACT WITH A NUMBER OF COMPLEX CHEMICALCOMPOUNDS. YEARS OF EXTENSIVE TESTING HAVEELIMINATED, HOPEFULLY, ALL OF THE HAZARDOUSCOMPOUNDS WHICH COULD BE EXPECTED IN THESPACECRAFT STRUCTURE AND SYSTEMS UNDER NORMALCONDITIONS. HOWEVER, NORMAL CONDITIONS CANNOT BEGUARANTEED IN SPACE MISSIONS. FOR THIS REASON ANUMBER OF POSSIBILITIES ARE BEING EXPLORED TOEXAMINE THE TOXIC HAZARDS TO BE EXPECTED IN ACONDITION OF MALFUNCTION. SEVERAL CHEMICALCOMPOUNDS HAVE BEEN IDENTIFIED AS BEING----

RTOP NO. 115-24-03 TITLE: STUDY OF A VEHICLE STATUS AND MONITORING SYSTEM CONCEPT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: LOVE, J. E. TEL. 805-258-3311
TECHNICAL SUMMARY

A STATE-OF-THE-ART SYSTEM DESIGNED FOR MONITORING AND CONTINUOUS INFLIGHT RECORDING OF PARAMETERS WHICH DETERMINE THE OPERATIONAL STATUS OF A VEHICLE WILL BE FLIGHT TESTED IN A HIGH PERFORMANCE JET AIRCRAFT. AFTER EACH FLIGHT, A QUICK ANALYSIS IS PERFORMED BY COMPUTER PROCESSING OF THE DIGITIZED MAGNETIC FLIGHT TAPE. OPERATIONAL DISCREPANCIES ARE DETECTED AND IDENTIFIED WHEN SENSED QUANTITIES EXCEED PREDETERMINED THRESHOLDS AS INSERTED INTO THE COMPUTER FOR ANALYSIS. THE TAPE ALSO SERVES AS A HISTORY OF OPERATION FROM WHICH PREDICTIONS OF MALFUNCTION OR FAILURE CAN BE MADE FROM LONG-TERM (SEVERAL HUNDRED HOURS OF FLIGHT) PARAMETRIC TREND ANALYSIS. THE FLIGHT EXPERIENCE AND DATA ACCUMULATED WILL PROVIDE BASIC INFORMATION FOR SYSTEM REQUIREMENTS FOR THE SPACE SHUTTLE VEHICLE TO ACHIEVE SHORT TURNAROUND TIME BY AUTOMATIC SYSTEM TESTING, FAULT LOCATION, AND CHECKOUT. THE OBJECTIVE IS ALSO TO DEMONSTRATE THE ABILITY TO REFLY THE ENGINE-INLET SYSTEM BASED UPON DATA FROM THE LAST FLIGHT WITH LITTLE OR NO FORMAL GROUND PREFLIGHT OF THAT SYSTEM.

RTOP NO. 115-24-04 TITLE: INSTRUMENTATION/SENSORS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: ALEXANDER, J. D. TEL. 713-483-3466
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO DEVELOP THE TECHNOLOGY, DESIGN, AND FABRICATE A PROTOTYPE SYSTEM, AND TO PERFORM EVALUATION TESTS OF A ZERO G LIQUID QUANTITY GAUGING SYSTEM THAT IS SUITABLE FOR USE ON THE SPACE SHUTTLE. THE PROBLEM OF GAUGING A LIQUID IN ZERO G IS ONE OF EITHER PRODUCING AN ARTIFICIAL GRAVITY BY ACCELERATION AND USING MORE CONVENTIONAL METERING, WHICH USES MORE PROPELLANT, OR USAGE CALCULATIONS WHICH CANNOT ACCOUNT FOR LOSSES DUE TO FAILURE OR MALFUNCTION. AN INHOUSE STUDY AND EVALUATION OF GAUGING SYSTEM TECHNIQUES CONCLUDED THAT THE NUCLEAR ABSORPTION TECHNIQUE WAS THE MOST PROMISING. THIS METHOD WILL INHERENTLY PROVIDE TOTAL MASS MEASUREMENT OF ANY SUBSTANCE REGARDLESS OF ITS PHYSICAL PHASE (SOLID, LIQUID, OR GAS). FOR THE SPACE SHUTTLE, THE MAXIMUM TANK SIZE THAT CAN BE METERED BY THIS TECHNIQUE IS DETERMINED BY THE ABSORPTION COEFFICIENTS OF THE PROPELLANT, DETECTOR DYNAMIC RANGE, AND SOURCE STRENGTH CONSIDERATIONS. LIQUID OXYGEN (LOX) TANKS ARE RESTRICTED TO A DIAMETER OF 10 FEET OR LESS WITH PRESENT TECHNIQUES AND SOURCE STRENGTH LIMITATIONS. FURTHER, THE TEMPERATURE RANGE OVER WHICH THE DETECTORS MUST PERFORM MAKES PRESENT MATERIALS MARGINAL IN THEIR PERFORMANCE. RECENTLY COMPLETED MATERIALS RESEARCH INDICATES THAT THE MATERIALS AND TECHNIQUES ARE AVAILABLE, AND A NEAR OPTIMUM DETECTOR CAN BE DEVELOPED WITHIN THE TIME SCHEDULES. AT LEAST TWO METHODS OF DEVELOPING VARIABLE INTENSITY SOURCES ARE AVAILABLE TO SOLVE THE PROBLEM OF HIGH DENSITY PROPELLANT PENETRATION WITHOUT EXCEEDING THE DETECTOR'S DYNAMIC RANGE OR POSING A RADIATION HAZARD TO THE CREW OR SERVICE PERSONNEL WHEN THE TANKS ARE EMPTY.

RTOP NO. 115-24-05 TITLE: SHUTTLE SENSORS & INSTRUMENTATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ESCUE, W. T. TEL. 205-453-4626
TECHNICAL SUMMARY

THE TECHNOLOGY BEING CONDUCTED IN THE AREAS OF AIR DATA SENSORS, ZERO "G" QUANTITY MEASUREMENT AND PROPELLANT UTILIZATION/LOADING SENSORS IS AN EXTENSION OF WORK BEING CONDUCTED UNDER RTOP 125-24-19, SHUTTLE SENSORS AND INSTRUMENTATION. THIS TECHNOLOGY HAS THE OBJECTIVE OF MEETING THE SHUTTLE OPERATING REQUIREMENTS FOR THESE VITAL MEASUREMENTS. GAS ANALYSIS INSTRUMENTATION FOR THE SHUTTLE ENVIRONMENTAL CONTROL SYSTEM WILL BE PURSUED FOR 02 AND C02 ALONG WITH TOXIC GAS DETECTION AND ABORT SITUATIONS FOR H2, NO, CO, CH4 ETC. THE APS ENGINE TESTING WILL REQUIRE A MASS FLOW DEVICE CAPABLE OF MEASURING 02 AND H2 FLOW FOR PULSE WIDTHS OF 50 MILLISECONDS. THIS INSTRUMENT IS VERY VITAL TO APS ENGINE AND CONTROL SYSTEM EVALUATION.

RTOP NO. 115-24-06 TITLE: ADVANCED IMAGING SYSTEMS TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE LONG TERM OBJECTIVE OF THIS RTOP IS THE DEVELOPMENT OF IMAGING SYSTEM ENABLING TECHNOLOGY TO MEET THE ANTICIPATED REQUIREMENTS OF FUTURE PLANETARY IMAGING MISSIONS. THE GENERAL APPROACH INCLUDES THE STUDY OF FUTURE MISSIONS AS A SOURCE FOR THE POSTULATION OF FUTURE IMAGING REQUIREMENTS, THE STUDY OF CURRENT AND PROJECTED IMAGING TECHNOLOGY AS A MEANS OF ESTABLISHING A STATE OF THE ART BASELINE, AND THE IMPLEMENTATION OF SPECIFIC TECHNOLOGY DEVELOPMENT TASKS TO PROVIDE THE DESIRED ENABLING TECHNOLOGY. WHILE THE PURPOSE OF THIS RTOP IS TO PROVIDE FOR LONG TERM REQUIREMENTS, CONSIDERATION WILL BE GIVEN TO DIVERTING THE EFFORT, ON AN INTERIM BASIS, TO MEET CRITICAL NEAR TERM REQUIREMENTS. THE CURRENT EFFORT IS DEVOTED TO MEETING SUCH A REQUIREMENT, NAMELY, THE DEVELOPMENT OF SILICON SENSOR TECHNOLOGY TO ATTEMPT TO MEET THE NEEDS OF THE OUTER PLANET MISSIONS IN THE MIDDLE AND LATE 1970'S. THE BASIS FOR THE DEVELOPMENT OF SILICON SENSOR TECHNOLOGY IS REPORTED IN JPL DOCUMENT NO. 701-94, ADVANCED IMAGING SYSTEMS TECHNOLOGY STUDY, DATED SEPTEMBER 30, 1970. THIS REPORT POINTS OUT THE ABSENCE OF AVAILABLE TECHNOLOGY TO MEET THE SENSOR NEEDS OF THE OUTER PLANET MISSIONS, PARTICULARLY IN THE AREAS OF SENSITIVITY AND LONG LIFE. THE RECOMMENDATION WAS MADE, AND HAS BEEN IMPLEMENTED, TO INITIATE DEVELOPMENT OF THE NECESSARY ENABLING TECHNOLOGY BY MEANS OF A SENSOR DEVELOPMENT CONTRACT. THE EFFORT INCLUDES DEVELOPMENT OF SILICON TARGETS WHICH WILL SURVIVE TEMPORARY EXPOSURE TO THE JUPITER RADIATION BELTS, AND THE DESIGN, DEVELOPMENT, AND TEST OF EXPERIMENTAL SILICON VIDICONS AND SILICON INTENSIFIER VIDICONS.

RTOP NO. 115-24-07 TITLE: ASTRONOMICAL INSTRUMENTATION AND IMAGE RECORDING SYSTEMS FOR HIGH PERFORMANCE AND DIFFRACTION LIMITED SPACE TELESCOPES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: DUNKELMAN, L. TEL. 301-982-4988
TECHNICAL SUMMARY

THE PURPOSE OF THIS EFFORT IS TO DEVELOP HIGH PERFORMANCE OPTICAL IMAGE RECORDING SYSTEM(S) FOR ADVANCED ASTRONOMICAL SPACE TELESCOPES. IN ORDER TO REALIZE THE OBSERVATIONAL POTENTIAL OF THE LARGE SPACE TELESCOPE, CURRENT TECHNOLOGY MUST BE MODIFIED, EXTENDED, AND IMPROVED TO PROVIDE THE FULL RANGE OF DETECTORS REQUIRED. THIS RTOP PROVIDES THE FRAMEWORK FOR THAT TASK. EMPHASIS IS PLACED ON ELECTRO-OPTICAL DETECTION TECHNIQUES IN ORDER TO PROVIDE HIGH QUANTUM DETECTIVITY, DESIRED SPECTRAL RESPONSE AND THE CAPABILITY OF ELECTRONIC READOUT. OTHER CHARACTERISTICS SUCH AS RESOLUTION, FORMAT, MAGNIFICATION, AND IMAGE CONTROL MUST BE MATCHED TO SPACE TELESCOPE INSTRUMENTATION REQUIREMENTS WHICH ARE BEING DEVELOPED SIMULTANEOUSLY. THESE TECHNIQUES IN CONJUNCTION WITH REAL-TIME IMAGE PROCESSING ARE USED TO ENHANCE THE SYSTEM PERFORMANCE AND INCREASE THE DESIGN CAPABILITY OF THE SPACE TELESCOPES.

RTOP NO. 115-24-08 TITLE: SOLID STATE SENSORS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, JR., G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP AN ADVANCED SOLID-STATE SENSOR TECHNOLOGY AND SENSORS FOR SPECIFIC AEROSPACE MEASUREMENT REQUIREMENTS. SOLID-STATE TECHNIQUES WILL BE USED WHICH PROVIDE CLEAR ADVANTAGES OVER EXISTING METHODS, FOR EXAMPLE, SMALLER SIZE, HIGHER RELIABILITY, AND GREATER SENSITIVITY. SPECIFIC EFFORTS INCLUDE RADIATION DOPED PHOTODETECTORS WITH EXTENDED INFRARED RESPONSE, NEW METAL ALLOY STRAIN SENSORS FOR USE ON HIGH TEMPERATURE STRUCTURES, PRESSURE AND HUMIDITY SENSORS WITH IMPROVED SENSITIVITY CHARACTERISTICS, AND GAS SENSORS BASED ON GAS-SOLID SURFACE REACTIONS. NEW DESIGN CONCEPTS INCORPORATING PHOTODETECTOR ARRAYS WILL BE USED TO IMPROVE THE SPATIAL RESOLUTION AND TO ADD SPECTROMETRIC CAPABILITY TO THE IMAGING SYSTEMS NEEDED FOR FUTURE PLANETARY MISSIONS (VIKING). SUCH IMPROVEMENTS WOULD SIGNIFICANTLY INCREASE THE SCIENTIFIC RETURN FROM MISSIONS TO MARS AND OTHER PLANETS.

RTOP NO. 115-24-09 TITLE: LASERS FOR REMOTE SENSING AND OPTICAL DATA PROCESSING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE BASIC OBJECTIVE OF THIS RESEARCH IS TO DEVELOP LASER TECHNOLOGY WHICH RELATES TO NASA RESEARCH PROGRAMS AND REQUIREMENTS IN ACTIVE REMOTE SENSING OF EARTH AND PLANETARY ENVIRONMENTS; OPTICAL RANGING AND ALTIMETRY; AND OPTICAL DATA PROCESSING AND STORAGE TECHNIQUES. TECHNOLOGY AREAS TO BE INVESTIGATED ARE: (1) TUNABLE DYE LASERS FOR USE IN LASER RADAR SCATTERING MEASUREMENTS OF CONSTITUENT AND POLLUTANT DISTRIBUTIONS IN THE ATMOSPHERE AND IN BODIES OF WATER; (2) CONTINUOUSLY TUNABLE PARAMETRIC DEVICES FOR USE IN RESONANCE ABSORPTION AND FLUORESCENCE STUDIES OF ATMOSPHERIC CONSTITUENTS; (3) AN AIRBORNE HYDROGRAPHIC LASER RADAR SYSTEM FOR MEASUREMENT OF OCEAN DEPTH, FERTILITY, AND TURBIDITY; AND (4) JUNCTION LASERS WITH IMPROVED PERFORMANCE FOR USE IN SPECTROSCOPIC INSTRUMENTATION; OPTICAL RANGING; AND OPTICAL DATA PROCESSING SYSTEMS WHERE SMALL SIZE, COHERENCE, EFFICIENCY, AND RELIABILITY ARE PRIMARY CONSTRAINTS. IMPROVEMENTS IN POWER OUTPUT AND NEAR UV PERFORMANCE OF TUNABLE DYE LASERS WILL BE ACHIEVED THROUGH DEVELOPMENT OF SPECIAL DYES AND FREQUENCY DOUBLING TECHNIQUES. PARAMETRIC OSCILLATOR AND AMPLIFIER TECHNIQUES EMPLOYING NEW NONLINEAR CRYSTALS WILL BE INVESTIGATED TO EXTEND LASER EMISSION INTO THE INFRARED REGIME. THE DEVELOPMENT OF AN AIRBORNE HYDROGRAPHIC LASER SYSTEM WILL INVOLVE THE INVESTIGATION OF DYE LASER LIGHT PROPAGATION AND PHYTOPLANKTON INDUCED FLUORESCENCE YIELDS IN SEAWATER, SYSTEM DESIGN OPTIMIZATION, AND SUBSEQUENT FABRICATION AND TESTING OF A PROTOTYPE HYDROGRAPHIC LASER SYSTEM. IMPROVEMENTS IN JUNCTION LASER TECHNOLOGY WILL EVOLVE THROUGH THE INVESTIGATION AND DEVELOPMENT OF NEWHETEROJUNCTION MATERIALS AND DEVICES WITH BAND----

RTOP NO. 115-25-01 TITLE: ELECTRONIC MATERIALS, COMPONENTS, AND PROCESSES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

EFFORTS WILL BE UNDERTAKEN ON SELECTED AREAS OF ELECTRONIC MATERIALS RESEARCH, COMPONENT DEVELOPMENT, AND PROCESSING TECHNIQUES FOR ADVANCED DEVICES AND CIRCUITS. EMPHASIS IS PLACED ON PROVIDING TECHNOLOGY FOR UNIQUE AERONAUTICAL AND SPACE MISSION NEEDS WHICH ARE NOT LIKELY TO BE MET BY RESEARCH NORMALLY CARRIED OUT BY INDUSTRY. CONTRACTUAL RESEARCH EFFORTS ARE UTILIZED FOR MAJOR PORTIONS OF THIS WORK; HOWEVER, RELATED LABORATORY RESEARCH AND EVALUATION PROGRAMS ARE UNDERTAKEN IN-HOUSE. CURRENT EFFORT ON ELECTRONIC MATERIALS INCLUDES RESEARCH ON EPITAXIAL FERROMAGNETIC GARNETS FOR MEMORY APPLICATIONS, GALLIUM NITRIDE FOR ELECTROLUMINESCENT USES, AND BORON ARSENIDE AND BORON PHOSPHIDE TO MEET HIGH-TEMPERATURE REQUIREMENTS. COMPONENT DEVELOPMENT INCLUDES A TWO-COLOR INTEGRATED ARRAY OF LIGHT-EMITTING DIODES FOR DISPLAY APPLICATIONS, ION-IMPLANTED GAAS MICROWAVE AMPLIFIERS FOR OPERATION AT 10 TO 20 GHZ, AND CHARGE-COUPLED DEVICES FOR STORAGE AND DATA TRANSFER APPLICATIONS. RESEARCH ON ADVANCED PROCESSING TECHNIQUES INCLUDES DIFFUSION METHODS FOR SHIELDED GATE COMPLEMENTARY MOS STRUCTURES TO ACHIEVE IMPROVED PERFORMANCE HIGH-DENSITY CIRCUITS, METALLIZATION AND INTERCONNECTION METHODS TO MEET ENVIRONMENTAL REQUIREMENTS, AND THE USE OF ION IMPLANTATION FOR BOTH DOPING AND DIAGNOSTIC ANALYSIS OF SOLID STATE MATERIALS TO BE USED IN HIGH-RELIABILITY APPLICATIONS.

RTOP NO. 115-25-02 TITLE: DESIGN, PROCESSING AND TESTING OF LSI ARRAYS FOR SPACE STATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ANDERSON, D. L. TEL. 205-453-3770
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS DIRECTED TOWARD DEVELOPING THE TECHNOLOGY AND TECHNIQUESFOR THE DESIGN, FABRICATION AND TESTING OF LARGE SCALE INTEGRATED CIRCUIT ARRAYS. THIS ENCOMPASSES THE DESIGN, DEVELOPMENT AND IMPLEMENTATION OF AUTOMATIC TEST EQUIPMENT INCLUDING COMPUTER SOFTWARE TO PERFORM DYNAMIC AS WELL AS FUNCTIONAL TESTS ON LSI ARRAYS. INHERENT IN THESE BROAD OBJECTIVES IS THE MAXIMUM USE OF AN IN-HOUSE XDS SIGMA 5 COMPUTER FACILITY TO DEVELOP AND APPLY CAD (COMPUTER AIDED DESIGN) TECHNIQUES TO SUCH LSI PROBLEMS AS LOGIC SIMULATION, CIRCUIT LAYOUT AND SYSTEM ANALYSIS. SPECIAL EMPHASIS WILL BE GIVEN TO FACILITATE THE COMPUTER OPERATIONS FOR THE USER AND INTERACTIVE GRAPHICS WILL BE EMPLOYED WHEREVER FEASIBLE. PROCESS TECHNOLOGY DEVELOPMENT WILL BE PURSUED IN THE PROMISING AREAS WHERE NEED EXISTS. FOR INSTANCE, THE APPLICATION OF BEAM LEADS TO MOS DEVICES IS AN IMMEDIATE SOLUTION TO THE PASSIVATION AND INTERCONNECTION PROBLEM. SIMILARLY THE SILICON-ON-SAPPHIRE INTEGRATED CIRCUITS AND MNOS DEVICES PROVIDE A GREAT AMBIENT OF POTENTIAL. THE GENERAL APPROACH TO IMPLEMENTING THIS PROGRAM WILL BE BASED FIRST ON DEVELOPING AND UTILIZING NEW LSI TECHNOLOGY THAT PROMISES TO BE USEFUL IN FUTURE NASA MISSIONS. COMPUTER AIDED DESIGN AND TESTING PROGRAMS WILL BE DEVELOPED TO

COMPLEMENT NEW LSI TECHNOLOGY.

RTOP NO. 115-25-03 TITLE: SCREENING AND RELIABILITY TESTING OF MICROCIRCUITS AND ELECTRONIC PARTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER,
MONITOR: HAMITER, L. C. TEL. 205-453-3986
TECHNICAL SUMMARY

TO DEVELOP EFFECTIVE PROCEDURES FOR ECONOMICAL QUALIFICATION AND RELIABILITY ASSURANCE OF LARGE SCALE INTEGRATED CIRCUITS (LSI) AND OTHER MICROELECTRONIC DEVICES THAT ARE SELECTED FOR USE IN FUTURE PROGRAMS. THIS WILL ENCOMPASS STUDYING AND UNDERSTANDING THE DESIGN, FAILURE MECHANISMS, CRITICAL PROCESSES, WORKMANSHIP AND APPLICATION CAPABILITY OF LSI, SOLID STATE RELAYS, PHOTOMULTIPLIERS, AND OTHER MICROELECTRONIC DEVICES SO EFFECTIVE PROCEDURES AND CRITERIA CAN BE ESTABLISHED FOR SCREENING, INSPECTION AND TESTING. ALL ASPECTS OF LSI CIRCUIT DESIGN AND MANUFACTURE; FROM BASIC SILICON MATERIAL THROUGH JUNCTIONS, METALLIZATION, INTERCONNECTION, PACKAGING AND APPLICATION, MUST BE CONSIDERED TO ASSURE ACCEPTABLE END ITEM RELIABILITY. THESE ACTIVITIES WILL BE DIRECTED IN A MANNER TO PROVIDE RELIABILITY ASSURANCE FOR THE WIDEST SELECTION OF DEVICES NECESSARY FOR THE DESIGN ENGINEERS TO DEVELOP THE MOST ADVANCED MICROELECTRONICS SYSTEMS. THE FIRST APPROACH WILL ASSURE COVERAGE FOR BEAM LEADED MOS AND BIPOLAR CHIPS BEING DEVELOPED AND PACKAGED WITH HYBRID TECHNIQUES, BOTH OF WHICH ARE COVERED UNDER RTOP 115-25-02. BACK UP APPROACHES WILL PROVIDE COVERAGE FOR DEVICES OF LESSER INTEGRATION USING FLYING LEADS AND CONVENTIONAL PACKAGING.

RTOP NO. 115-25-04 TITLE: ELECTRONIC COMPONENT PACKAGING AND INTERCONNECTION R&D
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE LONG TERM GOAL OF THIS RTOP IS TO DEVELOP ELECTRONIC PACKAGING AND INTERCONNECTION TECHNOLOGY THAT WILL ENABLE THE EFFECTIVE PERFORMANCE OF ADVANCED MISSIONS BY JPL AND OTHER NASA CENTERS. THE FY'72 OBJECTIVE IS CONSTRAINED TO THAT OF DEVELOPING A COMPREHENSIVE PLAN FOR THE CONTINUING JPL ELECTRONIC PACKAGING AND INTERCONNECTION R&D PROGRAM. THE TASK WILL: 1) DEVELOP CRITERIA FOR ASSESSING THE PRIORITIES OF SPECIFIC R&D TASKS AND SUPPORT FUNCTIONS, 2) IDENTIFY NEEDED ACTIVITIES, INDICATING THOSE WHICH ARE SUITABLE FOR OART R&AD SPONSORSHIP AND THOSE WHICH ARE MORE OF A SUPPORTING NATURE AND SHOULD BE OTHERWISE FUNDED, 3) PREPARE AND SUBMIT TO OART AN FY'73 RTOP DIRECTED TOWARD ACCOMPLISHMENT OF A LIMITED NUMBER OF THE MOST SIGNIFICANT ADVANCED DEVELOPMENT TASKS, AND 4) INDICATE THE RELATIONSHIP OF PROPOSED WORK TO POSSIBLE ADVANCED MISSIONS, TO OTHER WORK AT JPL, AND TO ELECTRONIC PACKAGING ACTIVITIES AT OTHER NASA CENTERS. IN CONNECTION WITH ITEM 1, IT IS BELIEVED POSSIBLE TO DEVELOP CRITERIA BASED ON COST EFFECTIVENESS. FOR EXAMPLE, ONE CAN DERIVE APPROXIMATE PROJECT COSTS PER UNIT SPACECRAFT WEIGHT AND THUS EVALUATE THE SIGNIFICANCE OF IMPROVEMENTS IN PACKAGING EFFICIENCY.

ONE CAN ALSO OBTAIN DATA ON COSTS OF REPACKAGING EQUIPMENT TO REMEDY DESIGN DEFECTS. IT IS NOT THE PURPOSE OF THIS DISCUSSION TO ANTICIPATE THE RESULT OF THE PLANNING ACTIVITY. IT WILL BE AN IN-HOUSE TASK, DRAWING INFORMATION FROM MATERIALS AND PROCESSES AND ELECTRONIC COMPONENT SPECIALISTS, FROM PROJECT EXPERIENCE, AND FROM INDUSTRY AND OTHER NASA CENTERS.

RTOP NO. 115-25-05 TITLE: ELECTRONIC COMPONENT SCREENING AND QUALIFICATION DEVELOPMENT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE EFFORT PROPOSED IN THIS TASK IS THE RESEARCH AND THE METHODOLOGY DEVELOPMENT NECESSARY TO PREPARE THE WAY FOR ACTUAL DEVELOPMENT AND SELECTION OF HIGHLY RELIABLE LONG-LIFE ELECTRONIC DEVICES REQUIRED BY FUTURE SPACECRAFT. PARTICULAR ATTENTION IS FOCUSED ON THE PROBLEM OF ACHIEVING LONG-LIFE MSI/LSI DEVICES. THE LONG RANGE APPROACH IS TO IDENTIFY FAILURE MECHANISMS WHICH LIMIT THE LONG-LIFE RELIABILITY OF ELECTRONIC DEVICES AND RELATE THESE MECHANISMS TO SPECIFIC ELEMENTS IN THE DEVICE DESIGN OR PROCESSING. THE OVERALL TASK WILL BE PURSUED THROUGH A COMBINATION OF BOTH IN-HOUSE AND CONTRACTED EFFORTS. THIS WORK IS NECESSITATED BY THE FACT THAT THE SPACECRAFT MISSIONS BEING CONSIDERED FOR THE 1970'S AND BEYOND DIFFER FROM THEIR PREDECESSORS IN THAT 1) MISSION TIME WILL BE SIGNIFICANTLY LONGER, 2) THE ENVIRONMENT WILL BE MORE SEVERE AND 3) THE SPACECRAFT WILL BE MORE COMPLEX. THE GRAND TOUR, FOR EXAMPLE, WILL REQUIRE A FLIGHT TIME OF 10 YEARS IN A RADIATION ENVIRONMENT. THIS IS AN ORDER OF MAGNITUDE MORE DEMANDING THAN ANY MISSION PREVIOUSLY ATTEMPTED. EVEN A CURSORY REVIEW OF THE LONGEVITY RECORD OF PREVIOUS SPACECRAFT REVEALS THAT THE RELIABILITY DEMONSTRATED BY THEIR ELECTRONICS IS TOTALLY INADEQUATE FOR MISSIONS OF 10 YEARS DURATION. WHEN CONSIDERATION OF THE ENVIRONMENTAL AND COMPLEXITY FACTORS OF FUTURE SPACECRAFT ARE INTRODUCED, THE DISPARITY BETWEEN THE DEGREE OF RELIABILITY ACHIEVED IN THE PAST AND THAT WHICH IS REQUIRED IN THE FUTURE BECOMES EVEN GREATER. THE PROBLEMS OF HOW TO ACHIEVE EXCEPTIONALLY LONG LIFE IN ELECTRONIC DEVICES FOR USE IN FUTURE SPACECRAFT IS DEFINITELY REAL AND MISSIONS OF 10 YEARS DURATION WILL HAVE A REASONABLE PROBABILITY OF SUCCESS ONLY WHEN THE PROBLEM IS SOLVED.

RTOP NO. 115-25-06 TITLE: RELIABILITY MODELING AND ASSESSMENT TECHNIQUES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

DEVELOP RELIABILITY PREDICTION, ASSESSMENT AND ANALYSIS TECHNIQUES APPLICABLE TO LONG DURATION MISSIONS. THESE TECHNIQUES INCLUDE NOT ONLY MATHEMATICAL MODELING OF COMPONENT, SUBSYSTEM AND SYSTEM EFFECTS BUT ALSO THE DEVELOPMENT OF ACCELERATED TEST TECHNIQUES FOR ASSEMBLIES AND SUBSYSTEMS AND QUALIFICATION METHODS

FOR COMPONENTS EXHIBITING WEAROUT MECHANISMS. INITIAL EFFORTS WILL BE CONCENTRATED IN AREAS WHERE EXISTING TECHNIQUES ARE INADEQUATE (TECHNIQUES MAY EMPLOY ASSUMPTIONS THAT ARE NO LONGER VALID WHEN CONSIDERING PARAMETERS OF LONG LIFE MISSIONS) OR NONEXISTENT. AN EXAMPLE OF THE FIRST IS THE AREA OF REDUNDANCY OPTIMIZATION, WHERE TECHNIQUES EXIST, BUT ALL EXISTING TECHNIQUES IGNORE THE EFFECTS OF SWITCHING, DORMANCY AND STANDBY REDUNDANCY, WHICH ARE THE DOMINANT EFFECTS IN LONG LIFE CONSIDERATIONS, WHILE AN EXAMPLE OF THE LATTER IS THAT ADEQUATE ACCELERATED TEST TECHNIQUES AT THE ASSEMBLY LEVEL HAVE NEVER EXISTED. THE APPROACH WILL EMPHASIZE FIRST THE TECHNIQUES NEEDED FOR EARLY USE BY PROJECTS. IN SUCCEEDING YEARS, OTHER TECHNIQUES, NOT QUITE SO CRUCIAL TO EARLY DESIGN, WILL BE DEVELOPED. IT IS NOTED THAT ALL TASKS PLANNED FOR FY'72 DEVELOP TECHNIQUES THAT WILL HAVE A DIRECT INFLUENCE ON EARLY ASSEMBLY, SUBSYSTEM, AND SYSTEM DESIGN. THE ANALYTICAL TECHNIQUES DEVELOPED FROM THE WORK PERFORMED IN THIS RTOP WILL HAVE APPLICATION TO ALL LONG LIFE SPACE MISSIONS IN MANNED FOR UNMANNED SPACECRAFT.

RTOP NO. 115-25-08 TITLE: STORAGE MATERIALS FOR OPTICAL MASS MEMORIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

EFFORTS WILL BE UNDERTAKEN TO DEVELOP IMPROVED STORAGE MATERIALS FOR APPLICATION IN OPTICAL MEMORY SYSTEMS WHICH ARE POTENTIAL CONDIDATES TO BE EMPLOYED ON FUTURE NASA MISSIONS SUCH AS THE SPACE STATION/BASE AND EARTH RESOURCES SATELLITES. THESE MISSIONS HAVE REQUIREMENTS FOR MASS MEMORY SYSTEMS WITH STORAGE CAPACITIES AS HIGH AS TEN TO THE 12TH POWER BITS, WRITING TIMES LESS THAN 0.0001 SEC, AND INCREASED RELIABILITY OVER PRESENTLY-USED TAPE RECORDERS WHICH NECESSITATES NO MOVING PARTS. SPECIAL EMPHASIS WILL BE PLACED ON THE DEVELOPMENT OF STORAGE MATERIALS WHOSE SENSITIVITY TO WRITING ENERGY IS IN THE RANGE REQUIRED BY THE OPTICAL MEMORY SYSTEMS PRESENTLY UNDER DEVELOPMENT BY MSFC (TEN TO THE MINUS 7TH POWER TO 0.000006 JOULES/MM-SQ) FOR THE SPACE STATION/BASE. INITIALLY, ORGANIC MATERIALS WHICH EXHIBIT CIS-TRANS ISOMERIZATION PROPERTIES AND MAGNETOOPTIC MATERIALS WILL BE INVESTIGATED SINCE THEY ARE PROMISING CANDIDATE MATERIALS.

RTOP NO. 117-07-01 TITLE: SPACE SHUTTLE CONFIGURATIONS, AEROTHERMODYNAMICS, AND OPERATIONAL ANALYSIS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

FULLY AND PARTIALLY REUSABLE SPACE SHUTTLE SYSTEMS ARE BEING STUDIED BY NASA/DOD TO SUPPORT FUTURE EARTH FOCUSED SPACE MISSIONS.

CURRENT CONTRACTOR CONCEPT-DEFINITION AND PRELIMINARY-DESIGN STUDIES ARE SCHEDULED TO END WITH FY 1971. TO ASSESS THE CONCEPTS AND TO MAKE RECOMMENDATIONS WHICH WILL HELP NASA IDENTIFY A PREFERRED CONFIGURATION THERE IS A NEED TO (1) EXAMINE THE AERODYNAMIC CHARACTERISTICS OF CANDIDATE ORBITER, BOOSTER, AND LAUNCH VEHICLE CONCEPTS FROM SUBSONIC THROUGH HYPERSONIC SPEEDS, (2) PERFORM DIAGNOSTIC STUDIES IN THE HYPERSONIC SPEED REGIME TO PROVIDE INSIGHT INTO (A) LOCAL FLOW FIELD CONDITIONS AND (B) POTENTIAL PROBLEM AREAS, (3) EXAMINE THE AEROHEATING CHARACTERISTICS OF CANDIDATE CONCEPTS, INDIVIDUALLY AND IN COMBINATION, (4) EXAMINE THE ABILITY OF CANDIDATE CONCEPTS TO PERFORM MAJOR OPERATIONAL AND MISSION REQUIREMENTS, (5) PERFORM SYSTEMS WEIGHT, BALANCE, PACKAGING, AND DETAILED COMPONENT DESIGN STUDIES OF BOTH BOOSTER AND ORBITER, AND (6) IDENTIFY FROM AEROTHERMODYNAMIC AND SYSTEMS CONSIDERATIONS FEASIBLE SUBSCALE ORBITER AND BOOSTER FLIGHT TEST VEHICLES.THIS RTOP ENCOMPASSES THE ACTIVITIES OF THE LANGLEY AEROTHERMODYNAMIC, SYSTEMS, AND OPERATIONS SPACE SHUTTLE TECHNOLOGY PROGRAM, COORDINATED WITH OTHER NASA CENTERS THROUGH THE AEROTHERMODYNAMICS/CONFIGURATIONS WORKING GROUP, TO ACCOMPLISH THE PRECEDING OBJECTIVES IN CONJUNCTION WITH COMPLEMETARY STUDIES IN THE AREAS OF STRUCTURES, MATERIALS, AND THERMAL PROTECTION AND DYNAMIC LOADS AND AEROELASTICITY.

RTOP NO. 117-07-02 TITLE: SPACE SHUTTLE - CONFIGURATIONS AND AEROTHERMODYNAMICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

TO EVALUATE THE AERODYNAMIC PERFORMANCE, STABILITY AND CONTROL, HEATING AND SONIC BOOM OVERPRESSURES OF SPACE SHUTTLE VEHICLES; TO PINPOINT AND FIND THE SOLUTION TO AEROTHERMODYNAMIC PROBLEMS OF THESE VEHICLES IN EVALUATION OF PHASE B AND SUPPORT OF PHASE C/D STUDIES. ACCORDINGLY, MODELS RESULTING FROM CONTRACTOR AND IN-HOUSE STUDIES WILL BE TESTED IN SUBSONIC, TRANSONIC, SUPERSONIC AND HYPERSONIC FACILITIES OF THE AMES RESEARCH CENTER. SHADOWGRAPH AND OIL-FLOW PHOTOGRAPHS, FLOW-FIELD PRESSURE SURVEYS, HEAT TRANSFER AND STATIC AND DYNAMIC AERODYNAMIC DATA WILL BE OBTAINED. THE WIND-TUNNEL DATA, TRAJECTORY DATA, AND RECENTLY OBTAINED STABILITY CRITERIA WILL BE USED TO EVALUATE THE SPACE SHUTTLE CHARACTERISTICS RELATIVE TO EXISTING AIRPLANES AND ENTRY VEHICLES SUCH AS LIFTING BODIES. THE EFFECTS OF REALISTIC GAPS, JOINTS, AND SURFACE CONDITIONS ON BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER WILL BE DETERMINED. TECHNIQUES WILL BE DEVELOPED FOR PREDICTING THE INVISCID AND VISCOUS REAL GAS FLOW FIELDS ABOUT SHUTTLE SPACECRAFT. TRAJECTORY CONSTRAINTS REQUIRED TO LIMIT SONIC BOOM OVERPRESSURES WILL BE DETERMINED.

RTOP NO. 117-07-03 TITLE: SPACE SHUTTLE: THERMAL PROTECTION SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

CANDIDATE MATERIALS FOR USE IN SPACE SHUTTLE THERMAL PROTECTION SYSTEMS WILL BE EVALUATED TO DETERMINE PERFORMANCE AND TO IDENTIFY FAILURE MODES. SAMPLES OF CANDIDATE MATERIALS (METALLIC AND NON-METALLIC) WILL BE TESTED IN ARC-JET FACILITIES CAPABLE OF DUPLICATING A NUMBER OF FULL-SCALE FLIGHT CONDITIONS. HEAT SHIELD MATERIALS TO BE INVESTIGATED INCLUDE THE NICKEL, COBALT AND COLUMBIAN ALLOYS, REUSEABLE SURFACE INSULATORS AND CARBONACEOUS AND POLYMERIC MATERIALS. EMPHASIS WILL BE ON THE EVALUATION OF MATERIALS THAT REQUIRE LITTLE OR NO REFURBISHMENT. PERFORMANCE EVALUATION WILL INCLUDE DETERMINATION OF THE EMITTANCE OF THE SURFACE AND ITS CATALYTIC BEHAVIOR REGARDING SURFACE RECOMBINATION OF DISSOCIATED BOUNDARY LAYER SPECIES. IN ORDER TO ACCOMPLISH THESE OBJECTIVES CONSIDERABLE IMPROVEMENTS IN ARC-JET OPERATION WILL BE MADE. THIS WILL INCLUDE INSTALLATION OF THE 2" X 9" SUPERSONIC DUCT IN A FACILITY BAY PREVIOUSLY OCCUPIED BY OTHER EQUIPMENT, INCREASING THE TOTAL POWER AND FLEXIBILITY OF THE D.C. POWER SUPPLY AND INCREASING THE LEVEL OF ENTHALPY OF THE ARC JET STREAMS.

RTOP NO. 117-07-03 TITLE: SPACE SHUTTLE THERMAL PROTECTION SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO INVESTIGATE THERMAL PROTECTION SYSTEMS FOR THE SPACE SHUTTLE, TO ASSESS THE ADEQUACY OF EXISTING TECHNOLOGY, AND TO IDENTIFY AND IMPLEMENT REQUIRED DEVELOPMENT PROGRAMS. THIS WILL BE ACCOMPLISHED PRIMARILY BY CONTRACT WORK SUPPORTED BY IN-HOUSE STUDIES AND TESTING. THREE TYPES OF HEAT SHIELDS WILL BE CONSIDERED: LOW-COST ABLATIVE SHIELDS, NONMETALLIC RADIATIVE-INSULATIVE SHIELDS, AND METALLIC RADIATIVE SHIELDS. FIBROUS INSULATION MATERIALS, NON-DESTRUCTIVE TEST TECHNIQUES, AND SOME ASPECTS OF CONVECTION COOLING WILL ALSO BE INVESTIGATED. PARAMETRIC HEAT-SHIELD STUDIES WILL BE MADE TO PROVIDE RATIONAL AND UP-TO-DATE ESTIMATES OF THE WEIGHT AND COST OF SYSTEMS INVOLVING ABLATORS, RADIATORS, INSULATORS, AND ACTIVE COOLING. LARGE-SCALE THERMAL PROTECTION SYSTEMS WILL BE DESIGNED, FABRICATED, AND TESTED TO VALIDATE ANALYTICAL RESULTS, WEIGHTS, AND, POSSIBLY, COSTS. THE RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION WHICH WILL SERVE AS A BASIS FOR THE SELECTION AND DESIGN OF THERMAL PROTECTION SYSTEMS FOR THE SPACE SHUTTLE.

RTOP NO. 117-07-04 TITLE: AEROTHERMODYNAMICS RESEARCH AND ABLATIVE HEAT PROTECTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THIS RESEARCH WILL LEAD TO THE DEVELOPMENT OF RELIABLE AND

ACCURATE ANALYTICAL AND EXPERIMENTAL TECHNIQUES FOR PREDICTING AND SIMULATING THE AERODYNAMIC AND THERMAL ENVIRONMENT TO BE ENCOUNTERED BY ENTRY VEHICLES DURING PLANETARY EXPLORATION AND EARTH RETURN. THERMAL PROTECTION MATERIALS WILL BE DEVELOPED TOGETHER WITH THE ANALYTICAL AND EXPERIMENTAL TECHNIQUES REQUIRED TO DESIGN HEAT SHIELDS FOR THESE MISSIONS. TO ACQUIRE THE RESEARCH CAPABILITIES TO SUPPORT PLANETARY EXPLORATION, NEAR TERM EMPHASIS WILL BE PLACED ON THE OPERATION AND DEVELOPMENT OF FACILITIES WHICH SIMULATE THE HEATING CONDITIONS ENCOUNTERED DURING ENTRY. THESE FACILITIES INCLUDE THE 6-INCH ELECTRIC DRIVE SHOCK TUBE (EXISTING) AND THE EXPANSION TUBE/TUNNEL (EXISTING) OF THE PRIMARY EMPHASIS HAS BEEN

RTOP NO. 117-07-04 TITLE: AEROTHERMODYNAMIC AND ABLATIVE HEAT PROTECTION FOR VERY-HIGH-SPEED ATMOSPHERIC ENTRY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE AEROTHERMODYNAMIC AND ABLATIVE HEAT-PROTECTION TECHNOLOGY REQUIRED TO DESIGN SPACECRAFT FOR ENTRY INTO VENUS AND THE OUTER PLANETS, AND TO EVALUATE DESIGN CONCEPTS FOR FUTURE SPACE-EXPIORATION VEHICLES CAPABLE OF ENTERING ATMOSPHERES AT SPEEDS UP TO 60 KM/SEC. THE WORK INCLUDES AEROTHERMODYNAMIC STUDIES TO DEFINE THE HEATING ENVIRONMENTS TO BE ENCOUNTERED; TO MINIMIZE THE HEATING RATES AND TOTAL HEAT LOADS BY PROPER CHOICE OF TRAJECTORY, VEHICLE SHAPE, AND HEAT SHIELD MATERIAL; TO EVALUATE AVAILABLE MATERIALS IN SIMULATED ENVIRONMENTS COVERING A VARIETY OF ATMOSPHERIC COMPOSITIONS AND COMBINED CONVECTIVE AND RADIATIVE AND CONVECTIVE HEATING LOADS; TO DEVELOP NEW MATERIALS TAILORED TO PROVIDE MAXIMUM HEAT PROTECTION IN PARTICULAR ENVIRONMENTS; AND FOR DEVELOPMENT OF FACILITIES REQUIRED TO SIMULATE THE ENVIRONMENTS BEING STUDIED. KNOWLEDGE OF THE HEATING ENVIRONMENTS AND HEAT-SHIELD MATERIAL PERFORMANCE, AND OF THE EFFECTIVENESS OF THE THERMAL PROTECTION SYSTEMS IS NECESSARY FOR THE DESIGN OF PROBES WHICH WILL ENTER THE ATMOSPHERES OF VENUS AND THE OUTER PLANETS.

RTOP NO. 117-07-05 TITLE: JUPITER ENTRY AEROTHERMODYNAMIC RESEARCH
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

WE ARE MAKING PROGRESS IN SEVERAL TECHNICAL SPECIALTIES RELATED TO JUPITER ATMOSPHERIC ENTRY AEROTHERMODYNAMICS. IN FLOW-FIELD ANALYSIS, RADIATIVE HEATING, CONVECTIVE HEATING, AND TRAJECTORY ANALYSIS WE HAVE PURSUED A COMBINED EXPERIMENTAL AND THEORETICAL METHOD TO MAKE _THIS PROGRESS. IN FLOW-FIELD ANALYSIS WE WILL COMPLETE THE DEVELOPMENT OF METHODS TO COMPUTE THE VISCOUS, CONDUCTING, RADIATING, AND REACTING FLOW ABOUT AN ENTRY BODY TO THE PLANET JUPITER. A DESCRIPTION _OF THE FLOW-FIELD IN THE ABLATION LAYER AND THE BASE REGION WILL MAKE IT POSSIBLE TO UNDERSTAND THE

COUPLING WHICH OCCURS BETWEEN THESE REGIONS AND THE SHOCK LAYER AND WAKE. IN ORDER TO PREDICT RADIATIVE HEATING TO AN ENTRY PROBE, THE RADIATIVE PROPERTIES OF HYDROGEN AND HELIUM SUBJECTED TO SHOCK HEATING AND COMPRESSION MUST BE KNOWN. THE DYNAMIC PROCESSES INCLUDING A SHOCK PRECURSOR, THE TEMPERATURE OVERSHOOT, AND RADIATIVE COOLING OF THESE GASES MUST BE MEASURED IN SHOCK TUBE TESTS AND COMPARED TO CHEMICAL KINETIC, AND FLOW-FIELD CALCULATIONS. THE ABSORPTION OF THE GRAPHITE HEATSHIELD ABLATION PRODUCTS MAY BE SO COMPLEX AS TO NECESSITATE SHOCK TUBE TESTS TO DISCOVER ADDITIONAL RADIATION ABSORPTION BANDS. BOUNDARY LAYER ANALYSIS WILL POSSIBLY _PREDICT CONVECTIVE HEATING QUITE ACCURATELY TO FLIGHT SPEEDS OF 50 KM/SEC. HOWEVER, SMALL MODELS WILL BE TESTED IN THE SHOCK TUBES TO VERIFY THESE THEORETICAL CALCULATIONS. WITH MASSIVE ABLATION OCCURRING WITH A JUPITER ENTRY PROBE, UNSTABLE MOTIONS OF THE VEHICLE ARE POSSIBLE EVEN WITH ENTRY PERTURBATIONS MINIMIZED. GROOVING, CROSS-HATCHING AND OTHER ABLATION PATTERNS WILL BE STUDIED THEORETICALLY WITH TRAJECTORY PROGRAMS AND IN FREE-FLIGHT WIND TUNNEL TESTS.

RTOP NO. 739-07-02 TITLE: PLANETARY ATMOSPHERE EXPERIMENTS TEST (PAET)
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THE PLANETARY ATMOSPHERE EXPERIMENTS TEST (PAET) IS TO DEMONSTRATE IN THE EARTH'S ATMOSPHERE THE ABILITY OF SELECTED EXPERIMENTS TO DETERMINE THE STRUCTURE AND COMPOSITION OF AN UNKNOWN PLANETARY ATMOSPHERE FROM A PROBE VEHICLE ENTERING THE ATMOSPHERE AT HIGH SPEEDS. RESULTS FROM THIS TEST WILL PROVIDE FLIGHT EXPERIENCE FOR THE EVALUATION OF EXPERIMENTS APPLICABLE TO ENTRY MISSIONS TO OTHER PLANETS. THREE EXPERIMENTS WILL BE FLOWN: AN ATMOSPHERE STRUCTURE EXPERIMENT, A SHOCK-LAYER RADIOMETER COMPOSITION EXPERIMENT, AND A MASS SPECTROMETER COMPOSITION EXPERIMENT. AN ENTRY VEHICLE DESIGNED TO ACCOMMODATE THESE EXPERIMENTS WILL BE BUILT AT AMES RESEARCH CENTER. THE ENTRY VEHICLE WILL BE FLOWN FROM WALLOPS ISLAND ON A FOUR-STAGE SCOUT LAUNCH VEHICLE. ENTRY WILL OCCUR NEAR BERMUDA.

RTOP NO. 747-81-01 TITLE: LIFTING ENTRY VEHICLE TRANSONIC FLIGHT-TEST PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311
TECHNICAL SUMMARY

THE LOW SUPERSONIC AND SUBSONIC CHARACTERISTICS OF LIFTING

REENTRY VEHICLES ARE BEING STUDIED BY MEANS OF A COORDINATED FLIGHT AND WIND-TUNNEL TEST PROGRAM WITH M2-F3, AND X-24A AIRCRAFT. THE PROGRAM WILL YIELD THE DETAILED AERODYNAMIC CHARACTERISTICS OF THESE AIRCRAFT AND A MEASURE OF THE ABILITY OF THE WIND TUNNELS TO PREDICT THESE CHARACTERISTICS. IN ADDITION, OPERATIONAL CHARACTERISTICS IN THE TERMINAL AREA ARE BEING EXPLORED. THIS EFFORT WILL ULTIMATELY YIELD AN IFR TERMINAL AREA ENERGY MANAGEMENT AND APPROACH TECHNIQUE APPLICABLE TO UNPOWERED LOW L/D ENTRY VEHICLES. AFTER ACCOMPLISHING THE BASIC FLIGHT OBJECTIVES, THE M2-F3 WILL BE USED TO EVALUATE COMMAND CONTROL SYSTEM CONCEPTS AND REACTION CONTROL BLENDING TECHNIQUES. SUBSEQUENT TO THE BASIC PROGRAM, THE X-24A WILL BE CONVERTED TO AN FDL-8 SHAPE TO EVALUATE A NEW CLASS OF VEHICLE.

RTOP NO. 770-90-01 TITLE: SPACE TECHNOLOGY APPLICATIONS (STA)
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: SPENCER, D. F. TEL. 213-354-6852
TECHNICAL SUMMARY

JPL WILL APPLY SPACE-DERIVED CAPABILITIES TO THE RESOLUTION OF PROBLEMS OF NATIONAL INTEREST, PARTICULARLY THOSE RELATING TO THE CIVIL SYSTEMS AREAS, INCLUDING PUBLIC SAFETY SUPPORT, MEDICAL ENGINEERING, ENVIRONMENTAL MANAGEMENT AND OTHERS. SPACE-DERIVED CAPABILITIES INCLUDE EXPERIENCE AND TECHNOLOGY THAT IS APPLICABLE IN: 1) PROJECT AND SYSTEMS MANAGEMENT 2) SYSTEMS ANALYSIS AND PROJECT ENGINEERING 3) SPECIALIZED TECHNICAL DISCIPLINES (E.G., COMMUNICATIONS, GUIDANCE, PROPULSION, ETC.) 4) DESIGN, OPERATION, AND EVALUATION OF COMPLEX TEST PROGRAMS. WITHIN THE CIVIL SYSTEMS AREAS, JPL WILL (1) IDENTIFY AND DEFINE PROBLEMS, (2) DETERMINE REQUIREMENTS, (3) APPLY A SYSTEMS APPROACH, AND (4) CONCENTRATE ON EVALUATING FEASIBLE HARDWARE PILOT DEMONSTRATIONS THAT WILL HELP INTERESTED GOVERNMENT AGENCIES AND/OR INDUSTRIAL COMPANIES IN SOLVING PROBLEMS THAT ARE NATIONAL IN SCOPE. A MIX OF TASKS WILL BE PERFORMED APPROPRIATE TO JPL'S CAPABILITY AND EMPHASIZING THE APPLICATION OF SPACE TECHNOLOGY.

RTOP NO. 770-90-02 TITLE: TECHNOLOGY APPLICATIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-1111
TECHNICAL SUMMARY

TO CONTINUE THE APPLICATION OF SPACE-DERIVED TECHNOLOGY DEVELOPED AT AMES TO THE RESOLUTION OF PROBLEMS OF NATIONAL INTEREST SUCH AS (A) TO DEVELOP FIRE-PROTECTIVE SYSTEMS UTILIZING FIRE-RETARDANT FOAMS AND INTUMESCENT COATINGS (B) TO INVESTIGATE THE CONCEPT OF A FIRE-RESISTANT AIRCRAFT WINDOW TO COMPLETE THE PASSENGER AIRCRAFT PROTECTION SYSTEM BEING DEVELOPED (C) TO PROVIDE SUPPORT TO THE NAVWPNSCEN AIRCRAFT SURVIVABILITY PROJECT (D) TO DEVISE METHODS FOR CONVERTING HYDROCARBONS TO METHANE IN ORDER TO REDUCE AIR POLLUTION CREATED BY INTERNAL COMBUSTION ENGINES AND (E) TO DEVELOP

CHEMICAL AND OTHER INSTRUMENTATION FOR THE DETECTION OF DANGEROUS DRUGS IN HUMANS AND OIL SPILLS IN COASTS. (A) AMES DEVELOPED FIRE-RETARDANT FOAMS, INTUMESCENT COATINGS AND OTHER HIGH TEMPERATURE COMPOSITES WILL BE EVALUATED AS FIRE PROTECTIVE MATERIALS AND BRAKES FOR SPECIFIC APPLICATIONS REQUESTED BY THE DOD, DOT AND POD. THESE MATERIALS WILL BE MODIFIED IF NECESSARY TO ENHANCE PROPERTIES REQUIRED. (B) PROTOTYPE FIRE-RESISTANT WINDOWS BASED ON NEW CHAR FORMING POLYMERS BEING DEVELOPED AT AMES WILL BE PRODUCED AND EVALUATED FOR POSSIBLE APPLICATIONS AS FIRE-RESISTANT WINDOWS FOR AIRCRAFT AND SPACE STATION. (C) SUPPORT OF THE NAVY'S SURVIVABILITY PROGRAM WILL BE PROVIDED BY RETROFITTING AN A-4 AIRCRAFT WITH FIRE-RETARDANT FOAMS AND INTUMESCENT COATING. (D) STUDIES OF METHANATION OF HYDROCARBON FUELS WILL CONTINUE AND A PROTOTYPE CATALYTIC REACTOR WILL BE DEVELOPED FOR CONVERTING HYDROCARBONS TO METHANE IN INTERNAL COMBUSTION ENGINES (E) CHEMICAL INSTRUMENTATION BASED ON A CHROMATOGRAPHIC COLUMN WILL BE DEVELOPED FOR THE DETECTION OF DANGEROUS DRUGS IN HUMANS. A MULTI-SENSOR OIL-SPILL

RTOP NO. 770-90-03 TITLE: TECHNOLOGY APPLICATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO SELECTIVELY APPLY AEROSPACE TECHNOLOGY TO ASSIST THE DOD, OTHER AGENCIES AND MEDICAL ORGANIZATIONS IN SOLVING PROBLEMS AFFECTING THE MILITARY AND MODERN SOCIETY. THE SELECTION OF PROJECTS IS BASED ON THE AVAILABILITY OF NEEDED TECHNOLOGY, AND THE AMOUNT OF TIME REQUIRED TO BUILD A PROTOTYPE OR DEMONSTRATE THE SOLUTION. WORK FOR PROJECTS SELECTED SHOULD BE LIMITED TO DEVELOPMENT OR THE APPLICATION OF TECHNOLOGY, WITH NO RESEARCH OR A VERY MINIMUM EXTENSION OF RESEARCH REQUIRED.

RTOP NO. 770-90-04 TITLE: TRACE ELEMENT AND COMPOUND POLLUTANT STUDY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROSENBLUM, L. TEL. 216-433 4000
TECHNICAL SUMMARY

ATMOSPHERIC TRACE ELEMENTS AND COMPOUNDS POSE A POTENTIAL HEALTH HAZARD. IN PART, WORK WILL BE CARRIED OUT IN SUPPORT OF THE DIVISION OF AIR POLLUTION CONTROL OF THE CITY OF CLEVELAND. MEASUREMENTS WILL BE MADE OF CONCENTRATION AND DISTRIBUTION OF TRACE ELEMENTS AND COMPOUNDS IN THE CLEVELAND AREA AND THE CLEVELAND HOPKINS AIRPORT. METHODS AND INSTRUMENTS WILL BE DEVELOPED TO ALLOW THE CONVENIENT, RAPID AND INEXPENSIVE MEASUREMENT OF TRACE POLLUTANT CONCENTRATION. PHYSICAL CHARACTERIZATION WILL BE MADE OF TRACE POLLUTANTS. CORRELATION OF POLLUTANT DATA WILL BE MADE WITH DIFFUSION MODELS FOR PURPOSES OF MODEL REFINEMENT AND FORECASTING. METHODS WILL BE ESTABLISHED FOR GENERAL AND SPECIFIC POLLUTANT SOURCE IDENTIFICATION THROUGH TRACER TECHNIQUE.

RTOP NO. 770-90-05 TITLE: LONG RANGE LASER TRAVERSING SYSTEM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CAUDILL, L. O. TEL. 301-982-4969
TECHNICAL SUMMARY

THIS RTOP IS FOR DEVELOPMENT OF A LIGHTWEIGHT, BACKPACKED PROTOTYPE LASER SYSTEM AND FOR PERFORMING FIELD EVALUATION EXPERIMENTS TO DETERMINE THE FEASIBILITY OF ESTABLISHING PRECISE LINE OF SIGHT USING THE SCATTERED LASER LIGHT FROM A DISTANCE VERTICALLY POINTED LASER. THIS WORK IS A DIRECT APPLICATION OF OPTICAL TECHNOLOGY DEVELOPED UNDER OART PROGRAM AND WILL PROVIDE THE U. S. FOREST SERVICE WITH A SURVEYING TECHNIQUE THAT WILL SAVE A GREAT DEAL OF TIME AND MONEY.

RTOP NO. 770-90-06 TITLE: TECHNOLOGY APPLICATIONS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: FLEIG, A. J. TEL. 301-982-2121
TECHNICAL SUMMARY

TECHNOLOGY DEVELOPED BY NASA FOR SPACE USE IS BEING ADAPTED FOR APPLICATION TO PROVIDE POTENTIAL SOLUTIONS TO MAJOR PROBLEMS IN MODERN SOCIETY THIS IS A PROGRAM TO APPLY THE APPLICATIONS EFFORT NECESSARY TO ASSURE SUCCESSFUL TRANSFER OF SELECTED ITEMS FROM THE SPACE PROGRAM TO OTHER AREAS TYPICALLY WITH LESS OF A TECHNOLOGY BASE. EFFORT AT PRESENT IS BEING APPLIED PRIMARILY TO TRANSFERS OF TECHNOLOGY TO HEALTH CARE AND ENVIRONMENTAL PROTECTION AREAS. THE MAJOR PROJECT IS TO DEVELOP A DEVICE FOR THE RAPID AUTOMATIC DETECTION OF BACTERIA IN BODY FLUIDS. THIS WORK IS BEING CONDUCTED UNDER A FORMAL INTERAGENCY AGREEMENT WITH THE PUBLIC HEALTH SERVICE. A SECOND PROJECT IS TO DEVELOP PORTABLE SENSITIVE INSTRUMENTATION FOR THE DETECTION OF HEAVY METALS SUCH AS MERCURY, ARSENIC, CADMIUM, ET CETERA, THROUGH USE OF FAST NEUTRON RADIATIVE CAPTURE TECHNIQUE. OTHER PROJECTS UTILIZING NASA DEVELOPED TECHNOLOGY, FACILITIES OR EXPERTISE WILL BE CONSIDERED FOR PROBLEMS IN FIELDS SUCH AS PUBLIC SAFETY, TRANSPORTATION, HOUSING ET CETERA.

RTOP NO. 770-90-08 TITLE: TECHNOLOGY APPLICATIONS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HAYS, E. L. TEL. 713-483-4933
TECHNICAL SUMMARY

TO EXPAND THE NASA WATER/WASTE MANAGEMENT DEVELOPMENT ACTIVITIES TO INCLUDE A CONCURRENT APPLICATION OF THE EVOLVING TECHNOLOGY TO DOMESTIC USE TO AID IN RESOLUTION OF NATIONAL PROBLEMS OF CONSERVATION PROTECTION AND REHABILITATION OF NATIONAL RESOURCES. THE ULTIMATE GOAL OF THIS PROGRAM IS TO EXPLOIT THE RECIPROCAL BENEFITS WHICH CAN BE OBTAINED BY PARALLEL USE OF THE TECHNOLOGY IN BOTH AEROSPACE AND DOMESTIC APPLICATIONS. THE APPROACH WILL INVOLVE DEVELOPMENT OF WATER RECOVERY HARDWARE MODULE WHICH WOULD BE A BASIC CORE UNIT FOR EFFECTING DOMESTIC ON SITE WATER RECOVERY AND SOLIDS WASTE HANDLING. TO EXPAND THE APPLICATIONS OF THE FIRE RESISTANT MATERIALS DEVELOPED AND INVESTIGATED IN THE APOLLO PROGRAM. THE ULTIMATE GOAL IS THE IMPROVEMENT OF FIRE SAFETY IN AIRCRAFT, GROUND

VEHICLES, BOATS, THE HOME, AND INDUSTRY. THE TRANSLATION OF THE APOLLO FLAMEPROOFING TECHNOLOGY TO IMPROVE FIRE SAFETY IN EVERY DAY LIFE SITUATIONS WILL HELP TO MITIGATE THE GREAT LOSS IN BOTH LIVES AND MONEY SUFFERED ANNUALLY IN THE COUNTRY AS A RESULT OF FIRE. TO ALLEVIATE THE EXCESS WEIGHT PROBLEM OF PRESENTLY AVAILABLE FIREMAN'S BREATHING SYSTEMS AND TO IMPROVE THE DESIGN OF THESE SYSTEMS WHERE FEASIBLE. TO SELECT AN OPTIMUM FIREMAN'S BREATHING SYSTEM CONCEPT AND TO DESIGN, FABRICATE, AND TEST A WORKING PROTOTYPE UNIT.

RTOP NO. 770-90-09 TITLE: APPLICATION OF MAGNETICS TECHNOLOGY TO MEDICAL AND GEODETIC PROBLEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

HIGHLY-ADVANCED LABORATORY INSTRUMENTATION AND ANALYTICAL METHODS DEVELOPED IN CONNECTION WITH MAGNETIC FIELD EXPLORATION IN SPACE WILL BE APPLIED TO THE SOLUTION OF PROBLEMS OF NATIONAL INTEREST. PROBLEM DEFINITION STUDIES WILL BE CONDUCTED IN AREAS WHERE TRANSFER OF THIS TECHNOLOGY FROM NASA WILL SATISFY EXISTING REQUIREMENTS AND WILL PREVENT A DUPLICATION OF DEVELOPMENT BY THE MEDICAL COMMUNITY AND BY OTHER GOVERNMENT AGENCIES. FOR EXAMPLE, STUDIES WILL BE CONDUCTED, IN CONJUNCTION WITH APPROPRIATE MEDICAL AUTHORITIES, TO DETERMINE AND PURSUE FRUITFUL AREAS IN WHICH SPACE-MAGNETIC TECHNOLOGY MAY BE DIRECTLY APPLIED TO BIOMAGNETIC INSTRUMENTATION. MAGNETIC FIELDS PRODUCED BY THE HUMAN BODY ARE KNOWN TO EXIST. NON-INVASIVE MEASUREMENTS OF THESE MAGNETIC FIELDS WILL PROVIDE NEW INFORMATION WHICH MAY SUBSTANTIALLY EXPAND AND IMPROVE HEALTH CARE TECHNIQUES RELATED TO DIAGNOSIS AND TREATMENT OF NERVE AND MUSCLE DISEASES AND DYSFUNCTIONS. ANOTHER POTENTIAL USE OF SPACE-MAGNETIC TECHNOLOGY LIES IN THE APPLICATION OF VECTOR MAGNETOMETRY FOR SETTING AND MAINTAINING STANDARDS FOR EARTH MAGNETIC FIELD MEASUREMENTS ON THE GROUND. THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (DEPT. OF COMMERCE) HAS INDICATED INTEREST IN UTILIZING AN AMES-DEVELOPED DIGITAL-FLUXGATE SENSOR SYSTEM AS A NEW STANDARD OBSERVATORY INSTRUMENT. CONTACTS WITH NOAA WILL BE ESTABLISHED TO DETERMINE THE FEASIBILITY OF AN APPLICATIONS EFFORT IN THIS AREA. AMES' SYSTEMS ENGINEERING DIVISION WILL COORDINATE THE PARTICIPATION OF NASA CENTERS HAVING UNIQUE MAGNETIC FIELD CAPABILITY AND WILL PROVIDE LIAISON BETWEEN NASA AND POTENTIAL USERS IN THE MEDICAL COMMUNITY AND IN OTHER AGENCIES.

RTOP NO. 770-90-10 TITLE: AUTOMOTIVE POWER SYSTEMS ASSISTANCE PROGRAM
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SHURE, L. I. TEL. 216-433-6632
TECHNICAL SUMMARY

THE OBJECTIVE OF THE AUTOMOTIVE POWER SYSTEMS ASSISTANCE PROGRAM IS TO MAKE AVAILABLE TO THE ADVANCED AUTOMOTIVE POWER SYSTEMS PROGRAM OF THE ENVIRONMENTAL PROTECTION AGENCY THE TECHNICAL EXPERTISE DEVELOPED UNDER THE NASA PROGRAMS. THIS EXPERTISE IS TYPIFIED BY THE

TECHNOLOGIES OF TURBINE ENGINES, BRAYTON ENGINE, RANKINE SYSTEMS, HIGH PERFORMANCE BATTERIES, ADVANCED ELECTRIC GENERATORS, AUTOMATIC CONTROLS, HEAT TRANSFER, MATERIALS, AND OTHER RELATED SCIENTIFIC DISCIPLINES. THE PRIMARY EMPHASIS WILL BE GIVEN TO THOSE AREAS THAT WILL BE OF MUTUAL BENEFIT TO BOTH AGENCIES. ANOTHER AREA OF SIGNIFICANT BENEFIT IS IN THE APPLICATION OF MANAGEMENT TECHNIQUES AND CAPABILITIES DEVELOPED BY LEWIS RESEARCH CENTER FOR THE CONDUCT OF FOCUSED TECHNOLOGY PROGRAMS BOTH IN-HOUSE AND UNDER CONTRACT.

RTOP NO. 770-90-11 TITLE: TECHNOLOGY FOR ADVANCED, LOW-POLLUTION GROUND POWER SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GUTSTEIN, M. TEL. 216-433-6862

TECHNICAL SUMMARY

THE NEED TO PROVIDE ADEQUATE, NON-POLLUTING SUPPLIES OF ELECTRICAL POWER WILL REQUIRE ADVANCED GROUND POWER SYSTEMS SUCH AS THE FAST BREEDER FISSION PLANT, HIGH-TEMPERATURE HIGH-THERMAL EFFICIENCY TOPPING CYCLES AND FUSION POWER. THE LEWIS RESEARCH CENTER HAS CONDUCTED RESEARCH AND TECHNOLOGY DEVELOPMENT IN A VARIETY OF SPACE-ORIENTED FIELDS WHICH HAVE THE POTENTIAL OF BEING APPLICABLE TO THESE ADVANCED GROUND POWER SYSTEMS. DURING FY 1972, A SMALL EFFORT WILL BE DEVOTED TO EXPLORE THE UTILIZATION OF THIS RESEARCH AND TECHNOLOGY FOR ADVANCED GROUND POWER SYSTEMS. THIS WORK WILL BE DIRECTED TOWARD EVALUATING THE FEASIBILITY OF HIGH-TEMPERATURE BRAYTON AND RANKINE SYSTEMS FOR TOPPING CYCLES OF CONVENTIONAL GROUND POWER SYSTEMS, THE APPLICABILITY OF THE HIGH-TEMPERATURE RANKINE SYSTEM TECHNOLOGY TO THE FUSION POWER CONVERSION SYSTEM, AND TO EVALUATE WAYS TO APPLY AND EXTEND THE LEWIS RESEARCH CENTER'S SPACE RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO THE ADVANCED GROUND POWER SYSTEMS.

RTOP NO. 132-15-01 TITLE: BEARINGS, SEALS AND LUBRICATION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: JOHNSON, R. L. TEL. 216-433-4000
TECHNICAL SUMMARY
BASIC MATERIALS, DEVELOPMENT, DESIGN THEORY, ANALYSIS AND EXPERIMENTATION WILL BE PERFORMED FOR EXTREME CONDITIONS WITH LUBRICANTS, LUBRICATION SYSTEMS, COMPONENT MATERIALS AND COMPONENT DESIGNS FOR BEARINGS, AND SEALS OF ADVANCED AIRCRAFT TURBINE ENGINES TO ACHIEVE EFFICIENT PERFORMANCE, RELIABILITY AND EXTENDED LIFE.

RTOP NO. 132-15-03 TITLE: APPLICATION STUDIES FOR AIRBREATHING ENGINES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: WEBER, R. J. TEL. 216-433-6605
TECHNICAL SUMMARY
DESIRABLE DESIGN CHARACTERISTICS OF VARIOUS FUTURE AIRCRAFT ANDTHEIR ASSOCIATED PROPULSION SYSTEMS WILL BE STUDIED. CYCLE ANALYSES AND WEIGHT ESTIMATES FOR A NUMBER OF ENGINE DESIGNS WILL BE COMBINED WITH STRUCTURAL AND AERODYNAMIC ESTIMATES FOR VARIOUS AIRFRAMES. RESULTS WILL PROVIDE COMPARISONS AND EVALUATIONS OF VARIOUS PROPULSION SYSTEMS IN MISSIONS OF INTEREST AND WILL SUPPORT THE EFFORTS OF COMPONENT RESEARCHERS IN OTHER GROUPS. STUDIES WILL BE DIRECTED AT SUCH AIRCRAFT AS VTOL, STOL, AND ADVANCED SUBSONIC TRANSPORTS.

RTOP NO. 132-63-01 TITLE: UPDATING & SUPPORT OF TEST FACILITIES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LOGAN, W. O., JR. TEL. 216-433-4000
TECHNICAL SUMMARY
MODERNIZE AND REFINE PROPULSION TEST STANDS AND LABORATORIES, AND DEVELOP MORE EFFICIENT EXPERIMENTAL TECHNIQUES FOR ENGINE AND COMPONENT RESEARCH. FACILITY IMPROVEMENTS AND INSTRUMENTATION PROCEDURES TO EXTEND TEST CAPABILITIES OR REDUCE OPERATIONAL MANPOWER REQUIREMENTS. OVERHAUL AND UPGRADING OF OLDER ITEMS WHICH ARE SERVICEABLE BUT INADEQUATE FOR PROJECTED RESEARCH PROGRAMS.

RTOP NO. 132-80-01 TITLE: AIRCRAFT PROPULSION SYSTEM NOISE
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY
THE GENERAL OBJECTIVES OF THIS TASK ARE (1) TO OBTAIN A CORRELATION BETWEEN THE FLUCTUATIONS AND THE INTENSITY AND FREQUENCY SPECTRUM OF THE NOISE RADIATED FROM SUPERSONIC JETS, AND (2) TO REDUCE THE NOISE GENERATED BY ATTEMPTING TO REDUCE THE TURBULENCE AND THE SHEAR. EXPERIMENTAL MEASUREMENTS OF THE PERCEPTIVE NOISE LEVEL WILL BE MADE IN THE SURROUNDINGS OF HIGH-TEMPERATURE JETS. ADDITIONAL MEASUREMENTS WILL CONSIST OF MASS FLOW RATE, GAS TEMPERATURES AND PRESSURES, NOZZLE WALL PRESSURES AND FLUCTUATING

QUANTITIES. THE EXPERIMENTAL DATA WILL BE ANALYZED TO EVALUATE THE FREQUENCY SPECTRUM, THE JET VELOCITY DISTRIBUTION AND THE THRUST. CORRELATIONS BETWEEN THE RADIATED NOISE AND THE FLUCTUATING QUANTITIES WILL BE ESTABLISHED. TESTS WILL BE CONDUCTED OVER A RANGE OF FLOW CONDITIONS. THE GENERATION OF JET NOISE DUE TO THE PROPAGATION OF IMPULSIVE DISTURBANCES CREATED IN THE NOZZLE PLENUM WILL BE INVESTIGATED THROUGH CONTINUING ANALYSIS OF EXISTING ROCKET ENGINE DATA. FURTHER TESTS WILL BE CONDUCTED ON A SMALL-SCALE COLD-FLOW SUPERSONIC NOZZLE USING A BLOWDOWN TANK. NEW METHODS OF REDUCING JET NOISE WILL BE INVESTIGATED IN THIS FACILITY.

RTOP NO. 132-80-01 TITLE: AIRCRAFT PROPULSION SYSTEM NOISE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GUEST, S. H. TEL. 205-453-0176
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE PHYSICAL MECHANISMS INVOLVED IN THE PROCESS OF SOUND GENERATION IN FLUID DYNAMIC FLOWS (JET AND ROCKET EXHAUST FLOWS), I.E., TO DESCRIBE THESE MECHANISMS THROUGH CORRELATION OF THE INTERNAL MEASURABLE EXHAUST FLOW PROPERTIES WITH THE EXTERNALLY OBSERVED ACOUSTIC FIELDS. UTILIZING THE KNOWLEGE OF THE BASIC NOISE GENERATION MECHANISMS, CONTROL OF THE RESULTING RADIATED ACOUSTIC FIELDS MAY BE AFFECTED. A SYSTEMATIC DETAILED DESCRIPTION OF THE PHYSICAL CHARACTERISTICS OF ENGINE EXHAUST FLOWS CAN BEOBTAINED BY----

RTOP NO. 132-80-01 TITLE: AIRCRAFT PROPULSION SYSTEMS NOISE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. J. TEL. 216-433-6878
TECHNICAL SUMMARY

THE WORK IN THIS PROGRAM IS DIRECTED TO OBTAINING AN UNDERSTANDING OF THE VARIOUS NOISE SOURCES IN AIRCRAFT PROPULSION SYSTEMS AND TO DETERMINING METHODS OF REDUCING OR SUPPRESSING THE NOISE. THE SOURCES INCLUDE THE FAN, COMPRESSOR, TURBINE, AND JET EXHAUST OVER A WIDE VELOCITY RANGE. ANALYTICAL STUDIES AND FULL-SCALE/SMALL-SCALE EXPERIMENTS ARE PERFORMED TO DETERMINE NOISE REDUCTION FEATURES IN THE DESIGN OF THESE COMPONENTS. SIMILAR STUDIES ARE PERFORMED FOR THE PURPOSE OF DETERMINING SUITABLE, ACOUSTICALLY TREATED NACELLE DESIGNS TO REDUCE NOISE FROM THE INTERNAL SOURCES AND NOZZLES TO REDUCE JET NOISE. IN REGARD TO JET NOISE, ONE GOAL WILL BE TO OBTAIN A CORRELATION THAT WILL BE ACCEPTABLE THROUGHOUT THE FIELD FOR PREDICTING THIS NOISE.

RTOP NO. 132-86-01 TITLE: COMBUSTION EMISSION ANALYSES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CHILDS, J. H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE CONCENTRATIONS OF VARIOUS PARTICULATE AND GASEOUS POLLUTANTS IN THE REGION OF THE ATMOSPHERE BETWEEN 20,000 AND 40,000 FEET WILL

BE MEASURED BY EMPLOYING SAMPLING DEVICES ON COMMERCIAL AIR TRANSPORTS. ADDITIONAL SAMPLING WILL BE CONDUCTED IN THE UPPER STRATOSPHERE USING A YF12 OR OTHER HIGH ALTITUDE AIRCRAFT. THESE MEASUREMENTS WILL BE USED TO ESTABLISH BASELINE DATA ON THE CONTAMINANTS IN THE ATMOSPHERE IN ORDER TO DEDUCE THE RELATIVE CONTRIBUTION TO ATMOSPHERIC POLLUTION BY JET AIRCRAFT. THIS INFORMATION MAY THEN BE USED TO DETERMINE ANY NECESSARY STEPS REQUIRED TO REDUCE POLLUTION BY JET AIRCAFT. COMPONENTS TO BE MEASURED WILL INCLUDE HYDROCARBONS, CARBON MONOXIDE, OXIDES OF NITROGEN, OXIDES OF SULFUR, OZONE, WATER, AND TOTAL PARTICULATES.

RTOP NO. 132-86-02 TITLE: LOW POLLUTANT COMPONENTS AND SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CHILDS, J. H. TEL. 216-433-4000
TECHNICAL SUMMARY

VARIOUS TECHNIQUES FOR REDUCING POLLUTANT EMISSIONS WILL BE INVESTIGATED IN FULL-SCALE PRIMARY COMBUSTORS, FULL-SCALE REHEAT BURNERS, AND IN VARIOUS COMBUSTOR SEGMENT RIGS. DESIGN TECHNIQUES TO BE INVESTIGATED FOR REDUCTION OF NITRIC OXIDE EMISSION INCLUDE REDUCED DWELL TIME IN THE REACTION ZONE, PREVAPORIZATION OF THE FUEL, AND PREMIXING OF FUEL AND AIR TO AN OPTIMUM INITIAL MIXTURE COMPOSITION. DESIGN TECHNIQUES FOR REDUCING THE EMISSIONS OF CARBON MONOXIDE AND UNBURNED HYDROCARBONS INCLUDE IMPROVED FUEL ATOMIZATION AND ENRICHMENT OF THE REACTION ZONE BY DIVERTING A PORTION OF THE AIR DURING ENGINE IDLE CONDITIONS. EXTENSIVE ITERATIVE TESTS WILL BE REQUIRED IN ORDER TO EVOLVE COMBUSTOR CONFIGURATIONS WHICH COMBINE LOW POLLUTANT EMISSIONS WITH THE OTHER PERFORMANCE CHARACTERISTICS REQUIRED OF COMBUSTORS. A CONTRACT PROGRAM WILL BE CONDUCTED TO APPLY MANY OF THESE SAME DESIGN FEATURES IN A COMBUSTOR WHICH CAN FIT INTO AN EXISTING COMMERCIAL AIRCRAFT ENGINE. EXPERIMENTS WILL BE PERFORMED IN A SMALL FLAMETUBE WHEREIN MIXTURE COMPOSITION, DWELL TIME, AND SCALE AND INTENSITY OF TURBULENCE CAN BE VARIED. A CONTRACT PROGRAM WILL BE INITIATED TO IDENTIFY THE ODOR-CAUSING CONSTITUENTS IN GAS TURBINE EXHAUST AT ENGINE IDLE CONDITIONS. WORK WILL CONTINUE ON DEVELOPMENT OF NON-CATALYTIC REACTORS FOR SPARK-IGNITION RECIPROCATING ENGINES.

RTOP NO. 762-73-01 TITLE: EXPERIMENTAL QUIET ENGINE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. J. TEL. 216-433-6878
TECHNICAL SUMMARY

PRELIMINARY DESIGN STUDIES AND LEWIS IN-HOUSE RESEARCH HAVE INDICATED THAT A SUBSTANTIAL REDUCTION IN NOISE OUTPUT OF ENGINES SUITABLE FOR SUBSONIC TRANSPORT AIRCRAFT CAN BE ACHIEVED. THE NEXT STEP IN THIS PROGRAM IS TO DEMONSTRATE THIS TECHNOLOGY IN AN EXPERIMENTAL ENGINE. A CONTRACT PROGRAM WILL PROVIDE ENGINE DETAILED DESIGNS; A FAN DEVELOPMENT PROGRAM; AND FABRICATION, TESTING AND

DELIVERY OF TEST ENGINES TO LEWIS RESEARCH CENTER. SUBSEQUENT TESTS OF THESE ENGINES AT LEWIS WITH ACOUSTICALLY TREATED NACELLES WILL DEMONSTRATE MINIMUM INSTALLED PROPULSION SYSTEM NOISE LEVELS.

RTOP NO. 762-73-02 TITLE: QUIET ENGINE RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KRAMER, J. J. TEL. 216-433-6878
TECHNICAL SUMMARY

RESEARCH WILL BE PERFORMED IN VARIOUS AREAS IN DIRECT SUPPORT OF THE QUIET ENGINE. PRIME AREAS OF ACTIVITY ARE FULL-SCALE NOISE TESTING, FULL-SCALE SUPPRESSOR DEVELOPMENT AND FULL-SCALE ENGINE TESTING. THE WORK IN THIS PROGRAM IS IN DIRECT SUPPORT OF RTOP 762-73-01 (EXPERIMENTAL QUIET ENGINE). IN THIS PROGRAM VARIOUS PROBLEM AREAS WILL BE EXPLORED USING HARDWARE OF APPROPRIATE SCALE FOR USE IN THE QUIET ENGINE. INITIAL ACTIVITY WILL CONSIST OF TESTING FULL-SCALE FANS AND SUPPRESSORS DESIGNED FOR USE IN THE QUIET ENGINE. SUBSEQUENT WORK AREAS ARE FURTHER NOISE REDUCTION OF TOTAL ENGINE SYSTEMS.

RTOP NO. 762-74-01 TITLE: ADVANCED INTEGRATED PROPULSION CONTROLS PROGRAM
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ZELLER, J. R. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO INVESTIGATE THE POTENTIAL AIRCRAFT PERFORMANCE GAINS POSSIBLE BY USING ADVANCED CONTROL TECHNIQUES TO INTEGRATE THE DYNAMIC OPERATION OF AN INLET AND TURBINE ENGINE SYSTEM INTO A TOTAL AIRBREATHING PROPULSION SYSTEM. THE GAINS BEING PURSUED WOULD BE IN AREAS SUCH AS: (1) REDUCING THE FREQUENCY OF ENGINE STALL DURING MANEUVERS, (2) INCREASING RANGE, AND (3) REDUCING TAKE-OFF DISTANCE. PREVIOUS STUDIES HAVE SHOWN THESE TO BE SOME OF THE AREAS IN WHICH AN ADVANCED INTEGRATED PROPULSION CONTROL SYSTEM CAN DEMONSTRATE IMPROVEMENT. TO PROVIDE COMPLETE FLEXIBILITY AND VERSATILITY FOR THE IMPLEMENTING OF MORE COMPLEX CONTROL LAWS, THE RESEARCH PROPULSION CONTROLLER WILL USE A DIGITAL COMPUTER CONTROL SYSTEM. TO FACILITATE AN INVESTIGATION OF THE BENEFITS OF INTEGRATED PROPULSION CONTROL IN A FLIGHT ENVIRONMENT, THE SYSTEM WILL BE EVALUATED IN A FLIGHT RESEARCH PROGRAM ON ONE SIDE OF THE F-111 AIRCRAFT. THIS AIRCRAFT IS SELECTED BECAUSE OF ITS OPERATIONAL STATUS AND THE FACT THAT IT USES A TWO SPOOL AFTERBURNING TURBOFAN ENGINE. THIS ENGINE IS TYPICAL OF THE ENGINES BEING DEVELOPEDFOR FUTURE MULTI-MISSION AIRCRAFT TO PROVIDE FOR THE FLIGHT TESTS, A DIGITAL COMPUTER CONTROL SYSTEM, QUALIFIED FOR A FLIGHT ENVIRONMENT WILL BE PROVIDED.

RTOP NO. 762-75-01 TITLE: HYPERSONIC RESEARCH ENGINE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO DEFINE A PRACTICAL, HIGH-PERFORMANCE, MACH 3 TO 8 LIQUID HYDROGEN HYPERSONIC RAMJET ENGINE OF LABORATORY SIZE BY BUILDING A FULL-SCALE, WATER-COOLED, AEROTHERMODYNAMIC INTEGRATION MODEL (AIM), AND A FULL-SCALE, HYDROGEN-COOLED, STRUCTURES ASSEMBLY MODEL (SAM) OF THE HRE; AND MEASURING THE AEROTHERMODYNAMIC PERFORMANCE FROM MACH 5 TO 7 WITH THE AIM AND EVALUATING AT MACH 7 THE ENGINE STRUCTURES THERMAL PERFORMANCE AND LOW CYCLE FATIGUE CHARACTERISTICS. THE OBJECTIVE IS TO ADVANCE AND CRYSTALLIZE THE TECHNOLOGY OF HYPERSONIC AIRBREATHING PROPULSION SYSTEMS AND EVALUATE THE REQUIREMENTS FOR FUTURE RESEARCH.THE SUPERIOR FUEL ECONOMY OF AIRBREATHING PROPULSION REQUIRES THAT SUCH SYSTEMS BE REEXAMINED IN LIGHT OF THE CURRENT TECHNOLOGY FOR APPLICATION TO ANY NEW HYPERSONIC ATMOSPHERIC FLIGHT MISSION.

RTOP NO. 762-75-01 TITLE: HYPERSONIC RESEARCH ENGINE
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LEZBERG, E. A. TEL. 216-433-4000
TECHNICAL SUMMARY

ENGINE TESTING OF THE HRE, AEROTHERMODYNAMIC INTEGRATION MODEL WILL BE CONDUCTED AT THE PLUM BROOK, HTF OVER A MACH NUMBER RANGE OF 5-7 TO PROVIDE INFORMATION ON COMPONENT INTERACTIONS, IGNITION, COMBUSTION MODE TRANSITION AND PERFORMANCE. TESTING SHOULD SPAN ABOUT A 8-9 MONTH PERIOD BEGINNING IN THE SECOND QUARTER OF FY 1972, AND INCLUDE TESTS AT TWO PRESSURE (ALTITUDE) LEVELS AND AT ANGLE OF ATTACK. A FOLLOW-ON PROGRAM BEGINNING IN FY 1974 WOULD BE TESTING OF A COMPONENT INTEGRATION MODEL MORE TYPICAL OF AN ENGINE FOR A REUSABLE BOOSTER OR CRUISE AIRPLANE TO DETERMINE PERFORMANCE IN THE SIMULATED VEHICLE FLOW FIELD.

RTOP NO. 764-72-02 TITLE: VTOL PROPULSION SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: STEWART, W. L. TEL. 216-433-4000
TECHNICAL SUMMARY

THE NASA IS ENGAGED IN A PROGRAM DIRECTED AT THE INVESTIGATION OF COMMERCIAL VTOL AIRCRAFT EMPLOYING DIRECT LIFT FAN ENGINES. RESPONSIBILITY FOR VTOL AIRFRAME AND AIRCRAFT STUDIES IS AT AMES AND IS COVERED UNDER ANOTHER RTOP. THE PROPULSION NEEDS OF THE PROGRAM ARE THE RESPONSIBILITY OF LEWIS RESEARCH CENTER AND INCLUDE 1) ESTABLISHING A TECHNOLOGY BASE FOR LIFT FAN ENGINES, AND 2) PROVIDING PROPULSION SUPPORT TO AMES FOR THEIR AIRCRAFT STUDIES AS REQUIRED. THE ENGINE TECHNOLOGY PROGRAM IS DIRECTED AT THE INVESTIGATION OF PROBLEMS ASSOCIATED WITH THE ENGINE COMPONENTS, INTEGRATION OF THE ENGINE COMPONENTS, ENGINE INSTALLATION EFFECTS, AND ENGINE NOISE

10X10 AND 8X6 SUPERSONIC WIND TUNNEL WITH AND WITHOUT A J-85 OR TF-30 ENGINE OR A RESEARCH COMPRESSOR. AT TRANSONIC SPEEDS, THE GROUND TEST FACILITIES ARE COMPLEMENTED BY A FLIGHT TEST PROGRAM WHICH IS BASED ON THE USE OF AN F-106 AIRCRAFT WITH UNIQUE MODIFICATIONS FOR INLET RESEARCH. THIS FACILITY PERMITS TESTING OF AIRFRAME INSTALLATION EFFECTS ON COMPLEX INLET MODELS AT A MUCH LARGER SCALE THAN CAN BE ACHIEVED IN EXISTING TRANSONIC WIND TUNNELS. PROPULSION SYSTEM PERFORMANCE, STABILITY AND COMPATIBILITY WILL BE DETERMINED AND RELATED TO INLET AND ENGINE DESIGN PARAMETERS. THESE TESTS WILL BE DONE BOTH ISOLATED AND ALSO IN THE FLOW FIELD OF A PORTION OF THE AIRFRAME SUCH AS A WING OR FOREBODY.

RTOP NO. 764-74-01 TITLE: SUPERSONIC INLETS, INLET CONTROLS, AND ENGINE DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO PROVIDE INFORMATION NEEDED IN THE DESIGN AND OPERATION OF EFFICIENT AIR INDUCTION SYSTEMS FOR SUPERSONIC AIRCRAFT. THE SPECIFIC AREAS RECEIVING ATTENTION ARE (1) A GENERAL UNDERSTANDING OF BASIC FLOW PROBLEMS ENCOUNTERED (FLOW FIELDS AT INLET ENTRANCE, BOUNDARY LAYER GROWTH, INTERACTION WITH SHOCKS, SEPARATION, BLEED, ETC.,) AND DERIVATION OF MATHEMATICAL DESIGN PROCEDURES (2) MORE DETAILED STUDIES OF TWO GENERAL CLASSES OF INLETS; TWO-DIMENSIONAL AND AXISYMMETRIC (3) CONTINUOUS UP-DATING OF AVAILABLE COMPUTER PROGRAMS DERIVED TO AID IN INLET DESIGN (4) FLOW DISTORTION AND FLUCTUATIONS AT THE COMPRESSOR FACE, AND (5) THE RELATION BETWEEN CLEAR-AIR TURBULENCE AND ENGINE UNSTARTS, OR INLET INSTABILITY. THE RESEARCH STUDIES ARE BOTH ANALYTICAL AND EXPERIMENTAL, AND INVOLVE IN-HOUSE, GRANT, AND CONTRACT EFFORTS.

RTOP NO. 764-74-02 TITLE: SUPERSONIC EXHAUST NOZZLE SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A PRIME GOAL OF JET EXIT RESEARCH IS TO ACHIEVE EXHAUST NOZZLE DESIGNS CAPABLE OF NEAR IDEAL CONVERSION OF THE PRESSURE AND THERMAL ENERGY OF THE ENGINE INTERNAL FLOW INTO THRUST OF THE EXHAUST JET; AND, TO DEVISE AND INVESTIGATE EXHAUST NOZZLE MECHANISMS WHICH PERMIT VARIATION OF THROAT SIZE AND NOZZLE EXPANSION RATIO TO MAINTAIN THIS NEAR IDEAL PERFORMANCE OVER ANY REQUIRED RANGE OF VEHICLE AIRSPEED AND NOZZLE PRESSURE RATIO. AN EQUALLY IMPORTANT GOAL IS REALIZATION OF SYSTEMATIC DESIGN PROCEDURES FOR INCORPORATION OF SINGLE OR MULTIPLE EXHAUST NOZZLES INTO AN AIRFRAME TO YIELD A CONFIGURATION NOT PENALIZED BY LOSS OF THRUST OR INCREASE IN DRAG RELATED TO THE EXHAUST NOZZLE INSTALLATION. A FURTHER GOAL IS CONTINUED STUDY OF BOUNDARY LAYER AND JET MIXING, AND OF JET EFFECTS ON BASE AND BOATTAIL DRAG, AND TO REDUCE TO SCIENCE THE KNOWLEDGE OF THESE MUTUAL INTERFERENCES BETWEEN EXHAUST JET PLUME, AIRFRAME, AND EXTERNAL AIRSTREAM, WITH A VIEW TO EXPLOIT THESE PHENOMENA FOR ACHIEVEMENT OF

GENERATION. LIFT ENGINE CONFIGURATIONS BEING CONSIDERED INCLUDE REMOTE DRIVE FANS, DRIVEN BY EITHER TURBOJET OR TURBOFAN GAS GENERATORS, AND INTEGRAL DRIVE FANS.

RTOP NO. 764-72-03 TITLE: HIGH SPEED SHAFTING AND GEARING
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ANDERSON, W. J. TEL. 216-433-4000
TECHNICAL SUMMARY

MATERIALS, FABRICATION TECHNIQUES, DESIGNS AND LUBRICATION TECHNIQUES FOR GEARING WILL BE DEVELOPED. ANALYTIC TECHNIQUES FOR BALANCING, DETERMINING AND CONTROLLING THE DYNAMIC BEHAVIOR OF SHAFTS AND ROTORS WILL BE DEVELOPED AND CORROBORATED EXPERIMENTALLY TO PROVIDE BETTER DESIGN TOOLS FOR HIGH SPEED TURBOMACHINERY, SHAFTING AND TRANSMISSIONS.

RTOP NO. 764-74-01 TITLE: SUPERSONIC INLETS, INLET CONTROLS, AND ENGINE DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEVELOP AN UNDERSTANDING OF THE INLET AND PROPULSION SYSTEM REQUIREMENTS FOR ADVANCED AIRCRAFT, TO DETERMINE THE TYPES OF DESIGNS WHICH SATISFY THESE REQUIREMENTS, AND TO PROVIDE THE TECHNOLOGY REQUIRED TO ASSURE SUCCESSFUL OPERATION OF ADVANCED INLETS. THE RESEARCH IS DIRECTED TOWARD MILITARY AND COMMERCIAL AIRCRAFT. CURRENTLY, PRIMARY EMPHASIS IS DIRECTED TOWARD DEVELOPING RELIABLE METHODS FOR PREDICTING THE PRESSURE DISTRIBUTIONS ON INLET AND NACELLE SURFACES AT SUBSONIC AND TRANSONIC SPEEDS. THE RESULTS OF ANALYTICAL METHODS WILL BE COMPARED WITH EXPERIMENTAL RESULTS FOR TWO-AND THREE-DIMENSIONAL INLETS. EMPIRICAL PROCEDURES WILL BE DEVELOPED AS REQUIRED. ANALYTICAL RESEARCH IS ALSO UNDERWAY TO DEVELOP METHODS FOR PREDICTING THE INLET FLOW FIELDS WHICH ARE GENERATED BY FUSELAGE FOREBODIES.

RTOP NO. 764-74-01 TITLE: SUPERSONIC INLETS AND ENGINE DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BEHEIM, M. A. TEL. 216-433-6374
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF INLETS FOR FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE STABILITY PROBLEMS OF HIGH-PERFORMANCE INLETS AT THEIR DESIGN SPEED, ON THE MUTUAL INTERACTION PROBLEMS THAT RESULT WHEN INTEGRATING THESE COMPONENTS INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM, AND ON THE PERFORMANCE AND VARIABLE-GEOMETRY PROBLEMS THAT ARE ENCOUNTERED DURING OFF-DESIGN OPERATION. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT. TO STUDY THESE PROBLEMS, SUPERSONIC CRUISE AND DASH INLETS WILL BE DESIGNED AND TESTED IN THE

IMPROVED VEHICLE PERFORMANCE. THE TERM EXHAUST NOZZLE HERE IS MEANT TO INCLUDE JET NOISE SUPPRESSORS AND THRUST REVERSERS. STUDIES OF THE EFFECT OF JET DEFLECTION ON LIFT INDUCED ON THE AIRFRAME WILL BE CONTINUED. THIS WORK IS DIRECTED TOWARD AIRCRAFT CONFIGURATIONS OF HIGH MANEUVERABILITY AND INCREASED RANGE. WORK WILL BE STARTED ON EXPLOITATION OF JET ENTRAINMENT OF THE EXTERNAL FLOW TO REDUCE SHOCK INDUCED AIRFRAME DRAG AND WING INDUCED DRAG. AN EXHAUST NOZZLE, CAPABLE OF JET NOISE ATTENUATION, YET HAVING HIGH PERFORMANCE OVER A WIDE SPEED RANGE, WILL BE INVESTIGATED.

RTOP NO. 764-74-02 TITLE: SUPERSONIC JET EXHAUST SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BEHEIM, M. A. TEL. 216-433-6374
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF NOZZLES OF FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE PERFORMANCE, COOLING, NOISE SUPPRESSION, AND VARIABLE GEOMETRY PROBLEMS THAT ARE ENCOUNTERED DURING OPERATION OVER A BROAD RANGE OF FLIGHT SPEEDS. IN ADDITION, STUDIES WILL BE MADE OF THE MUTUAL INTERACTION PROBLEMS THAT OCCUR WHEN INTEGRATING THE NOZZLE INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT. AS NEW NOZZLE REQUIREMENTS ARISE AND FABRICATION METHODS IMPROVE, NEW NOZZLE DESIGNS APPEAR. THE INTERNAL FLOW OF THESE NOZZLES WILL BE INVESTIGATED ANALYTICALLY AND EXPERIMENTALLY IN A QUIESCENT TEST FACILITY. THE EXTERNAL FLOW EFFECTS AT TRANSONIC SPEEDS WILL BE EXPERIMENTALLY INVESTIGATED BOTH ISOLATED AND IN THE AIRFRAME FLOW FIELD. SMALL SCALE TESTS WILL BE DONE IN THE 8X6 SWT UTILIZING COLD FLOW FROM AN EXTERNAL SOURCE OR A 4" TURBOJET SIMULATOR. LARGER SCALE TESTS CANNOT BE DONE IN A WIND TUNNEL, AND SO AN F-106 UTILIZING UNDERWING NACELLES OBTAINS INTERFERENCE-FREE DATA FOR 25" NOZZLES MOUNTED JUST AFT OF THE WING. NOZZLE COOLING WILL BE INVESTIGATED ANALYTICALLY AND BY TESTING COOLED NOZZLE CONFIGURATIONS BEHIND AN AFTERBURNING J-85 ENGINE.

RTOP NO. 764-74-03 TITLE: COMPRESSORS AND FANS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: HARTMANN, M. J. TEL. 216-433-6650
TECHNICAL SUMMARY

APPROACHES TO REDUCE FAN AND COMPRESSOR WEIGHT AND IMPROVE PERFORMANCE WILL BE INVESTIGATED. REDUCTIONS IN COMPONENT WEIGHT CAN BE ACHIEVED BY INCREASING STAGE PRESSURE RATIO, THUS REDUCING THE NUMBER OF STAGES AND BY INCREASING THE FLOW RATE TO OBTAIN A SMALLER DIAMETER. THE LIGHTWEIGHT FAN AND COMPRESSOR MUST OPERATE EFFICIENTLY WITH THE NECESSARY STALL MARGIN AND DISTORTION TOLERANCE OVER A WIDE RANGE OF FLIGHT CONDITIONS. A. BLADING FOR HIGHER STAGE PRESSURE RATIO COMPRESSORS MUST BE DESIGNED TO OPERATE AT HIGHER MACH NUMBERS AND HIGHER LEVELS OF AERODYNAMIC LOADING. B. INCREASED BLADE LOADING TO ACHIEVE HIGHER PRESSURE RATIOS MUST BE STUDIED.

VARIOUS APPROACHES TO DELAY END WALL STALL INCLUDING CASING TREATMENT MAY PROVIDE INCREASED STALL MARGIN AND TOLERANCE TO INLET FLOW DISTORTION. C. DESIGNS PERMITTING HIGHER FLOW VELOCITIES WILL BE STUDIED. APPROACHES TO ANALYZING "FLOW CHOKING" AND FLOW CONDITIONS IN THE REGION OF THE SHOCKS MUST BE DEVISED. D. CONCEPTS THAT PROVE PROMISING IN SINGLE STAGE STUDIES ARE BEING INVESTIGATED IN MULTISTAGE COMPRESSORS. THESE INCLUDE ADVANCED BLADE SHAPES, VARIABLE CAMBER BLADE ROWS AND CASING TREATMENT. E. LOW HUB DIAMETER FANS SUITABLE FOR LOW NOISE HIGH BYPASS RATIO ENGINE SYSTEMS MUST BE INVESTIGATED.

RTOP NO. 764-74-04 TITLE: ADVANCED COMBUSTORS AND FUELS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CHILDS, J. H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRIMARY COMBUSTOR RESEARCH WILL ESTABLISH THE TECHNOLOGY NECESSARY FOR COMBUSTORS HAVING HIGH PERFORMANCE, LOW POLLUTANT EMISSIONS, AND GOOD DURABILITY AT OPERATING CONDITIONS TYPICAL OF ADVANCED COMMERCIAL AND MILITARY AIRCRAFT. THREE BASICALLY DIFFERENT COMBUSTOR TYPES ARE PRESENTLY UNDER INVESTIGATION: A RAM INDUCTION COMBUSTOR, A MODULAR SWIRL ELEMENT COMBUSTOR, AND A ONE-SIDE-ENTRY COMBUSTOR. EXTENSIVE ITERATIVE TESTS WILL BE REQUIRED TO DETERMINE THE EXTENT TO WHICH EACH OF THESE COMBUSTOR TYPES CAN PROVIDE THE DESIRED PERFORMANCE. PRIMARY COMBUSTORS OF THREE DIFFERENT SIZES WILL BE INVESTIGATED; IT IS EXPECTED THAT DIFFERENT CONFIGURATIONS WILL BE REQUIRED FOR EACH OF THESE SIZES. THE REHEAT BURNER PROGRAM PLACES PRIMARY EMPHASIS ON THE REQUIREMENTS OF ADVANCED ENGINES WITH HIGHER TURBINE-EXIT TEMPERATURES. VARIOUS NEW REHEAT BURNER CONCEPTS WILL BE INVESTIGATED; THESE INCLUDE MODULAR SWIRL-TYPE COMBUSTOR ELEMENTS AND CONFIGURATIONS WHICH EMPLOY FUEL PREVAPORIZATION AND PREMIXING WITH AIR IN A CONFINED FUEL-RICH REGION UPSTREAM OF THE FLAMEHOLDERS. RESEARCH WILL BE CONDUCTED ON FILM COOLING OF COMBUSTOR LINERS, MULTIPLE JET PENETRATION AND MIXING, NEW TYPES OF FUEL INJECTORS, AND SHORT-LENGTH, BLEED-TYPE COMBUSTOR INLET DIFFUSERS. CONCLUDING RESEARCH WILL BE DONE ON FUEL SYSTEM COMPONENTS AND HANDLING TECHNIQUES FOR LIQUID METHANE AND LIQUID HYDROGEN FUELS.

RTOP NO. 764-74-05 TITLE: TURBINES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ESGAR, J. B. TEL. 216-433-6625
TECHNICAL SUMMARY

THE TURBINE PROGRAM INCLUDES RESEARCH ON TURBINE AERODYNAMICS, TURBINE COOLING, AND TURBINE LIFE. EACH OF THESE AREAS ARE INTERRELATED, AND IT IS NOT PRACTICAL TO CONDUCT RESEARCH IN ONE AREA WITHOUT CONSIDERING HOW THE OTHER AREAS WILL BE AFFECTED. ADVANCED COOLING SCHEMES FOR VERY HIGH GAS TEMPERATURE OPERATION WILL REQUIRE INCREASED USE OF FILM AND TRANSPIRATION COOLING. THE EFFECTS OF THESE AND OTHER TYPES OF COOLING AIR DISCHARGE ARE BEING INVESTIGATED FROM THE STANDPOINTS OF BOTH HEAT TRANSFER AND AERODYNAMICS, AND THE

EFFECTS ON BLADE LIFE WILL BE INVESTIGATED IN THE FUTURE. THE TURBINE AERODYNAMICS RESEARCH IS ALSO INVESTIGATING THE EFFECT OF AIR DISCHARGE IN THE FORM OF A JET FLAP FOR PROVIDING PNEUMATIC VARIABLE GEOMETRY TO THE TURBINE. INVESTIGATIONS ARE BEING MADE ON MULTISTAGE TURBINES WITH WORK FACTORS FROM 3 TO 5 FOR APPLICATION TO HIGH BYPASS RATIO LIFT OR CRUISE ENGINES. HEAT TRANSFER, FLUID FLOW, AERODYNAMICS, AND LIFE INVESTIGATIONS ARE UNDERWAY FOR A VARIETY OF CONVECTION, FILM, AND TRANSPIRATION CONFIGURATIONS FOR TURBINE SIZES RANGING FROM THOSE FOR HELICOPTER ENGINES TO HIGH SPOOL TURBINES FOR TURBOFAN ENGINES. FUNDAMENTAL HEAT TRANSFER INVESTIGATIONS ON FILM AND TRANSPIRATION COOLING ARE ALSO CONTINUING. TURBINE COOLING PROBLEMS BECOME MUCH MORE SEVERE AT THE VERY HIGH HEAT FLUXES THAT ARE ENCOUNTERED WITH TURBINE INLET TEMPERATURES IN EXCESS OF 3000 DEGREES F AND HIGH GAS PRESSURES ENCOUNTERED WITH COMPRESSOR PRESSURE RATIOS IN THE RANGE FROM 30 TO 40. DESIGN AND FABRICATION OF A TURBINE RIG TO INVESTIGATE THE AERODYNAMIC, HEAT TRANSFER, AND LIFE PROBLEMS ENCOUNTERED WITH THESE HIGH TEMPERATURE, HIGH PRESSURE TURBINES IS BEING INITIATED.

RTOP NO. 764-74-06 TITLE: TURBINE ENGINE SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: POVOLNY, J. H. TEL. 216-433-6624
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE TECHNOLOGY RELATIVE TO TURBINE ENGINE SYSTEMS REQUIRED FOR FUTURE SUBSONIC AND SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON SEEKING AN UNDERSTANDING AND SOLUTION OF THE DYNAMIC INTERACTION PROBLEMS ASSOCIATED WITH FLIGHT SYSTEMS. THE LATEST LARGE SCALE TURBOJET AND TURBOFAN ENGINES DESIGNED FOR BOTH SUBSONIC AND SUPERSONIC CRUISE AND SUPERSONIC DASH APPLICATIONS WILL BE USED IN THE INVESTIGATIONS. EXPLORATORY AND PERFORMANCE EVALUATIONS WILL BE MADE OF SYSTEMS APPLICABLE TO THE ATT AND MILITARY AIRPLANES CURRENTLY BEING DESIGNED. THIS EFFORT IS CONCERNED WITH THE EFFECTS OF INLET PRODUCED ENVIRONMENT ON THE ENGINE AND THE INTERACTIONS OF THE VARIOUS ENGINE COMPONENTS AS WELL AS INTERACTIONS BETWEEN THE ENGINE AND THE INLET. THIS EFFORT IS CLOSELY RELATED TO THE INLET, INLET CONTROL, AND INLET ENGINE DYNAMICS RESEARCH DESCRIBED IN RTOP 764-74-01.

RTOP NO. 764-74-07 TITLE: DYNAMICS AND CONTROL OF PROPULSION SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BOKSENBOM, A. S. TEL. 216-433-6196
TECHNICAL SUMMARY

THIS RTOP COLLECTS TOGETHER DYNAMICS AND CONTROL EFFORTS THAT IN PREVIOUS YEARS HAVE BEEN REPORTED UNDER OTHER RTOPS. CONTROL ANALYSIS AND ENGINE AND INLET CONTROLS HAVE BEEN DONE UNDER OLD NUMBERS 720-03-15 AND 720-03-10. SIMULATION WAS DONE UNDER 126-63-12. THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP AND APPLY METHODS OF DYNAMIC ANALYSIS AND CONTROL THEORY AND CONCEPTS TO THE PROBLEMS OF AIRBREATHING PROPULSION SYSTEMS. ANALYSES AND SIMULATIONS OF THE DYNAMIC CHARACTERISTICS OF THESE SYSTEMS WILL BE

DEVELOPED. CONTROL THEORIES AND CONCEPTS WILL BE DEVELOPED AND APPLIED TO ACHIEVE IMPROVED PERFORMANCE AND OPERATION OF THE SYSTEM. SPECIAL CONTROL HARDWARE, SUCH AS SERVOS, INSTRUMENTS, AND ACTUATORS, WILL BE DEVELOPED AS REQUIRED. EXPERIMENTS WITH COMPONENTS AND COMPLETE SYSTEMS WILL BE PERFORMED TO VALIDATE THE METHODS AND CONCEPTS DEVELOPED FOR PROPULSION SYSTEM CONTROL.

RTOP NO. 764-75-01 TITLE: HYPERSONIC COMPONENTS AND SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

RESEARCH INVESTIGATIONS TO DEVELOP AEROTHERMODYNAMIC CONCEPTS FOR SCRAMJET ENGINES FOR VEHICLE APPLICATIONS ARE UNDERWAY. THE RESEARCH PROGRAM INCLUDES AN ACTIVE INLET DESIGN AND TESTING PROGRAM FOR FLIGHT MACH NUMBERS UP TO 10 WITH INLETS WHICH RELY ON COMPLEX COMPRESSION SURFACES OR THREE-DIMENSIONAL CONTOURS TO ACHIEVE RAPID COMPRESSION AND INTEGRATED WITH THE AIRCRAFT SURFACE. AN ANALYTICAL AND EXPERIMENTAL RESEARCH PROGRAM ON SUPERSONIC COMBUSTION AND MIXING IS ALSO INCLUDED WHICH INVOLVES THE USE OF A COMBUSTION HEATER FOR SIMULATING THE CONDITIONS AT THE COMBUSTOR ENTRANCE CORRESPONDING TO FLIGHT MACH NUMBERS FROM 3 TO 9. INVESTIGATIONS OF COMBUSTION, HYDROGEN FUEL INJECTION, MIXING, AND HEAT TRANSFER IN BOTH 2-DIMENSIONAL AND AXISYMMETRIC FLOW FIELDS FOR BOTH WALL AND STREAM INJECTION WILL BE CONDUCTED. SOME SPECIFIC TASKS IN THIS PROGRAM WILL BE CONDUCTED BY CONTRACT. MODIFICATION TO THE LANGLEY 4-FT. ARC TUNNEL WILL BE UNDERTAKEN TO PERMIT TESTS OF COMPLETE, SMALL-SCALE SCRAMJET ENGINES BURNING HYDROGEN FUEL WITH DUPLICATION OF M = 7 FLIGHT CONDITIONS. ALSO PROOF OF CONCEPT RESEARCH ON AN ADVANCED TYPE OF GROUND FACILITY EMPLOYING A CERAMIC-LINED TANK FOR STORING ARC-HEATED AIR WILL BE CONTINUED. THIS CONCEPT ALLEVIATES POWER LIMITATIONS ON ARC HEATERS AND WILL PROVIDE LARGE MASS FLOW, TRUE-TEMPERATURE, CLEAN AIR, TESTING CAPABILITY AT M = 9.

RTOP NO. 764-75-01 TITLE: HYPERSONIC INLET RESEARCH INCLUDING COMBUSTOR EFFECTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

ANALYTICAL PROCEDURES FOR THE PREDICTION OF THE AIR FLOW CHARACTERISTICS IN HYPERSONIC INLETS (AND, CONSEQUENTLY, THEIR AERODYNAMIC PERFORMANCE) ARE CURRENTLY INADEQUATE BECAUSE THEY DO NOT TREAT ACCURATELY OR COMPREHENSIVELY SUCH FACTORS AS SHOCK WAVE/BOUNDARY LAYER INTERACTIONS AND EFFECTS PRODUCED BY OPERATION OF A COMBUSTOR. THIS RESEARCH WILL PROVIDE IMPROVED COMPUTATION METHODS, AND CORRELATING WIND TUNNEL DATA, FOR SEVERAL INLET INTERNAL CONFIGURATIONS WITH AND WITHOUT A SIMULATED COMBUSTOR. A PORTION OF THE EFFORT HAS BEEN COMPLETED UNDER CONTRACT, AND BY TESTS IN THE AMES 3.5-FOOT HYPERSONIC WIND TUNNEL. THE REMAINDER OF THE PROGRAM WILL USE A CONTINUATION OF THIS APPROACH.

RTOP NO. 764-75-01 TITLE: HYPERSONIC COMPONENTS AND SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LEZBERG, E. A. TEL. 216-433-4000
TECHNICAL SUMMARY

EXPERIMENTAL AND ANALYTICAL WORK WILL BE CONDUCTED ON COMBUSTION FUNDAMENTALS, COMPONENT DEVELOPMENT, AND MEASUREMENT AND SIMULATION TECHNIQUES FOR HYPERSONIC PROPULSION TESTING. RESEARCH ON COMBUSTORS FOR SCRAMJETS WILL INCLUDE EXPERIMENTAL STUDIES OF GASEOUS FUEL INJECTION AND SPREADING. SIMILARLY, COMBUSTION STUDIES ARE BEING CONDUCTED IN HIGH TEMPERATURE VITIATED AND CLEAN AIR STREAMS TO BETTER UNDERSTAND IGNITION AND MIXING BEHAVIOR IN THE PRESENCE OF FLAME GENERATED GRADIENTS. LARGE SCALE DIRECT-CONNECT TESTS OF AN 18-INCH DIAMETER COMBUSTOR WILL BE CONDUCTED AT THE HYPERSONIC TUNNEL FACILITY (HTF) AT CONDITIONS SIMULATING MACH 7 AND 8 FLIGHT AND COMBUSTOR PERFORMANCE EVALUATED FROM THRUST MEASUREMENTS. REGENERATIVELY COOLED COMBUSTORS WILL BE EVALUATED LATER IN THE PROGRAM. THE HTF WILL ALSO BE UTILIZED FOR TESTS OF TWO-DIMENSIONAL FIXED GEOMETRY INLETS TO EVALUATE PERFORMANCE AND TO DETERMINE AERODYNAMIC INTERACTIONS WITH INJECTED FUEL. A TECHNIQUE FOR GENERATING THICK BOUNDARY LAYERS WITH A TAILORED HONEYCOMB FLOW PASSAGE WILL BE EVALUATED. LATER INLET MODELS MAY INCORPORATE SUCH A BOUNDARY LAYER GENERATOR FOR SIMULATION OF AN INLET IN A VEHICLE FLOW FIELD. ANALYTICAL AND EXPERIMENTAL STUDIES OF THE EXHAUST NOZZLE WILL BE INITIATED WITH THE OBJECTIVE OF DEVELOPING CONTOURS SUITABLE FOR FIXED GEOMETRY OPERATION OVER A REPRESENTATIVE FLIGHT TRAJECTORY. EXPERIMENTAL WORK WILL BE CONTINUED TO EXTEND THE TEMPERATURE-MACH NUMBER CAPABILITY OF HTF WITH SIMULATED AIR.

RTOP NO. 133-17-01 TITLE: DEVELOPMENT OF STOL AVIONICS FOR TERMINAL AREA FLIGHT INVESTIGATION IN AIR TRAFFIC ENVIRONMENT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE IS TO DEVELOP NAVIGATION, GUIDANCE, AND CONTROL AVIONICS FOR USE IN STOL FLIGHT EXPERIMENTS AND FOR USE IN STOL VALIDATION FLIGHTS FOR THE NEW COMMON-USE CIVIL/MILITARY MICROWAVE SCANNING BEAM LANDING GUIDANCE SYSTEM (MW-SBLGS). PERFORMANCE AND DESIGN REQUIREMENTS FOR A FLEXIBLE AVIONICS SYSTEM, WHICH WILL OPERATE IN VARIOUS MANUAL AND AUTOMATIC MODES, WILL BE DEFINED TO SATISFY THE OBJECTIVES OF STOL FLIGHT EXPERIMENTS AND OF STOL MW-SBLGS VALIDATION FLIGHTS. IN PARTICULAR, REQUIREMENTS WILL BE BASED ON THE USE OF THE DEVELOPMENTAL SCANNING BEAM SYSTEM, MODILS, TO BE PROVIDED BY THE FAA FOR USE IN THE STOL FLIGHT EXPERIMENTS. THE AVIONICS SYSTEM, REFERRED TO AS STOLAND, WILL BE DESIGNED AND DEVELOPED AND THEN INSTALLED IN APPROPRIATE STOL AIRCRAFT AND TESTED IN FLIGHT. WITH THE EXCEPTION OF MODILS, THE FLIGHT TESTS WILL BE CONDUCTED USING STANDARD INSTRUMENTATION, TRACKING, DATA PROCESSING, AND NAVIGATION AIDS. THE DETAILED DESIGN

AND DEVELOPMENT OF STOLAND, WHICH WILL BE PERFORMED BY A CONTRACTOR, WILL BE SUPPORTED BY RELAT AND AVIONICS SYSTEM AT THE AMES RESEARCH CENTER. RESEARCH FLIGHTS USING STOLAND AND MODILS PLUS ADVANCED SYSTEM STUDIES CONDUCTED UNDER 133-17-02 WILL BE USED TO DEFINE A CONCEPT FOR AN INTEGRATED ADVANCED TECHNOLOGY AVIONIC SYSTEM WHICH WILL BE DEVELOPED UNDER 133-17-01 FOR USE IN THE MW-SBLGS VALIDATION FLIGHTS.

RTOP NO. 133-17-02 TITLE: STOL OPERATING SYSTEMS EXPERIMENTS AND VALIDATION OF THE STOL COMMON-USE CIVIL/MILITARY MICROWAVE SCANNING BEAM LANDING GUIDANCE SYSTEM (MW-SBLGS)

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE IS TO OBTAIN EXPERIMENTAL NAVIGATION, GUIDANCE, CONTROL, AND FLIGHT MANAGEMENT DATA FOR STOL AIRCRAFT USING ADVANCED AVIONICS AND THE NEW MW-SBLGS. THE DATA IS TO BE USED BY GOVERNMENT AND INDUSTRY TO ESTABLISH SYSTEM CONCEPTS, DESIGN CRITERIA, AND OPERATIONAL PROCEDURES FOR STOL AIRCRAFT. THIS PROGRAM IS PART OF THE JOINT DOT/NASA OPERATING SYSTEMS EXPERIMENT PROGRAM. THE BASIC APPROACH IS TO CONDUCT A GROUP OF CLOSELY RELATED INVESTIGATIONS FOR STOL, ENCOMPASSING ANALYSES, SIMULATION, FLIGHT EXPERIMENTS, AND SUPPORTING STUDIES. THESE INVESTIGATIONS WILL EMPHASIZE THE TERMINAL AREA NAVIGATION, GUIDANCE, CONTROL, AND FLIGHT MANAGEMENT PROBLEMS WHICH MUST BE SOLVED TO TAKE MAXIMUM ADVANTAGE OF STOL CAPABILITIES FOR MAKING STEEP ASCENTS AND DESCENTS, TIGHT TURNS, AND SLOW SPEED APPROACHES AND LANDINGS. THE FLIGHT EXPERIMENTS WILL BE CONDUCTED USING A FLEXIBLE AVIONICS SYSTEM, REFERRED TO AS STOLAND, IN CONJUNCTION WITH APPROPRIATE STOL AIRCRAFT. THE COMPLETE STOL FLIGHT RESEARCH SYSTEM COMPRISES STOL AIRCRAFT, AVIONICS, INSTRUMENTATION, TRACKING, AND THE FOLLOWING NAVIGATION AIDS: VOR/DME, TACAN, AND A SCANNING BEAM LANDING GUIDANCE SYSTEM TO BE PROVIDED BY THE FAA. MOST OF THE FLIGHT TESTING WILL BE CONDUCTED WITH A DEVELOPMENTAL SCANNING BEAM LANDING GUIDANCE SYSTEM, REFERRED TO AS MODILS. FINAL VALIDATION OF STOL USE WITH SCANNING BEAM LANDING GUIDANCE WILL BE PERFORMED USING THE MW-SBLGS. THE MW-SBLGS VALIDATION WITH STOL WILL BE CONDUCTED USING AN INTEGRATED ADVANCED TECHNOLOGY AVIONIC SYSTEM, WHICH WILL BE DEVELOPED UNDER 133-17-01 USING A SYSTEM CONCEPT DEFINED UNDER 13-17-02.

RTOP NO. 133-17-03 TITLE: DEFINITION OF ADVANCED STOL AVIONICS CONFIGURATIONS AND EXPERIMENTS

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

TO DEFINE FUNCTIONS TO BE PERFORMED BY INTEGRATED STOL AVIONICS SYSTEMS, TO IDENTIFY SYSTEM REQUIREMENTS AND POTENTIAL PROBLEM AREAS, TO ESTABLISH A PRELIMINARY DESIGN FOR AN INTEGRATED ALL-DIGITAL AVIONICS SYSTEM REPRESENTATIVE OF FUTURE OPERATIONAL STOL AVIONICS

SYSTEMS, AND TO RECOMMEND SETS OF SIMULATION AND FLIGHT-TEST EXPERIMENTS TO ASSESS: 1) THE CAPABILITIES OF ADVANCED AVIONICS SYSTEMS, AND 2) THE IMPACT OF ENROUTE AND TERMINAL AREA ATC PROCEDURES ON STOL AIRCRAFT DESIGN AND OPERATIONS. THE OBJECTIVE WILL BE ACCOMPLISHED THROUGH TWO SEPARATE BUT RELATED EFFORTS. THE FIRST OF THESE EFFORTS WILL BE AN ANLYTICAL STUDY BASED ON THE AIR TRAFFIC ENVIRONMENT AND OPERATIONAL PROCEDURES FOR STOL AIRCRAFT DEFINED BY THE WORK PERFORMED UNDER RTOP 139-06-03, AND WILL LEAD TO THE IDENTIFICATION OF RESEARCH NEEDED FOR TWO STOL AIRCRAFT AVIONICS SYSTEMS: ONE SYSTEM WILL BE FOR THE 1975-1980 TIME PERIOD, AND THE SECOND SYSTEM WILL BE AN ALL-DIGITAL ADVANCED SYSTEM FOR THE 1980-1990 TIME PERIOD. THE SECOND OF THESE EFFORTS WILL INCORPORATE THE TECHNIQUES OF SYSTEMS ANALYSIS, FAST TIME ATC SIMULATION, AND REAL TIME ATC SIMULATION TO EVALUATE THE PROPOSED AVIONICS AND ATC SYSTEMS AND TO ESTABLISH THEIR IMPACT ON THE DESIGN AND OPERATION OF STOL VEHICLES.

RTOP NO. 133-17-05 TITLE: VLF WIDE AREA NAVIGATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THIS WORK IS TO INVESTIGATE VLF NAVIGATION TECHNIQUES AND TO DEVELOP PROMISING APPROACHES FOR EN-ROUTE AND TERMINAL AREA NAVIGATION.THE OBJECTIVE IS TO DEVELOP HYPERBOLIC POSITION DETERMINATION TECHNIQUES USING VLF GROUND WAVE PROPAGATION SUCH THAT LARGE GEOGRAPHIC COVERAGE CAN BE OBTAINED WITH A LIMITED NUMBER OF GROUND STATIONS. SYSTEMS SUCH AS THIS WOULD ALLOW DIRECT TERMINAL TO TERMINAL FLIGHTS OPERABLE OVER THE ENTIRE COUNTRY. IT WILL ENHANCE AIR SAFETY BY REDUCING PILOT WORKLOADS AND RELIEVING AIRLANE CONGESTION RESULTING FROM THE CURRENT PRACTICE OF NAVIGATING WITHIN A NETWORK OF APPROXIMATELY 1000 VOR STATIONS. INITIAL WORK WILL BE CONDUCTED IN TWO AREAS. THE FIRST AREA WILL CONSIST OF A STUDY OF THE PROBLEMS ASSOCIATED WITH VLF TECHNIQUES SUCH AS ERRORS RESULTING FROM ATMOSPHERIC NOISE, PROPAGATION ANOMALIES, AND SYSTEMS RESPONSE TIME. THE SECOND AREA CONSISTS OF THE DEVELOPMENT OF AREA NAVIGATION TECHNIQUES UTILIZING THE NAVY'S OMEGA SYSTEM TRANSMISSIONS. THIS APPROACH HAS THE POTENTIAL FOR PROVIDING POSITION INFORMATION AND COURSE COMPUTATION IN THE OMEGA GRID AT A RELATIVELY LOW COST REQUIRED BY GENERAL AVIATION.

RTOP NO. 133-17-06 TITLE: VEHICLE DEPENDENT ASPECTS OF TERMINAL AREA GUIDANCE AND CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE AIRCRAFT PERFORMANCE AND CONTROL SYSTEM CHARACTERISTICS NEEDED FOR EFFICIENT OPERATION IN A TERMINAL AREA WITH ADVANCED AIR-TRAFFIC MANAGEMENT CONCEPTS AND IMPROVED AVIONICS. EMPHASIS IS PLACED ON THE VEHICLE DEPENDENT ASPECTS SUCH AS MANEUVER CAPABILITY, SPEED CONTROL, TURBULENCE

RESPONSE, RIDE QUALITY, AND THE RELATION OF CONTROL CHARACTERISTICS TO AVIONIC SYSTEMS. BOTH CTOL AND STOL AIRCRAFT WILL BE CONSIDERED. CONCURRENT LANGLEY EFFORTS ON TERMINAL AREA OPERATING PRACTICES, HANDLING QUALITIES, AND AVIONICS FOR TERMINAL AREA USE ARE IMPORTANT CONSIDERATIONS IN THIS WORK. MODELING AND SIMULATION TECHNIQUES WILL BE DEVELOPED TO EXAMINE VARIOUS CLASSES OF AIRCRAFT WITH SELECTED TERMINAL AREA TRAFFIC AND AIRSPACE CONSTRAINTS, CONTROL CONCEPTS, AVIONIC SYSTEMS, AND THE GROUND BASED ELEMENTS OF AIR-TRAFFIC CONTROL SYSTEMS. INITIAL STUDIES WILL USE KINEMATIC REPRESENTATIONS. THESE WILL BE FOLLOWED BY FULL AERODYNAMIC AND CONTROL SYSTEM SIMULATIONS. ANALYSIS AND SIMULATION DEVELOPMENT IS CLOSELY RELATED TO THE AVIONIC SYSTEMS EFFORT UNDER RTOP 135-06-01.

RTOP NO. 133-17-07 TITLE: INTEGRATION OF FLIGHT CONTROL, GUIDANCE, AND NAVIGATION FUNCTIONS THROUGH THE USE OF COMMON COMPONENTS

ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE IS TO UTILIZE THE POTENTIAL OF DIGITAL COMPUTERS, INERTIAL SENSORS, AND DISPLAYS TO EFFICIENTLY UNIFY THE NAVIGATION, GUIDANCE, AND FLIGHT CONTROL FUNCTIONS OF V/STOL AIRCRAFT. TECHNIQUES FOR PROVIDING EACH FUNCTION WILL BE INVESTIGATED WITH EMPHASIS ON THE REQUIREMENTS FOR A COMMON SYSTEM. EXISTING AND DEVELOPMENTAL INERTIAL SENSORS WILL BE REVIEWED TO SELECT THOSE WHICH MEET SYSTEM NEEDS WITH THE MOST ADVANTAGEOUS COMBINATION OF PERFORMANCE AND COST, AND METHODS WILL BE STUDIED FOR UPDATING INERTIAL SYSTEMS TO OBTAIN THE PRECISION NEEDED IN TERMINAL AREA OPERATIONS. COMPUTER-CONTROLLED CRT DISPLAYS WILL BE CONSIDERED AS A MEANS OF IMPROVING THE PRESENTATION OF DATA TO THE PILOT. AN INTEGRATED SYSTEM WILL THEN BE DEVELOPED AND EVALUATED IN GROUND-BASED SIMULATION TESTS. THIS WILL BE FOLLOWED BY A FLIGHT EVALUATION PROGRAM.

RTOP NO. 133-17-10 TITLE: GUIDANCE, NAVIGATION AND CONTROL EXPERIMENTS AND SYSTEMS CONCEPTS FOR VTOL AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

OBTAIN VTOL GUIDANCE, NAVIGATION AND CONTROL (GN&C) DATA THAT WILL BE OF VALUE TO INDUSTRY AND GOVERNMENT AGENCIES IN ESTABLISHING THE RELATIONSHIPS BETWEEN CONCEPTS, SYSTEM COMPLEXITY, PERFORMANCE, PILOT REQUIREMENTS AND OPERATIONAL REQUIREMENTS. VTOL GUIDANCE, NAVIGATION AND CONTROL REQUIREMENTS AND CONCEPTS WILL BE INVESTIGATED THROUGH ANALYTICAL STUDIES, SIMULATION EXPERIMENTS AND FLIGHT EXPERIMENTS.THE FLIGHT CONTROL SYSTEMS FOR THE VSTOL RESEARCH TRANSPORT AIRCRAFT (VRTA) WILL BE DESIGNED WITH AN INTERFACE COMPATIBLE WITH STOLAND (DEVELOPED UNDER RTOP 133-17-01). A STOLAND SYSTEM WILL BE MODIFIED AND INSTALLED IN THE VRTA. IFR TERMINAL AREA APPROACH AND LANDING EXPERIMENTS WILL BE CONDUCTED TO OBTAIN DATA ON

GN&C CONCEPTS AND PERFORMANCE AS A FUNCTION OF SYSTEM COMPLEXITY (MANUAL SYSTEMS THROUGH AUTOMATIC SYSTEMS), PILOT REQUIREMENTS AND OPERATIONAL REQUIREMENTS.

RTOP NO. 133-61-01 TITLE: NOISE ABATEMENT APPROACHES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

A SUCCESSFUL DEMONSTRATION OF THE USE OF EXISTING 3D-RNAV FLIGHT TECHNIQUES BY AN AIRLINES COULD LEAD TO THE ACCEPTANCE AND APPROVAL BY THE AIRLINES AND FAA, OF TWO-SEGMENT APPROACHES FOR NOISE ABATEMENT AT AN EARLY DATE. A CONTRACT IS BEING NEGOTIATED WITH AMERICAN AIRLINES TO INVESTIGATE THE USE OF A 3-D AREA NAVIGATION SYSTEM FOR ESTABLISHING TWO-SEGMENT NOISE ABATEMENT VERTICAL REFERENCE PATHS. THE AIRCRAFT WILL BE EQUIPPED WITH CONVENTIONAL AIRLINES AVIONIC SYSTEMS MODIFIED TO ALLOW THE PILOT TO FOLLOW THE TWO-SEGMENT REFERENCE PATH.A FLIGHT EVALUATION WITH THIS EQUIPMENT REPRESENTS A LOGICAL EXTENSION OF EARLIER NASA AND FAA STUDIES. SIMULATION WILL BE USED TO EXTRAPOLATE THE RESULTS OF THE FLIGHT TEST TO OTHER AIRCRAFT AND TO EXAMINE ANY DIFFICULTIES ENCOUNTERED IN FLIGHT. THE RESULTS OF THE FLIGHT TEST AND SIMULATION WILL BE USED TO DEFINE AN OPERATIONAL SYSTEM CONCEPT THAT WILL BE EVALUATED IN A FOLLOW ON FLIGHT TEST PROGRAM. THE FOLLOW ON FLIGHT TEST PROGRAM WILL BE CONTRACTED TO AN AIRLINES IN FY 72. OTHER NOISE ABATEMENT APPROACHES SUCH AS THE DECELERATING APPROACH WILL BE STUDIED IN HOUSE. THESE STUDIES WILL INCLUDE BOTH SIMULATION, AND FLIGHT TEST. THE RESULTS OF THIS IN HOUSE PROGRAM WILL BE USED TO DEFINE AN OPERATIONAL SYSTEM CONCEPT THAT IS PRESENTLY PLANNED TO BE EVALUATED BY AN AIRLINES IN FY 73. IN CONJUNCTION WITH THE SIMULATION AND FLIGHT PROGRAMS, THEORETICAL STUDIES WILL BE CONDUCTED TO DEFINE OPTIMAL NOISE ABATEMENT APPROACHES AND TO DEVELOP NOISE MODELS THAT CAN BE USED TO ESTIMATE AND EXTRAPOLATE THE PERCEIVED NOISE TO DIFFERENT CONDITIONS AND DIFFERENT AIRCRAFT.

RTOP NO. 133-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: EHERNBERGER, L. J. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK IS THE DEFINITION OF THE ATMOSPHERIC CONDITIONS IN WHICH TURBULENCE, TEMPERATURE TRANSIENTS, POTENTIAL PRESSURE ALTIMETRY PROBLEMS, AND EXCESSIVE WIND SHEARS OCCUR. THE MAJOR EMPHASIS IS THE ATMOSPHERIC ENVIRONMENT OF SUPERSONIC AIRCRAFT. DEVELOPMENT AND ACQUISITION OF SENSORS NEEDED TO MEASURE THESE PHENOMENA ARE ALSO INCLUDED. RESULTS OF THIS WORK WILL BE APPLICABLE TO AIRCRAFT SYSTEMS DESIGN AS WELL AS FLIGHT OPERATIONS ROUTING AND SCHEDULING. OBSERVATIONS OF THESE PHENOMENA ARE OBTAINED FROM INSTRUMENTED AIRCRAFT TEST FLIGHTS. THE ASSOCIATED METEOROLOGICAL CONDITIONS ARE ANALYZED AND STUDIED BOTH IN-HOUSE AND ON-CONTRACT.

RTOP NO. 133-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE AND DEFINE ATMOSPHERIC PARAMETERS FOR USE IN THE DESIGN ANDDEVELOPMENT OF OPERATIONAL TECHNIQUES OF CTOL AND V/STOL FLIGHT VEHICLES. CERTAIN PARAMETERS SUCH AS ATMOSPHERIC TURBULENCE OR THE HAIL ASSOCIATED WITH THUNDERSTORMS REPRESENT DISTINCT FLIGHT HAZARDS AND ARE IMPORTANT CONSIDERATIONS TO THE STRUCTURAL DESIGN AND THE STABILITY AND CONTROL CHARACTERISTICS OF THE AIRPLANE. OTHER PARAMETERS SUCH AS AEROSOLS OR MOLECULAR AND PARTICULATE MATTER IN THE ATMOSPHERE ARE FUNDAMENTAL TO AN UNDERSTANDING OF ATMOSPHERIC PROCESSES, AS FOR EXAMPLE, THE FORMATION OF CLEAR AIR TURBULENCE. AEROSOLS AND OTHER CONTAMINANTS ALSO RELATE TO THE OPERATIONAL PROBLEMS OF AIRPORT SLANT RANGE VISIBILITY AND SONIC BOOM RESEARCH. THE LARGE CONCENTRATIONS OF JET ENGINE EXHAUST PRODUCTS IN LOCAL AIRPORT AREAS ARE BECOMING OF INCREASING CONCERN TO THE ATMOSPHERIC POLLUTION PROBLEM AND TO THE SLANT RANGE VISIBILITY PROBLEM FOR LANDING AND TAKEOFF OPERATIONS. THESE AND OTHER ATMOSPHERIC PARAMETERS WILL BE STUDIED THROUGH FLIGHT MEASUREMENT AND GROUND BASED EXPERIMENTAL PROGRAMS AND THE RESULTS CORRELATED WITH THEORETICAL CALCULATIONS.

RTOP NO. 133-61-10 TITLE: ATMOSPHERIC PARAMETERS
ORGANIZATION: MARSHALL SPACE FLIGHT
MONITOR: FICHTL, G. H. TEL. 205-453-3168
TECHNICAL SUMMARY

THERE ARE TWO PRACTICAL WAYS TO PROBE CLEAR AIR TURBULENCE (CAT): (1) INSTRUMENTATION ABOARD AIRCRAFT AND (2) THE FPS-16 RADAR/JIMSPHERE BALLOON WIND SENSOR SYSTEM. THE FORMER YIELDS EXTENSIVE INFORMATION ABOUT THE HORIZONTAL STRUCTURE OF CAT, WHILE THE LATTER PROVIDES MEANINGFUL INFORMATION ABOUT THE VERTICAL STRUCTURE OF CAT AND THE PHENOMENA THAT GENERATE CAT. EXTENSIVE EFFORTS HAVE BEEN MADE BY VARIOUS INVESTIGATORS TO ANALYZE THE AIRCRAFT OBSERVATIONS, WHILE VERY LITTLE EFFORT HAS BEEN DEVOTED TO THE ANALYSIS OF JIMSPHERE DATA IN A CAT CONTEXT. ACCORDINGLY, THE OBJECTIVE OF THIS REQUEST IS TO EXPLOIT THE FPS-16 RADAR/JIMSPHERE BALLOON SYSTEM AND MSFC'S GROUND WIND MEASUREMENT SYSTEMS TO ACHIEVE A BETTER UNDERSTANDING OF ATMOSPHERIC TURBULENCE FOR THE DEFINITION OF ATMOSPHERIC PARAMETERS FOR USE IN AIRCRAFT DESIGN AND OPERATION. THIS WILL BE ACCOMPLISHED BY ESTABLISHING THE RELATIONSHIP BETWEEN HIGH RESOLUTION WIND AND TEMPERATURE PROFILES AND AIRCRAFT OBSERVATIONS OF CAT AND IN TURN ESTABLISHING THE RELATIONSHIP BETWEEN THESE PROFILES AND SYNOPTIC- AND MESO-SCALE CONDITIONS THAT PRODUCE THE DETAILS ON THESE WIND AND TEMPERATURE PROFILES. THE RESULTS OF THIS RESEARCH, COUPLED WITH THE CAT LASER DOPPLER DETECTION SYSTEM, SHOULD BETTER ESTABLISH THE RELATIONSHIP BETWEEN CAUSE AND EFFECT WITH REGARD TO IMPROVING CURRENT CRITICAL AIR TURBULENCE PREDICTING AND DETECTION CAPABILITIES BESIDES AIDING IN THE DEVELOPMENT OF AIRCRAFT/SHUTTLE DESIGN CRITERIA AND REMOTE CAT SENSING SYSTEMS.THESE ARE ALL PRIOR YEAR TASKS AND WERE COVERED UNDER CODE 126-61-10 WITH THE SAME TITLE AS THIS RTOP. EACH TASK IS BEING CHANGED TO REFLECT

CHANGES, OBJECTIVES, AND APPROACH.

RTOP NO. 133-61-11 TITLE: AIRCRAFT OPERATING EXPERIENCES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

STATISTICAL DATA ON THE OPERATIONAL EXPERIENCES OF COMMERCIAL PASSENGER AND CARGO TRANSPORTS, GENERAL AVIATION AIRPLANES, RESEARCH TYPE AIRPLANES, AND HELICOPTERS ARE BEING COLLECTED AND ANALYZED. THE DATA ARE COLLECTED DURING ROUTINE OPERATIONS OF THE AIRPLANES BY USE OF NASA INSTRUMENTATION.THE DATA FROM THE COMMERCIAL AND GENERAL AVIATION AIRPLANES ARE OBTAINED THROUGH COOPERATIVE PROGRAMS WITH THE MANUFACTURERS, AIRLINES, AND PRIVATE OWNERS. THE DATA PROVIDE INFORMATION ON THE GROUND AND FLIGHT LOADS, AIRSPEED AND ALTITUDE OPERATING PRACTICES, THE TURBULENCE ENVIRONMENT, AND ON UNUSUAL EVENTS SUCH AS LOSS OF CONTROL IN TURBULENCE, COLLISION AVOIDANCE MANEUVERS, AND AUTOPILOT INDUCED MANEUVERS. THE INFORMATION OBTAINED PROVIDES A CONTINUED BASIS FOR COMPARING ACTUAL AIRPLANE OPERATIONS WITH THE CONCEPTS USED IN DESIGN, FOR DETECTING UNANTICIPATED OPERATIONAL ASPECTS, AND PROVIDES A RESERVOIR OF DATA USEFUL IN THE DESIGN AND DEVELOPMENT OF AIRWORTHINESS REQUIREMENTS FOR NEW TYPES OF AIRPLANES.

RTOP NO. 133-61-12 TITLE: TIRE TRACTION, BRAKING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

AIRCRAFT OPERATIONS ON PREPARED RUNWAYS UNDER ADVERSE WEATHER CONDITIONS AND ON CERTAIN UNPREPARED SOILS CAN RESULT IN UNSAFE BRAKING AND STEERING PERFORMANCE. FURTHER, AIRFIELD ROUGHNESS, INCLUDING OBSTRUCTIONS, CAN CONTRIBUTE TO HIGH TAKEOFF, LANDING AND TAXI LOADS ON THE AIRCRAFT. THE OBJECTIVES OF PROGRAMS COVERED BY THIS RTOP ARE:(1) TO IMPROVE THE PERFORMANCE AND LIFETIME OF CURRENT PNEUMATIC TIRES AND BRAKING SYSTEMS, (2) TO DEVELOP NEW LANDING GEAR SYSTEM CONCEPTS, (3) TO DEFINE ACCEPTABLE LEVELS OF RUNWAY AND TAXIWAY ROUGHNESS AND (4) TO RELATE THE CHARACTER OF THE RUNWAY SURFACE TO AIRCRAFT PERFORMANCE. RESEARCH TO MEET THESE OBJECTIVES WILL EMPLOY FULL-SCALE AIRCRAFT AND LANDING GEAR SUBSYSTEMS IN ADDITION TO SCALED MODELS OF PNEUMATIC TIRES AND LANDING GEAR SYSTEMS. THE TEST FACILITIES WILL CONSIST OF THE LANDING LOADS TRACK, AIRPORT RUNWAYS, INCLUDING THE LANDING RESEARCH RUNWAY AT WALLOPS STATION, GROUND TEST VEHICLES, AND VARIOUS LABORATORY EQUIPMENTS.

RTOP NO. 133-61-12 TITLE: AIRCRAFT BRAKES, TIRES.
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RTOP INCLUDES (A) THE DEVELOPMENT AND EVALUATION OF POLYMERIC MATERIALS FOR IMPROVED BRAKE LININGS AND (B) THE SYNTHESIS AND CHARACTERIZATION OF ELASTOMERS FOR IMPROVED AIRCRAFT TIRES. (A) TO DEVELOP AND EVALUATE POLYMERIC COMPOSITE MATERIALS SUCH AS P-POLY-PHENYLENES, WHICH COULD SERVE AS SUPERIOR TO THE STATE OF THE ART AIRCRAFT BRAKE LININGS FOR PRESENT AND FUTURE HIGH SPEED AIRCRAFT WITH IMPROVED FRICTIONAL AND WEAR PROPERTIES OF ELEVATED TEMPERATURES. (B) TO SYNTHESIZE, DEVELOP AND EVALUATE IMPROVED ELASTOMERIC MATERIALS FOR USE IN TIRES ON PRESENT AND FUTURE HIGH SPEED AIRCRAFT HAVING PROPERTIES AT ELEVATED TEMPERATURES WHICH ARE SUPERIOR TO THE STATE OF THE ART MATERIALS. (A) P-POLYPHENYLENE AND OTHER HIGH TEMPERATURE COMPOSITES WILL BE TESTED AND COMPARED WITH EXISTING STATE OF THE ART MATERIALS. PROTOTYPE BRAKE LININGS WILL BE FABRICATED AND EVALUATED. (B) IMPROVED ELASTOMERS AND COPOLYMERS WILL BE COMPOUNDED AND THEIR THERMO-PHYSICAL PROPERTIES EVALUATED AND COMPARED WITH STATE OF THE ART MATERIALS. IMPROVED PROCESSING METHODS WILL BE DEVELOPED WHICH WILL AID IN THE DEVELOPMENT OF HIGH PERFORMANCE AIRCRAFT TIRES.

RTOP NO. 133-61-12 TITLE: TIRE TRACTION, BRAKING
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MILLER, C. D. TEL. 216-433-6947
TECHNICAL SUMMARY

THE OBJECTIVE IS TO FIND MUCH NEEDED WAYS OF IMPROVING BRAKING OF AIRCRAFT ON RUNWAYS, PARTICULARLY FOR ABORTED TAKE-OFFS. ALSO, TRACTION NEEDS TO BE IMPROVED TO AVOID SLIDING OFF THE RUNWAYS. THIS WILL ALLEVIATE THE NEED FOR GREATLY INCREASED RUNWAY LENGTHS. THROUGH GRANTS AT THE UNIVERSITY OF MICHIGAN AND RPI, AND THROUGH IN-HOUSE ANALYTICAL EFFORT, A CONCURRENT TWO-PRONGED APPROACH IS DIRECTED TOWARD (1) A BASICALLY NEW METHOD OF BRAKING DESIGNED TO DISSIPATE AIRCRAFT KINETIC ENERGY INTO A THERMALLY CONDUCTIVE RUNWAY SURFACE AND (2) IMPROVEMENT OF MATERIALS AND SYSTEMS FOR CONVENTIONAL BRAKES.

RTOP NO. 133-61-13 TITLE: REDUCTION OF WAKE VORTEX HAZARD
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE LIFT INDUCED, TRAILING VORTEX SYSTEM REPRESENTS A SERIOUS HAZARD TO FOLLOWING AIRCRAFT. THIS HAZARD HAS BECOME MORE SERIOUS AS JET TRANSPORTS HAVE BECOME HEAVIER. AVOIDANCE OF THE VORTEX WAKE OF THE PRECEDING AIRCRAFT REQUIRES SUFFICIENT AIRCRAFT SEPARATION DISTANCE, AND THEREFORE, IS A FACTOR WHICH INFLUENCES RUNWAY CAPACITY. THE SENSITIVITY OF STOL AIRCRAFT TO VORTEX WAKES, AND THE CHARACTERISTICS OF THEIR WAKES MAY BE CRITICAL FACTORS INFLUENCING THE SUCCESS OF FUTURE TRANSPORTATION SYSTEMS EMPLOYING THESE

AIRCRAFT. THEREFORE, THE CHARACTERISTICS OF THE VORTEX WAKE FROM POWERED-LIFT STOL AIRCRAFT WILL BE INVESTIGATED IN FLIGHT AT THE EARLIEST OPPORTUNITY. PRACTICAL MEANS WILL BE SOUGHT TO ACCELERATE THE DISSIPATION OF VORTEX WAKES.A FLIGHT PROGRAM WILL BE CONDUCTED TO CORROBORATE WIND TUNNEL RESULTS (RTOP 760-73-02), TO EVALUATE EXISTING THEORIES ON VORTEX DECAY, AND TO TEST DEVICES THAT SHOW PROMISE OF ACCELERATING VORTEX DISSIPATION RATES.

RTOP NO. 133-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BASIC TECHNOLOGY DATA FOR THE IMPROVEMENT OF THE LEVEL OF SAFETY IN AIRCRAFT OPERATIONS. TECHNICAL ASSISTANCE IS BEING PROVIDED TO VARIOUS AGENCIES HAVING SAFETY OF FLIGHT PROBLEMS. METHODS OF DETECTING CLEAR AIR TURBULENCE ARE BEING INVESTIGATED. THE CHARACTERISTICS OF WING TRAILING VORTICES SHED AT HIGH ALTITUDES AND IN CLOSE PROXIMITY OF THE GROUND ARE BEING STUDIED. THE FEASIBILITY OF USING A RAMAN OPTICAL RADAR TO OBTAIN A REMOTE MEASUREMENT OF VISUAL RANGES ALONG THE GLIDE SLOPE WHICH WILL BE USABLE TO A PILOT WILL BE STUDIED.

RTOP NO. 133-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: ROBINSON, G. H. TEL. 805-258-3311
TECHNICAL SUMMARY

OPERATING PROBLEMS RELATED TO THE CURRENT AND FUTURE JET TRANSPORT AIRPLANES ARE BEING INVESTIGATED. HANDLING CHARACTERISTICS AND OPERATIONAL PROCEDURES RELATED TO POTENTIAL HAZARDS SUCH AS ATMOSPHERIC TURBULENCE, WING VORTEX WAKE, INSTRUMENT WEATHER, ETC., WILL BE EVALUATED. IN ADDITION, ABUSIVE OPERATIONAL PRACTICES AND CRITERIA PERTINENT TO FUTURE CERTIFICATION STANDARDS ARE INCLUDED FOR CONSIDERATION.CURRENT STUDIES ARE DIRECTED TO AN EVALUATION OF THE INFLUENCE OF THE WING VORTEX WAKE FROM LARGE TRANSPORTS ON AIRCRAFT SPACING IN THE AIR TRAFFIC SYSTEM. PRELIMINARY OPERATIONAL TESTS ARE BEING CONDUCTED WITH A VARIETY OF GENERATING AND PROBE AIRCRAFT TO ASSESS LOGICAL AIRWAYS SPACING CRITERIA. ADDITIONAL TESTING WILL BE PERFORMED FOLLOWING THE OPERATIONAL PHASE TO INVESTIGATE VARIOUS ASPECTS OF THE THEORETICAL DESCRIPTION OF THE WING WAKE BEHAVIOR.

RTOP NO. 133-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: CHIARITO, P. T. TEL. 216-433-6941
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BASIC DATA FOR THE IMPROVEMENT OF THE OPERATIONAL SAFETY OF CIVIL AND MILITARY AIRCRAFT. THROUGH NASA SUPPORTED RESEARCH, WHICH COMPLEMENTS RESEARCHES CONDUCTED BY OTHER SEGMENTS OF THE AVIATION COMMUNITY, PROVIDE DEVICES AND TECHNIQUES

WHICH OVERCOME OPERATIONAL PROBLEMS. THESE PROBLEMS ARE PRESENTED BY THE DESIRE TO IMPROVE THE SAFETY OF AIRPLANE OPERATIONS WHILE EXTENDING THE MISSION OF THE AIRPLANE AND IMPROVING THE ECOMOMICS OF ITS OPERATION. COMMERCIAL AND GENERAL AVIATION AIRCRAFT, INCLUDING V/STOL, SUBSONIC AND SUPERSONIC, WILL BE CONSIDERED. SPECIFIC AREAS OF CURRENT INTEREST INCLUDE: LIGHTNING HAZARDS TO AIRCRAFT AVIONICS, ROTOR BURST PROTECTION, DETECTION OF INCIPIENT STRUCTURAL FAILURE, OZONE HAZARD IN HIGH ALTITUDE AIRCRAFT, WIND SHEAR EFFECTS, AND ICING TESTS.

RTOP NO. 133-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION
ORGANIZATION: MARSHALL SPACE FLIGHT
MONITOR: HUFFAKER, R. M. TEL. 205-453-1156
TECHNICAL SUMMARY

DEVELOP A GROUND BASED LASER DOPPLER SYSTEM TO DETECT AIRCRAFT TRAILING VORTICES ON APPROACHES TO AND DURING AIRPORT TERMINAL AREA OPERATIONS. THIS SYSTEM WILL BE CAPABLE OF MEASURING THE 3-DIMENSIONAL VELOCITY STRUCTURE OF THE ATMOSPHERIC WINDS AND OF AIRCRAFT TRAILING VORTICES. THIS SYSTEM WILL BE USED IN THE TERMINAL AREA TO GAIN MORE INFORMATION OF THE PROPERTIES OF AIRCRAFT VORTICES AND WARN OF HAZARDOUS TURBULENCE CONDITIONS ON AIRPORT RUNWAYS AND MAKE ATMOSPHERIC WIND VELOCITY AND TURBULENCE MEASUREMENTS. DEVELOP A CLEAR AIR TURBULENCE DETECTION SYSTEM FOR RESEARCH PURPOSES AND TO ACT AS AN ON-BOARD WARNING SYSTEM FOR AIRCRAFT. PRIOR TO THE DEVELOPMENT OF AN AIRPORT SYSTEM, FEASIBILITY EXPERIMENTS WITH AN EXISTING 1-DIMENSIONAL CO2 LASER WILL BE PERFORMED TO DETERMINE AIRCRAFT VORTEX VELOCITY SIGNATURES. A STUDY HAS BEEN INITIATED TO DETERMINE THE FEASIBILITY OF USING A LASER DOPPLER SYSTEM IN THE TERMINAL AREA TO ACT AS AN AIRPORT WARNING SYSTEM FOR AIRCRAFT VORTICES AND ATMOSPHERIC TURBULENCE. A DESIGN EFFORT FOR AN AIRPORT WARNING SYSTEM WILL BE MADE. SYSTEM STUDIES AND COMPLETE OPTICAL, ELECTRICAL, AND MECHANICAL DESIGN FOR A RESEARCH SYSTEM WILL BE MADE. USING THE DEVELOPED SYSTEM, EXTENSIVE GROUND TESTS WILL BE MADE IN AND AROUND AIRPORTS AND MEASUREMENTS OF ATMOSPHERIC WIND VELOCITY AND TURBULENCE WILL BE MADE. THE DEVELOPMENT OF CO2 LASER AMPLIFIERS, SYSTEM STUDIES AND ELECTRICAL AND MECHANICAL DESIGN OF A RESEARCH AIRBORNE CAT DETECTION SYSTEM WILL BE PERFORMED. THE SYSTEM WILL BE FABRICATED AND INTEGRATED INTO A FLYABLE RESEARCH SYSTEM ON AN AIRCRAFT. INITIAL FLIGHT TESTS WILL BE MADE FOLLOWED BY EXTENSIVE FLIGHT TESTING TO OPTIMIZE THE SYSTEM.

RTOP NO. 133-61-14 TITLE: AIRFIELD TRAFFIC
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

AIRCRAFT TRAFFIC CONGESTION CURRENTLY EXISTS AT SOME AIRPORTS AND THREATENS OTHERS. THIS CONGESTION COMPROMISES THE EFFICIENCY AND ECONOMY OF AIRCRAFT OPERATIONS, INCONVENIENCES THE PASSENGERS AND CONTRIBUTES TO AIR AND NOISE POLLUTION. THE OBJECTIVES OF PROGRAMS COVERED BY THIS RTOP ARE TO MINIMIZE THE RUNWAY OCCUPANCY TIME AND TO

EXPEDITE AIRFIELD TRAFFIC THROUGH EFFECTIVE GROUND CONTROL OF AIRCRAFT. RESEARCH TO MEET THESE OBJECTIVES WILL STUDY AND ASSESS VARIOUS TECHNIQUES TO SAFELY INCREASE THE FLOW OF AIRCRAFT TRAFFIC ON THE GROUND AND AT THE PASSENGER GATES.

RTOP NO. 133-61-15 TITLE: BUILDING RESPONSE TO NOISE AND SONIC BOOM
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY, TO QUANTIFY, AND TO PREDICT THE DETRIMENTAL EFFECTS OF NOISE AND SONIC BOOMS ON GROUND BASED STRUCTURES AND EQUIPMENT IN ORDER THAT DESIGN AND OPERATIONAL PROCEDURES MAY BE DEVISED TO MINIMIZE SUCH EFFECTS. THE EMPHASIS IS ON BUILDING STRUCTURES FOR WHICH VIBRATIONS, NOISE TRANSMISSION AND SUPERFICIAL DAMAGES DUE TO REPEATED LOADS, ARE OF PARTICULAR CONCERN. PARTICULAR EMPHASIS IS PLACED ON THE LOW FREQUENCY RANGE WHICH IS IMPORTANT FOR FUTURE FLIGHT VEHICLES SUCH AS STOL'S AND SST'S. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES AND MODEL COMPONENT TESTS USING LABORATORY ACOUSTICAL EXCITATION.

RTOP NO. 133-61-16 TITLE: INSTRUMENTATION EVALUATION AND DEVELOPMENT OF FLIGHT RESEARCH SENSORS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WEBB, L. D. TEL. 805-258-3311
TECHNICAL SUMMARY

THE ADVANCED TYPE RESEARCH FLIGHTS BEING CONDUCTED AT FRC REQUIRES THE USE OF NEW AND UNPROVEN TYPES OF SENSORS TO OBTAIN THE DESIRED RESEARCH MEASUREMENTS. THE OBJECTIVE OF THIS PROGRAM IS THE DESIGN, DEVELOPMENT AND TESTING OF ADVANCED SENSORS PARTICULARLY WHEN THE WORK IS BEING DONE IN ADVANCE OF, OR APART FROM, THE VEHICLE ON WHICH IT WILL ULTIMATELY BE USED. EXAMPLES OF NEEDED SENSORS ARE ALTIMETERS FOR USE AT HIGH SPEEDS AND EXTREME ALTITUDES, MINIATURE PRESSURE TRANSDUCERS CAPABLE OF WITHSTANDING MACH 3 STAGNATION TEMPERATURES, PRESSURE SURVEY RAKES SUITABLE FOR MEASURING DYNAMIC FLOWS. SPECIAL COMPENSATED PITOT-STATIC PROBES, AND MINIATURE FLOW DIRECTION SENSORS FOR DETERMINING LOCAL FLOW ANGULARITIES. WHENEVER POSSIBLE "OFF-THE-SHELF" ITEMS WILL BE USED WITH FLIGHT SUITABILITY BEING DETERMINED IN FRC LABS. DEVELOPMENT OF NEW CONCEPTS WILL BE SPONSORED IF NO AVAILABLE DEVICES SUIT THE NEEDS.

RTOP NO. 133-61-16 TITLE: FLIGHT TEST INSTRUMENTATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

NEW CONCEPTS, TECHNIQUES, AND ADVANCED TECHNOLOGY WILL BE INVESTIGATED, DEVELOPED, AND APPLIED TO IMPROVE, REPLACE, OR TO FILL VOIDS IN AIRCRAFT FLIGHT TEST INSTRUMENTATION TECHNIQUES AND SYSTEMS REQUIRED FOR RESEARCH RELATING TO THE EFFICIENT AND SAFE OPERATION OF

ALL CLASSES OF AIRCRAFT. EFFORT WILL BE CONCENTRATED IN MAKING AVAILABLE TO RESEARCHERS NEW OR IMPROVED SENSORS, DATA SYSTEMS WITH BOTH PCM AND ANALOG CAPABILITY, AND SPECIAL ELECTRONIC CIRCUIT AND SYSTEM TECHNIQUES TO PERFORM UNIQUE DATA COLLECTION TASKS.

RTOP NO. 133-61-18 TITLE: EXTENDING CROSSWIND LANDING LIMITS FOR STOL OPERATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NICKS, O. W. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE STOL CROSSWIND LANDING PROBLEMS AND METHODS OF EXTENDING THE CROSSWIND LIMITS FOR LANDING. A FLIGHT INVESTIGATION WILL BE CONDUCTED TO DETERMINE THE RELATION BETWEEN AIRPLANE RESPONSE, PILOTING TECHNIQUE, FLIGHT SAFETY MARGINS, AND CROSSWIND LIMITS DURING STOL-TYPE LANDING OPERATIONS. AN ANALYTICAL STUDY WILL ALSO BE CONDUCTED TO INVESTIGATE CROSSWIND LANDING GEAR CONFIGURATIONS. FINALLY, A CROSSWIND LANDING GEAR WILL BE DESIGNED, BUILT, AND FLIGHT TESTED.

RTOP NO. 134-03-03 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THIS IS A PROGRAM OF EXPERIMENTAL AND THEORETICAL RESEARCH AIMED AT DETERMINING THE BASIC RELATIONSHIPS BETWEEN ELECTRONIC AND DEFECT STRUCTURES OF MATERIALS AND THEIR POTENTIALLY USEFUL ELECTRONIC PROPERTIES. THE KNOWLEDGE OBTAINED WILL MAKE POSSIBLE THE DEVELOPMENT OF IMPROVED, OR NEW, COMPONENT CONCEPTS FOR NASA FLIGHT AND GROUND-BASED ELECTRONIC SYSTEMS. DURING THE COMING YEAR, THE RESEARCH WILL ENCOMPASS THEORETICAL STUDIES OF SUPERCONDUCTIVITY IN METAL AND ORGANIC SUPERCONDUCTORS, EXPERIMENTAL INVESTIGATIONS OF SUPERCONDUCTING TRANSMISSION LINES AND THE JOSEPHSON EFFECT IN SUPERCONDUCTING THIN FILMS, CHARGE TRANSPORT AND STORAGE IN HIGHLY INSULATING THIN FILMS, THERMOMAGNETIC AND MAGNETO-OPTIC EFFECTS IN FILMS OF INTERMETALLIC COMPOUNDS, THE ELECTRICAL AND NOISE PROPERTIES OF SPACE-CHARGE-LIMITED CURRENTS IN ELEMENTAL AND COMPOUND SEMICONDUCTORS, AND PHOTO-EFFECTS ASSOCIATED WITH SCHOTTKY BARRIERS IN SEMICONDUCTORS.

RTOP NO. 134-03-20 TITLE: ADVANCED MATERIALS FOR AERONAUTICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: FRECHE, J. C. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO DEVELOP ADVANCED MATERIALS

AND MATERIAL PROTECTION SYSTEMS WITH SUPERIOR CHARACTERISTICS FOR VARIOUS AERONAUTICS APPLICATIONS AND TO EXTEND PROCESSING TECHNOLOGY SO THAT ADVANCED MATERIALS CAN BE EFFECTIVELY EXPLOITED. TO ACHIEVE THESE OBJECTIVES, RESEARCH IS UNDERWAY TO IMPROVE THE CAPABILITY OF A NUMBER OF ALLOY SYSTEMS PRINCIPALLY FOR HIGH TEMPERATURE USE, BUT IN SOME CASES FOR INTERMEDIATE TEMPERATURE APPLICATIONS AS WELL. THESE SYSTEMS INCLUDE TITANIUM, IRON, NICKEL, COBALT, AND CHROMIUM-BASE ALLOYS AS WELL AS REFRACTORY COMPOUNDS WHICH HAVE POTENTIAL FOR ULTRA-HIGH TEMPERATURE APPLICATIONS. ALLOYING, DISPERSION STRENGTHENING, PREALLOYED POWDER TECHNOLOGY, THERMOMECHANICAL PROCESSING AND DIRECTIONAL SOLIDIFICATION ARE UNDER INVESTIGATION. STUDIES ARE ALSO BEING CONDUCTED IN SPECIFIC AREAS OF CORROSION ASSOCIATED WITH VARIOUS AERONAUTICS APPLICATIONS, SUCH AS HOT SALT STRESS CORROSION OF TITANIUM ALLOYS, AND OXIDATION AND SULFIDATION OF SUPERALLOYS. WHERE APPLICABLE, PROTECTIVE COATINGS ARE BEING DEVELOPED AND THEIR EFFECTIVENESS STUDIED AS A FUNCTION OF TEMPERATURE, TIME AND ENVIRONMENT. IMPLICIT IN EACH RESEARCH AREA ARE BASIC STUDIES DESIGNED TO CONTRIBUTE TO THE UNDERSTANDING OF FUNDAMENTAL MATERIAL BEHAVIOR.

RTOP NO. 134-03-20 TITLE: ADVANCED MATERIALS FOR AERONAUTICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE BEHAVIOR AND THE SUITABILITY OF ADVANCED MATERIALS FOR AIRCRAFT STRUCTURAL APPLICATIONS AND TO CONDUCT STUDIES ON ADVANCED FABRICATION METHODS, MATERIALS BEHAVIOR, EFFECTS OF ENVIRONMENTS ON MATERIAL PERFORMANCE, AND TO MAKE METALLURGICAL EXAMINATIONS AND STUDIES TO CHARACTERIZE THE NATURE AND MAGNITUDE OF THE MATERIAL DEGRADATION. THE WORK WILL CONSIST OF RESEARCH TO ESTABLISH THE PROPERTIES OF MATERIALS EXPOSED TO SIMULATED AIRCRAFT ENVIRONMENT, TO MAKE ANALYTICAL STUDIES OF CREEP, OXIDATION AND DIFFUSION TO PREDICT PERFORMANCE AND BY SUITABLE ADJUSTMENT OF HEAT TREATMENT PARAMETERS OR SURFACE TREATMENTS TO ENHANCE PERFORMANCE OF THESE MATERIALS FOR AIRCRAFT APPLICATIONS. SOME ATTENTION WILL BE GIVEN TO STUDY ADVANCED FABRICATION METHODS, EFFECTS OF FABRICATION ON MATERIAL PROPERTIES AND THE APPLICATION OF NONDESTRUCTIVE EVALUATION TECHNIQUES TO PREDICT DEGRADATION OF MATERIAL PROPERTIES. ENVIRONMENTAL EFFECTS ASSOCIATED WITH HIGH-SPEED AIRFLOW INCLUDING STRESS CORROSION AND EROSION BY WATER, ICE CRYSTALS AND DUST WILL BE INVESTIGATED TO ESTABLISH POSSIBLE DEGRADATION IN MECHANICAL OR PHYSICAL PROPERTIES. FRACTURE SURFACES OBTAINED FROM MATERIALS TESTED UNDER VARIOUS LOADS AND ENVIRONMENTS WILL BE SYSTEMATICALLY CHARACTERIZED METALLURGICALLY TO AID IN INTERPRETING MATERIALS FAILURES IN AIRCRAFT STRUCTURES.

RTOP NO. 134-03-21 TITLE: FATIGUE, FRACTURE, AND LIFE PREDICTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THIS RESEARCH IS PART OF A LONG-RANGE PLAN TO PROVIDE THE NECESSARY UNDERSTANDING OF FATIGUE AND FRACTURE BEHAVIOR. IT IS AIMED AT DEVELOPING DESIGN RULES FOR EFFICIENT AIRCRAFT STRUCTURE WITH HIGH STRUCTURAL INTEGRITY. BECAUSE FATIGUE AND FRACTURE ARE PHENOMENA INFLUENCED BY A LARGE NUMBER OF PARAMETERS, THIS RESEARCH INCLUDES A SYSTEMATIC INVESTIGATION OF ONLY SELECTED PARAMETERS JUDGED TO BE AMENABLE TO RATIONAL SOLUTION AND FOR WHICH ENGINEERING RULES ARE URGENTLY NEEDED. BOTH EXPERIMENTAL AND ANALYTICAL INVESTIGATIONS WILL BE CONDUCTED AS APPROPRIATE FOR EACH PARAMETER. IF ANALYTICAL SOLUTIONS ARE AVAILABLE (FOR EXAMPLE, CRACK PROPAGATION BEHAVIOR OF STIFFENED PANELS), THE EXPERIMENTAL INVESTIGATIONS ARE USED TO DEMONSTRATE APPLICABILITY. ON THE OTHER HAND, SOME PARAMETERS ARE NOT CAPABLE OF ANALYTICAL PREDICTION (FOR EXAMPLE, BEHAVIOR OF SPECIFIC MATERIALS). DATA ARE GENERATED THROUGH SYSTEMATIC TESTS AND ARE CORRELATED EMPIRICALLY. FOR MATERIAL BEHAVIOR, SPECIAL EMPHASIS WILL BE PLACED ON BEHAVIOR OF COMPOSITES AND ON TITANIUM ALLOYS. ONGOING RESEARCH WILL BE CONTINUED TO IMPROVE THE METHODS FOR ACCOUNTING FOR STRESS CONCENTRATION, ABSOLUTE SIZE AND SHAPE OF PARTS, LOADING HISTORIES, THERMAL EFFECTS, AND CORROSIVE EFFECTS. EFFECTIVE AND ECONOMICAL METHODS FOR DETECTING DAMAGE AND FOR MONITORING SERVICE LOADS WILL BE DEVELOPED.

RTOP NO. 134-03-21 TITLE: FATIGUE, FRACTURE, AND LIFE PREDICTION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MANSON, S. S. TEL. 216-433-4000
TECHNICAL SUMMARY

A MAJOR OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF THE FAILURE OR FRACTURE MECHANISMS THAT ARE INVOLVED IN THE APPLICATION OF ADVANCED MATERIALS TO AERONAUTICS STRUCTURES OR PROPULSION SYSTEMS. A SECOND MAJOR OBJECTIVE IS TO DEVELOP METHODS FOR PREDICTING THE LIFE OF SPECIMENS OR COMPONENTS WHEN THEY ARE SUBJECTED TO CONSTANT TEMPERATURE AND MONOTONIC LOADS OR TO COMPLEX PATTERNS OF TEMPERATURES AND LOADS AS A FUNCTION OF TIME. TO ACHIEVE THESE OBJECTIVES, RESEARCH IS UNDERWAY TO EXTEND EXISTING LIFE PREDICTION TECHNIQUES AND ANALYSES, AND 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 REACTION OF ADVANCED MATERIALS TO THESE DISCONTINUITIES WHEN SUBJECTED TO VARIOUS ENVIRONMENTAL CONDITIONS. VARIOUS APPROACHES ARE ALSO BEING EXAMINED FOR PREDICTING THE TIME TO INITIATION OF THE FIRST DETECTABLE CRACKS AS A RESULT OF MECHANICAL AND THERMAL FATIGUE AND TO PREDICTING THE PROPAGATION RATE OF THESE CRACKS. STANDARD FRACTURE TEST METHODS AND SPECIMENS ARE BEING DEVELOPED TO PROPERLY CHARACTERIZE THE FRACTURE BEHAVIOR OF MATERIALS AND TO PROVIDE BACKGROUND INFORMATION FOR RATIONAL DESIGN PROCEDURES.

RTOP NO. 134-03-21 TITLE: FATIGUE, FRACTURE, AND LIFE PREDICTION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE DELETERIOUS EFFECTS OF STRESS CORROSION ON THE MECHANICAL PROPERTIES OF AIRCRAFT AND SPACECRAFT STRUCTURAL METALS ARE BEING STUDIED IN ORDER TO DEVELOP ANALYTICAL TECHNIQUES AND PHYSICAL TEST CRITERIA FOR PREDICTING AND MINIMIZING SUCH EFFECTS. IN PARTICULAR, AN UNDERSTANDING OF THE EMBRITTLEMENT OF METALS BY GASEOUS HYDROGEN WILL BE SOUGHT. EFFECTS OF REPRESENTATIVE EARTH ENVIRONMENTS, SUCH AS HUMID AND SALT LADEN AIR, ON CRACK GROWTH AND FATIGUE PROPERTIES WILL BE INCLUDED IN THE STUDY. AS DEMANDS INCREASE FOR MATERIALS TO PERFORM AT THE LIMITS OF THEIR CAPABILITY, THERE IS URGENT NEED FOR TECHNIQUES TO PREDICT THE EFFECTS OF THE ENVIRONMENT ON MATERIAL PERFORMANCE TO AID IN THE PROPER SELECTION OF MATERIALS AND IN THE DEVELOPMENT AND SELECTION OF PROTECTIVE METHODS.

RTOP NO. 134-03-22 TITLE: POLYMERS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: PATTERSON, W. J. TEL. 205-453-1224
TECHNICAL SUMMARY

THREE INTERRELATED TASKS HAVING THE FOLLOWING INDIVIDUAL OBJECTIVES COMPRISE THIS TOTAL EFFORT. (1) SEALANTS - THE DEVELOPMENT AND EVALUATION OF NEW POLYMER SYSTEMS CHARACTERIZED BY LONG TERM STABILITY TO HYDROCARBON FUELS AND ELEVATED TEMPERATURES FOR EVENTUAL USE AS INTEGRAL FUEL TANKAGE SEALANTS FOR ADVANCED AEROSPACE VEHICLES. (2) ADHESIVES - THE DEVELOPMENT AND SIMULATED SERVICE TESTING OF ELASTOMERIC ADHESIVES SUITABLE FOR ATTACHMENT OF LOW DENSITY CERAMIC THERMAL PROTECTION SYSTEM (TPS) MATERIALS TO THE SUBSTRUCTURES OF ADVANCED REUSABLE AEROSPACE VEHICLES. (3) LONG TIME PROPERTIES - THE EVALUATION AND ULTIMATE PREDICTION OF LONG TERM STRUCTURAL, ADHESION, THERMAL AND DIMENSIONAL STABILITY PARAMETERS OF CANDIDATE ELASTOMERS INTENDED FOR SPECIFIC FUEL TANK SEALANT (TPS) ADHESIVE AND RELATED CRITICAL APPLICATIONS WHEREIN AN EXCEPTIONALLY LONG SERVICE LIFETIME IS CRITICAL.

RTOP NO. 134-03-22 TITLE: POLYMERS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

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 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. THE GENERAL APPROACH SHOULD INVOLVE THE SYNTHESES OF BOTH NEW AND MODIFIED POLYMERIC AND PROTOTYPE CHEMICAL STRUCTURES, THE CHARACTERIZATION OF THESE MATERIALS AND THE DETERMINATION OF CHEMICAL STRUCTURE AND PROPERTY RELATIONSHIPS.

APPLICATIONS FOR THE MECHANICAL PROPERTIES WORK MIGHT RANGE FROM IMPROVED SOLID PROPELLANTS, SEALANTS FOR HIGH-SPEED AIRCRAFT AND NEW TYPES OF REINFORCED PLASTICS.

RTOP NO. 134-03-22 TITLE: POLYMERS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT BASIC RESEARCH ON THE PREPARATION, PROPERTIES, AND PROCESSING CHARACTERISTICS OF NEW POLYMERS. EXPLORATORY SYNTHESES WILL LEAD TO NEW POLYMERS WITH UNIQUE PROPERTIES WHILE DIRECTED SYNTHETIC RESEARCH WILL TAILOR THE PROPERTIES OF CURRENT POLYMER SYSTEMS TO ACHIEVE IMPROVED PROCESSING QUALITIES. THUS, NEWLY DISCOVERED POLYMERS WITH UNPREDICTABLE BUT NOVEL PROPERTIES CAN BE RAPIDLY DEVELOPED TO SATISFY FUTURE MATERIALS PROBLEMS WHICH EMERGE FROM ADVANCED PERFORMANCE AIRCRAFT, IN ADDITION TO THE EXPLOITATION OF MODIFIED POLYMER SYSTEMS TO SATISFY CONTEMPORARY CRITICAL AERONAUTICAL APPLICATIONS. THE BASIC PROPERTIES OF NEW AND MODIFIED POLYMER SYSTEMS, PARTICULARLY THOSE DERIVED FROM AROMATIC-HETEROCYCLIC CLASSES WITH EXCEPTIONAL LEVELS OF THERMO-OXIDATIVE AND RADIATION STABILITY, WILL BE STUDIED NOT ONLY BY A VARIETY OF CLASSICAL POLYMER CHARACTERIZATION TECHNIQUES BUT ALSO BY SEVERAL NEWLY DEVELOPED POLYMER RESEARCH DISCIPLINES. IT IS ANTICIPATED THAT GUIDELINES FOR THE IMPROVEMENT OF POLYMER PROCESSABILITY WILL RESULT BY DEFINING THE INTERRELATIONSHIP BETWEEN THE CHEMICAL STRUCTURES OF POLYMERS AND CERTAIN PROPERTIES SUCH AS THERMO-MECHANICAL BEHAVIOR AND THERMO-OXIDATIVE STABILITY. IN ADDITION, THE ESTABLISHMENT OF A TEST PROGRAM TO EVALUATE THE EFFECTS OF OPERATING ENVIRONMENT UPON A BROAD VARIETY OF POLYMERIC MATERIALS WILL ENHANCE THE RELEVANCE OF POLYMER RESEARCH TO AERONAUTICAL MATERIALS TECHNOLOGY.

RTOP NO. 134-03-22 TITLE: POLYMERS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RTOP INCLUDES THE FOLLOWING AREAS OF POLYMER RESEARCH: CHEMICAL KINETICS OF POLYMERIC MATERIALS USED FOR FIRE RETARDANCE, THERMAL PROTECTION AND FLAME INHIBITION; SYNTHESIS AND CHARACTERIZATION OF MODEL HIGH-TEMPERATURE AND ABLATIVE POLYMERS; KINETICS OF SMOG FORMATION; MATERIALS TOXICOLOGY; AND MECHANISMS OF DEGRADATION OF POLYMERS IN SPACE ENVIRONMENT. TO CONDUCT FUNDAMENTAL RESEARCH ON THE PROPERTIES AND BEHAVIOR OF POLYMERS WITH A VIEW TOWARD THEIR APPLICATION IN THE PHYSICAL AND LIFE SCIENCES AND IN SPACE TECHNOLOGY. APPLICATIONS FOR THIS WORK ARE IN THE FIELDS OF SPACECRAFT HEAT PROTECTION, FIRE RETARDATION, PROTECTION AND SUPPRESSION, ENVIRONMENTAL EFFECTS ON MATERIALS, AIR AND WATER POLLUTION CONTROL AND MATERIALS TOXICOLOGY. CHEMICAL KINETICS AND IGNITION STUDIES WILL BE MADE TO DETERMINE OPTIMUM FIRE SUPPRESSIVE AND ABLATIVE MATERIALS. FIRE-RESISTANT AND ABLATIVE POLYMERIC

MATERIALS WILL BE SYNTHESIZED AND CHARACTERIZED. MECHANISMS BY WHICH THE SPACE ENVIRONMENT CAN ALTER THE MOLECULAR STRUCTURE OF POLYMERS AND THE PHOTOCHEMISTRY _OF SMOG FORMATION WILL BE INVESTIGATED. THE MOLECULAR STRUCTURE AND PHYSICO-CHEMICAL PROPERTIES OF BIOLOGICALLY ACTIVE COMPOUNDS WILL BE STUDIED AND THEIR EFFECT ON THE ION-TRANSPORT PROPERTIES OF SYNTHETIC MEMBRANES WILL BE INVESTIGATED.

RTOP NO. 134-03-23 TITLE: COMPOSITES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: FRECHE, J. C. TEL. 216-433-4000
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS RESEARCH IS TO DEVELOP FIBER AND LAMINATE COMPOSITE MATERIALS, STRUCTURES, AND COMPONENTS FOR VARIOUS AERONAUTICAL APPLICATIONS. BOTH POLYMER AND METAL MATRIX COMPOSITES MUST EXHIBIT GREATER STRENGTHS, TOUGHNESS, MODULUS OF ELASTICITY, AND WHEREVER POSSIBLE, LIGHTER WEIGHT THAN BULK, MONOLITHIC ENGINEERING MATERIALS. SUPERIOR PROPERTY-TO-WEIGHT ADVANTAGES (E.G., SPECIFIC WEIGHT OR SPECIFIC MODULI) MUST BE MAINTAINED AT TEMPERATURE LEVELS OF INTEREST WHICH RANGE FROM CRYOGENIC TEMPERATURES TO OVER 2500 F. THE WORK IS ORIENTED TOWARD USE OF THESE MATERIALS IN ADVANCED GAS TURBINE ENGINES AND MAJOR EFFORTS ARE GEARED TOWARD INCREASING USE TEMPERATURES FOR FAN BLADES, COMPRESSOR BLADES, TURBINE BUCKETS, AND NOZZLE VANES, WHILE MAINTAINING SUPERIOR PROPERTY-TO-WEIGHT ADVANTAGES. THE MAJOR OBJECTIVES FOR THE PROGRAMS ARE AS FOLLOWS: 1. TO DEVELOP OR SYNTHESIZE IMPROVED POLYMERS SUITABLE FOR USE AS MATRIX MATERIALS FOR TEMPERATURES UP TO 600 F. 2. TO IMPROVE SUCH PROPERTIES OF POLYMER MATRICES AS THERMO-OXIDATIVE STABILITY, SHEAR STRENGTH (IN ASSOCIATION WITH FIBERS) AND TOUGHNESS. 3. TO DEVELOP CARBON AND BORON FIBER-POLYMER MATRIX COMPOSITES WITH GREATER STRENGTHS, MODULI, FIBER MATRIX BONDS AND TOUGHNESS.

RTOP NO. 134-03-23 TITLE: COMPOSITES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEFINE AND INVESTIGATE SUPERIOR REINFORCEMENTS AND MATRIX MATERIALS FOR FILAMENTARY COMPOSITES AND TO STUDY THE FUNDAMENTAL MECHANICAL AND CHEMICAL BEHAVIOR OF STRUCTURAL COMPOSITES. THE WORK WILL FOCUS ON INVESTIGATION OF NEW OR ADVANCED FILAMENTARY MATERIALS, MATRIX MATERIALS AND COMPOSITES TO ESTABLISH MECHANICAL PROPERTIES, FABRICATION PROBLEMS, AND RESISTANCE TO APPROPRIATE ENVIRONMENTS WITH A VIEW TOWARD THEIR STRUCTURAL APPLICATIONS IN ADVANCED AERONAUTICAL AND SPACE VEHICLES. STUDIES WILL ALSO BE MADE OF ADHESIVES, RESINS, BONDING OF RESIN-MATRIX COMPOSITES TO STRUCTURAL METALS, METAL-MATRIX COMPOSITES AND BRAZING METAL-MATRIX COMPOSITES TO STRUCTURAL METALS. THIS PROGRAM WILL YIELD INFORMATION ON THE FUNDAMENTAL BEHAVIOR OF ADVANCED COMPOSITES AND WILL PROVIDE A BASIS FOR SELECTING ADVANCED COMPOSITES FOR FURTHER STUDIES AIMED AT APPLICATIONS IN FLIGHT VEHICLES.

RTOP NO. 134-14-01 TITLE: COMPOSITE MATERIALS APPLICATION TO AIRCRAFT STRUCTURES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-2042

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT RESEARCH ON COMPOSITE MATERIALS TO RESOLVE PROBLEMS THAT MAY HINDER THEIR APPLICATION AND TO DEVELOP THE TECHNOLOGY REQUIRED FOR THEIR UTILIZATION IN FUTURE AIRCRAFT STRUCTURES. THE WORK CONSISTS OF THE FOLLOWING: DEVELOP ANALYTICAL METHODS TO IMPROVE UNDERSTANDING OF COMPOSITE MATERIALS; EVALUATE BEHAVIOR OF COMPOSITES UNDER VARIOUS ENVIRONMENTAL CONDITIONS; DEVELOP CONCEPTS, FABRICATION AND NONDESTRUCTIVE EVALUATION TECHNOLOGY. FABRICATE AND TEST CRITICAL COMPONENTS TO DEMONSTRATE PERFORMANCE AND TO INDICATE CAPABILITY FOR POSSIBLE APPLICATIONS IN AIRCRAFT STRUCTURES. INCLUDED ARE VIBRATION AND FLUTTER TESTS ON COMPOSITE-REINFORCED WING STRUCTURES. CONDUCT FEASIBILITY STUDIES TO DETERMINE APPLICABILITY OF REINFORCING THE PRIMARY STRUCTURE OF COMMERCIAL OR MILITARY AIRCRAFT INCLUDING HELICOPTERS WITH COMPOSITE MATERIALS. PREPARE DETAILED PLANS AND COST ESTIMATES FOR APPLICATION OF THE COMPOSITE MATERIAL IN AIRCRAFT STRUCTURES. DEVELOP APPLICATIONS TO OPERATIONAL AIRCRAFT SUCH AS THE CH-54 HELICOPTER. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE UNDERTAKEN. THE RESULTS OF THESE STUDIES WILL PROVIDE NEW TECHNICAL INFORMATION AND WILL DEVELOP CONFIDENCE REQUIRED TO PERMIT EARLY APPLICATION OF FILAMENTARY COMPOSITES IN SUBSONIC AND SUPERSONIC AIRCRAFT STRUCTURES.

RTOP NO. 134-14-02 TITLE: ANALYSIS AND DESIGN OF STRUCTURAL COMPOSITES

ORGANIZATION: NASA-LEWIS RESEARCH CENTER

MONITOR: MANSON, S. S. TEL. 216-433-4000

TECHNICAL SUMMARY

COMPOSITE MATERIALS OFFER A HIGH POTENTIAL FOR REDUCING THE WEIGHT OF CERTAIN ENGINE COMPONENTS AND ALSO AIRFRAME STRUCTURAL COMPONENTS. HOWEVER, BEFORE FULL ADVANTAGE CAN BE TAKEN OF THE UNUSUAL PROPERTIES OF COMPOSITE MATERIALS IN SUCH APPLICATIONS, CONSIDERABLE MATERIAL PROPERTY AND DESIGN INFORMATION IS NEEDED. IT IS PROPOSED THAT STUDIES BE CONTINUED THAT WILL: 1. DEVELOP (IN-HOUSE) ANALYTICAL DESIGN TECHNIQUES FOR PREDICTING STRUCTURAL CHARACTERISTICS OF GIVEN COMPOSITE CONFIGURATIONS. 2. DEVELOP (IN-HOUSE) ANALYTICAL DESIGN TECHNIQUES FOR OPTIMIZING COMPOSITE STRUCTURES FOR MINIMUM WEIGHT. 3. DETERMINE (BY CONTRACT) FIBER PROPERTY INFORMATION FOR USE IN ANALYTICAL DESIGN PROCEDURES. 4. DETERMINE (BY CONTRACT) THE EFFECTS OF RESIDUAL STRESSES AND THERMAL FATIGUE ON THE LOAD CARRYING ABILITY OF COMPOSITE STRUCTURES.

RTOP NO. 134-14-03 TITLE: COMPOSITE MATERIALS APPLICATIONS TO C-130 CENTER WING STRUCTURE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO OBTAIN LONGTIME FLIGHT SERVICE PERFORMANCE OF FILAMENTARY COMPOSITE MATERIALS IN THE CENTER WING BOX OF C-130 AIRCRAFT. THE OBJECTIVE WILL BE ACHIEVED THROUGH A SYSTEMATIC PROGRAM AS FOLLOWS: CONDUCT ADVANCED DEVELOPMENT STUDY TO PROVIDE DESIGN ALLOWABLES, MANUFACTURING AND PROCESS METHODS, AND REQUIRED ANALYSIS METHODS; PERFORM DETAILED DESIGN; FABRICATE THREE COMPOSITE-REINFORCED ALUMINUM-ALLOY WING BOXES; PERFORM GROUND TEST ON ONE FULL-SCALE BOX (FATIGUE AND STRENGTH); INSTALL WING BOXES IN TWO C-130 AIRCRAFT; RETURN AIRCRAFT TO AIR FORCE; PERFORM PERIODIC MONITORING TO ESTABLISH PERFORMANCE OF WING BOXES; THE RESULTS OF THIS FLIGHT SERVICE PROGRAM WILL PROVIDE MEANINGFUL DATA ON THE PERFORMANCE OF COMPOSITE MATERIALS IN A PRIMARY STRUCTURE IN THE FLIGHT ENVIRONMENT. RESULTS WILL ALSO BE OBTAINED ON DESIGN, MANUFACTURING AND PROCESSING METHODS, NONDESTRUCTIVE EVALUATION AND FIELD INSPECTION PROCEDURES HERETOFORE UNAVAILABLE ON LARGE SCALE COMPOSITE-REINFORCED PRIMARY AIRCRAFT STRUCTURES. THE PROGRAM WILL PROVIDE CONFIDENCE NEEDED BEFORE COMMITMENTS ARE MADE TO FUTURE APPLICATIONS IN AIRCRAFT STRUCTURES.

RTOP NO. 134-14-04 TITLE: NASTRAN (NASA STRUCTURAL ANALYSIS) MANAGEMENT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

TO PROVIDE NASA WITH THE TECHNICAL MANAGEMENT REQUIRED FOR THE MAINTENANCE AND CONTINUED IMPROVEMENT OF THE NASTRAN SYSTEM FOR STRUCTURAL ANALYSIS. THE MAINTENANCE AND IMPROVEMENT WILL BE CARRIED OUT THROUGH A LEVEL OF EFFORT TYPE OF CONTRACT UNDER THE DIRECTION OF THE NASTRAN SYSTEMS MANAGEMENT OFFICE (NSMO). THE OBJECTIVE IS TO MAINTAIN NASTRAN AS A STANDARDIZED, STATE-OF-THE-ART, INTEGRATED SYSTEM FOR STRUCTURAL ANALYSIS FOR NASA AND THE AEROSPACE COMMUNITY.

RTOP NO. 134-14-05 TITLE: AIRCRAFT STRUCTURAL DESIGN TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

AUTOMATE THE DESIGN PROCESS FOR ADVANCED AIRCRAFT CONFIGURATIONS. DEVELOP METHODS FOR INTEGRATING EXISTING DISCIPLINE ANALYSIS CAPABILITIES INTO A COMPUTER SYSTEM FOR MULTIDISCIPLINARY STRUCTURAL DESIGN OF ADVANCED AIRCRAFT. IMPROVE ANALYSIS AND DESIGN METHODOLOGY BASIC TO THE MULTIDISCIPLINARY DESIGN SYSTEM. INCORPORATE STRENGTH, FLUTTER, AND AEROELASTIC CONSIDERATIONS INTO THE SYSTEM AND EXTEND PRESENT ANALYSIS PROCEDURES TO ACCOUNT FOR LARGE DEFLECTIONS, BUCKLING, PLASTIC BEHAVIOR, AND THE INFLUENCE OF IMPERFECTIONS ON STRENGTH. IN-HOUSE, GRANT AND CONTRACTUAL STUDIES

WILL BE PERFORMED TO EXPLORE AND IMPROVE ANALYSIS PROCEDURES REPRESENTING THE MAJOR DISCIPLINES CONTRIBUTING TO AIRCRAFT DESIGN AND TO INCORPORATE THESE ANALYSES INTO MULTIDISCIPLINARY DESIGN SYSTEMS. A WORKING SYSTEM FOR PRELIMINARY DESIGN OF ADVANCED AIRCRAFT CONFIGURATIONS INCORPORATING ALL DOMINANT DISCIPLINES IN THE PROCESS WILL BE CONSTRUCTED AND EVALUATED IN BOTH IN-HOUSE AND CONTRACTUAL STUDIES. THE FOCUS OF THIS EFFORT WILL BE THE DEVELOPMENT OF AN EXECUTIVE COMPUTER SYSTEM TO MANAGE THE ANALYSIS AND DESIGN PROCEDURES AND PERFORM THE BOOKKEEPING FUNCTIONS CONTRIBUTING TO THE VEHICLE DESIGN. IN-HOUSE ANALYTICAL STUDIES WILL BE PERFORMED TO EXPLORE AND EVALUATE THE USE OF NASTRAN AND ELAS FOR ANALYSIS OF AIRCRAFT STRUCTURES AND AS MODULES IN A DESIGN CYCLE, AND IN-HOUSE EXPERIMENTAL WORK WILL EVALUATE ANALYSIS PROCEDURES FOR AIRCRAFT STRUCTURES. UNDER CONTRACT, BUCKLING ANALYSIS METHODS FOR AIRCRAFT STRUCTURES WILL BE IMPROVED, NONLINEAR ELASTIC AND PLASTIC FINITE ELEMENT METHODS WILL BE DEVELOPED, AND STUDIES ON IMPROVED ANALYSIS AND DESIGN PROCEDURES TO----

RTOP NO. 134-14-06 TITLE: DYNAMICS OF AERONAUTICAL STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE WORK TO BE PERFORMED UNDER THIS RTOP IS TO DEVELOP AND ESTABLISH IMPROVED METHODS OF PREDICTING THE DYNAMIC RESPONSE OF AIRCRAFT TYPE STRUCTURES TO OSCILLATORY AND TRANSIENT LOADINGS. IMPROVED ANALYTICAL PROCEDURES WILL RESULT IN OPTIMIZATION PROCEDURES THAT CONSIDER DYNAMIC FACTORS. FACTORS THAT WILL BE CONSIDERED INCLUDE NOISE, CHARACTERISTICS OF STRUCTURAL MATERIALS SUCH AS COMPOSITES, VIBRATION ISOLATION SYSTEMS, VIBRATION AND OTHER DYNAMIC ENVIRONMENTS.----

RTOP NO. 134-14-07 TITLE: DYNAMICS OF AERONAUTICAL STRUCTURES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-1111
TECHNICAL SUMMARY

THE EFFECTS OF NON-STEADY AERODYNAMIC PHENOMENA, SUCH AS BOUNDARY LAYER NOISE AND PANEL FLUTTER, ARE KNOWN AND APPRECIATED, BUT BASIC UNDERSTANDING OF THE CAUSE OF THESE EFFECTS IS LIMITED. AN OBJECTIVE OF THIS RESEARCH PROGRAM IS TO MEASURE, ACCURATELY AND IN CONSIDERABLE DETAIL, THE UNSTEADY FORCES WITHIN THE BOUNDARY LAYER, INCLUDING SUCH FACTORS AS THE INTENSITY AND SPATIAL CORRELATION OF SURFACE STATIC PRESSURES. MATHEMATICAL PROCEDURES WILL BE DEVELOPED TO ESTIMATE THE WIND TUNNEL RESULTS, AND GUIDE THE RESEARCH PROGRAM. SIMILARLY, METHODS WILL BE EVOLVED TO CALCULATE STRUCTURE RESPONSE (AND FEEDBACK) TO THE AERODYNAMIC INPUT. WITH REGARD TO PANEL FLUTTER, THE DAMPING INFLUENCE OF THE BOUNDARY LAYER WILL BE THROUGHLY EXAMINED.

RTOP NO. 134-14-08 TITLE: ADVANCED CONCEPTS FOR FUTURE AIRCRAFT STRUCTURES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT IS BEING CARRIED OUT TO ESTABLISH A TECHNOLOGY BASE FROM WHICH THE STRUCTURES FOR ADVANCED AIRCRAFT CAN BE DESIGNED AND EVALUATED. INCLUDED IN THE PROGRAM ARE BOTH ANALYTICAL AND EXPERIMENTAL EFFORTS ON SELF-ADAPTIVE, VARIABLE GEOMETRY, STRUCTURAL/AERODYNAMIC MECHANISMS APPLICABLE TO LOW SPEED AIRCRAFT AS WELL AS ON ENGINE AND AIRFRAME STRUCTURE CONCEPTS WHICH WILL WITHSTAND THE RIGORS OF EXTENDED AND REPEATED SUPERSONIC AND HYPERSONIC FLIGHT. RESEARCH DATA OBTAINED IN THE EXPERIMENTAL PROGRAM WILL SERVE TO EVALUATE DESIGN METHODS AND PROCEDURES AND TO ESTABLISH DESIGN APPLICATION GUIDELINES.

RTOP NO. 134-14-09 TITLE: ADVANCED CONCEPTS FOR FUTURE AIRCRAFT STRUCTURES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: VANO, A. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THE PROGRAM WILL ATTEMPT TO EXPERIMENTALLY VALIDATE SIGNIFICANT HYPERSONIC-VEHICLE STRUCTURAL CONCEPTS AND INVESTIGATE FLIGHT-LOADS MEASURING TECHNIQUES FOR THESE STRUCTURAL CONCEPTS AS THEY APPLY TO THE MHTV.

RTOP NO. 135-17-01 TITLE: ALL-WEATHER INDEPENDENT LANDING MONITOR
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS PROGRAM IS CONCERNED WITH DEVELOPMENT OF AN INDEPENDENT LANDING MONITOR (ILM) WHICH MAY BE USED BY AIRCRAFT PILOTS TO VERIFY INDEPENDENTLY THE PERFORMANCE OF AN INSTRUMENT LANDING SYSTEM (ILS) DURING CATEGORY II AND III VISIBILITY CONDITIONS, AND TO PROVIDE AN INDEPENDENT EMERGENCY LANDING CAPABILITY. THE DERIVATION OF A SET OF REQUIREMENTS FOR SUCH AN ILM WILL BE CONTINUED IN THIS FISCAL YEAR. DURING THE PREVIOUS YEAR, IT HAS BEEN DETERMINED THAT CURRENT TECHNOLOGY CANNOT IMPLEMENT THE HARDWARE REQUIRED TO PRODUCE A COMPLETELY UNCOOPERATIVE INDEPENDENT LANDING MONITOR USING ONLY THE NATURALLY-OCCURRING RADIATION FROM THE AIRCRAFT SCENE IN THE MICROWAVE PORTIONS OF THE SPECTRUM. HOWEVER, ENHANCEMENT OF THE SCENE USING MICROWAVE "FLOOD-LIGHTING" AND/OR MICROWAVE "MARKERS" IN A NUMBER OF POSSIBLE ORIENTATIONS, PULSING ARRANGEMENTS AND SCANNING CONFIGURATIONS MAKES FEASIBLE POTENTIAL OPTIONS FOR AN ILM USING MANY OF THE TECHNIQUES OF MICROWAVE RADIOMETRY. ONE OF THE MOST PROMISING OF THESE SUGGESTED SYSTEMS, EMPLOYING A SCANNING ANTENNA OF MODEST ANGULAR RESOLUTION IN THE VERTICAL DIRECTION AND A PULSED WIDE BAND

MICROWAVE ILLUMINATOR ON THE GROUND IS BEING DEVELOPED UNDER CONTRACT AND WILL BE DELIVERED IN FY 72. GROUND TESTS WILL BE CONDUCTED TO DETERMINE PRELIMINARY SYSTEM PERFORMANCE, WHICH WILL THEN BE VERIFIED IN ACTUAL FLIGHT TESTS. OPTIMUM PARAMETERS FOR THE AIRCRAFT AND GROUND EQUIPMENT, INCLUDING AIRCRAFT DISPLAY WILL BE CONSIDERED AND CONCLUSIONS INCORPORATED IN A PROJECTED FINAL BREADBOARD OF A SECOND GENERATION FLIGHT APPARATUS. FURTHER OBJECTIVES OF THIS STUDY WILL BE TO CONSIDER THE SUITABILITY OF THE CANDIDATE SYSTEM AND DISPLAYSFOR COLLISION AVOIDANCE AND AIRPORT SURFACE----

RTOP NO. 135-17-02 TITLE: AVIONICS FOR GENERAL AVIATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP AVIONICS WHICH WILL IMPROVE THE SAFETY AND UTILITY OF GENERAL AVIATION AIRCRAFT OPERATING IN THE ENVIRONMENT WITH AIR CARRIERS AND MILITARY VEHICLES. ONE EFFORT IS IN THE DEVELOPMENT OF COLLISION-HAZARD WARNING TECHNIQUES WHICH ARE SUITABLE FOR GENERAL AVIATION AS WELL AS OTHER CLASSES OF AIRCRAFT. THIS WORK IS BASED ON AN OPEN-ACCESS C.W. DOPPLER TECHNIQUE OPERATING AT MICROWAVE FREQUENCIES WITH A UNIQUE MODULATION METHOD WHICH PERMITS THE MEASUREMENT OF RANGE AND CLOSING VELOCITY, AND THE INTERCHANGE OF ALTITUDE INFORMATION BETWEEN AIRCRAFT. A LOW-COST TRANSPONDER IS REQUIRED ON EACH AIRCRAFT WITH THE COST OF ASSOCIATED INTERROGATION AND DISPLAY EQUIPMENT DETERMINED BY AIRCRAFT PERFORMANCE. THE COST OF INSTALLATIONS FOR LOW-SPEED, LOW-ALTITUDE AIRCRAFT WOULD BE MUCH LESS THAN THE COST FOR HIGH-PERFORMANCE VEHICLES. ANOTHER EFFORT IS RESEARCH ON AN AIRCRAFT POSITION DISPLAY BASED ON A MAP OVERLAY USING LIQUID CRYSTALS. THE DISPLAY WOULD BE COMPATIBLE WITH CURRENT VOR RECEIVING EQUIPMENT. IT WOULD AID THE PILOT IN HIS NAVIGATION TASK AND IMPROVE SAFETY DURING ADVERSE WEATHER CONDITIONS.

RTOP NO. 135-17-03 TITLE: AIRCRAFT TERMINAL AREA, VISIBILITY STUDIES
ORGANIZATION: NASA/WALLOPS STATION
MONITOR: HOLLAND, A. C. TEL. 703-824-3411
TECHNICAL SUMMARY

DEFINITION AND DEVELOPMENT OF A LOW-COST, IMPROVED SYSTEM FOR MEASURING OR DETERMINING SLANT-PATH VISIBILITY ALONG AIRPORT, LANDING APPROACH GLIDE PATHS. SUCH SYSTEMS ARE INCREASINGLY NECESSARY FOR CATEGORY II AND III. THE MAJOR ELEMENTS OF THIS PROGRAM INCLUDE ANALYTICAL MODELLING OF EXISTING TRANSMISSOMETER SYSTEMS TO DETERMINE OPTIMUM METHODS FOR MEASURING PILOTS SLANT PATH VISIBILITY; SYSTEM DEFINITION AND SYNTHESIS; DEVELOPMENT OF PROTOTYPE INSTRUMENTATION AND DEMONSTRATION OF FEASIBILITY.

RTOP NO. 135-19-05 TITLE: GENERAL AVIATION FLIGHT CONTROL SYSTEMS AND DISPLAYS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: GEE, S. W. TEL. 805-258-3311
TECHNICAL SUMMARY

THE TOTAL PROGRAM IS A COORDINATED EFFORT TO PROVIDE AVIONIC SYSTEM TECHNOLOGY, DEVELOPMENT AND CRITERIA THAT WILL CONTINUE THE IMPROVEMENTS IN SAFETY AND UTILITY OF ALL AIRCRAFT, PARTICULARLY GENERAL AVIATION TYPE AIRCRAFT. VARIOUS NEW CONCEPTS IN FLIGHT CONTROL, NAVIGATION, AND DISPLAY SYSTEMS ARE BEING INVESTIGATED THROUGH THE USE OF SIMULATORS AND FLIGHT VEHICLES THAT WILL EVENTUALLY PERMIT COMPLETELY _AUTOMATIC FLIGHT THROUGH AIRBORNE AND GROUND CONTROL COMPUTER PROGRAMING.

RTOP NO. 135-19-06 TITLE: DIGITAL FLY-BY-WIRE FLIGHT CONTROL SYSTEM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: BURKE, M. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OVERALL OBJECTIVES OF THIS EFFORT ARE TO DESIGN, DEVELOP AND FLIGHT TEST AN ADVANCED FLY-BY-WIRE FLIGHT CONTROL SYSTEM UTILIZING DIGITAL COMPUTATIONAL ELEMENTS. THE SYSTEM FLIGHT TESTED IN PHASE 1 WILL CONSIST OF A PRIMARY SINGLE CHANNEL, THREE AXIS DIGITAL MECHANIZATION WITH REDUNDANCY PROVIDED THROUGH MULTICHANNEL BACKUP MODES WHICH ARE SIMPLE TRANSFER FUNCTIONS FOR COMMANDED SURFACE POSITION. THE PRIMARY CHANNEL WILL UTILIZE AVAILABLE SPACE HARDWARE FROM THE APOLLO PROGRAM. PHASE 2 WILL BE A MULTICHANNEL DIGITAL SYSTEM, UTILIZING HARDWARE THAT IS MORE REPRESENTATIVE OF WHAT IS AVAILABLE ON THE MARKET TODAY.

RTOP NO. 135-24-01 TITLE: TECHNIQUES FOR SENSING AIR DATA PARAMETERS ON LOW SPEED AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

TECHNIQUES WILL BE DEVELOPED FOR SENSING AIR DATA PARAMETERS DURING SLOW SPEED, LOW ALTITUDE FLIGHT OF HELICOPTERS, VTOL, AND STOL AIRCRAFT. INITIAL EFFORT IS ON METHODS FOR ACCURATE MEASUREMENT AT VELOCITIES BETWEEN 1 AND 50 FT/SEC, AND THE DEVELOPMENT OF HEIGHT-ABOVE-TERRAIN SENSORS FOR OPERATION OVER THE RANGE FROM 0 TO 100 FEET. FLUIDIC, ACOUSTIC, AND ELECTROMAGNETIC METHODS ARE BEING CONSIDERED. FUTURE EFFORT WILL INCLUDE INVESTIGATION OF SENSORS FOR MEASUREMENT OF AIRFLOW DIRECTION, LINEAR AND ANGULAR ACCELERATION, AND VELOCITY VECTOR DURING LOW SPEED FLIGHT.

RTOP NO. 135-24-02 TITLE: FLIGHT RESEARCH SENSOR TECHNOLOGY
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: VEATCH, D. W. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO DEVELOP PRECISION SENSORS AND _SIGNAL CONDITIONING TO MEASURE RESEARCH PARAMETERS ON MANNED AIRCRAFT USED IN AERONAUTICAL FLIGHT RESEARCH. THREE MAIN AREAS OF CONSIDERATION ARE ADDRESSED IN THIS PROGRAM. SENSORS FOR USE IN FLIGHT MECHANICS, FLIGHT LOADS, AND FLIGHT DYNAMICS RESEARCH ARE PRIME CANDIDATES FOR DEVELOPMENT. SENSORS WHICHSHOW DEFINITE PROMISE OF MEETING THE PARTICULAR NEEDS OF THE FLIGHT RESEARCH CENTER IN THE AREA OF IN-FLIGHT PARAMETER MEASUREMENT ARE THE ONLYONES SELECTED FOR FURTHER DEVELOPMENT. DUE LARGELY TO LIMITED IN-HOUSE MANPOWER, SENSOR DEVELOPMENT EFFORTS UTILIZE CONTRACTORS TO A GREAT EXTENT. FINAL EVALUATION AND ACCEPTANCE TESTING ARE PERFORMED IN-HOUSE.

RTOP NO. 136-13-01 TITLE: AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RESEARCH DEALS WITH THEORETICAL AND EXPERIMENTAL AERODYNAMIC INVESTIGATIONS OF COMPONENTS, COMBINATIONS, AND COMPLETE RESEARCH CONFIGURATIONS FOR AERONAUTICAL VEHICLES THROUGHOUT THE FLIGHT SPEED RANGE. IT INCLUDES THE DEVELOPMENT OF IMPROVED LIFTING SURFACE THEORIES AND WING DESIGN METHODS, STUDIES OF BOUNDARY LAYERS AND SKIN FRICTION, HEAT TRANSFER, VORTEX FLOWS, SEPARATED FLOW, AND COMPONENT INTERFERENCE INCLUDING EXTERNAL STORE SEPARATION CHARACTERISTICS. IT INCLUDES PERFORMANCE, STABILITY, CONTROL, AND DYNAMIC DERIVATIVE ASPECTS AND DEALS WITH THE EFFECTS OF REYNOLDS NUMBER, MIXED TRANSONIC FLOW, SUPERSONIC FLOW, NONRIGID BODIES AND CORRELATIONS BETWEEN THEORY AND EXPERIMENT. THIS RESEARCH IS BEING ACCOMPLISHED BY THE DEVELOPMENT OF NEW THEORETICAL APPROACHES, THE APPLICATION OF EXISTING THEORIES, AND BY SYSTEMATIC WIND-TUNNEL AND FLIGHT TESTING. THE PURPOSE IS TO PROVIDE ADVANCED RESEARCH INFORMATION AND TECHNIQUES FOR PREDICTING AND IMPROVING THE AERODYNAMICS OF AERONAUTICAL VEHICLES.

RTOP NO. 136-13-01 TITLE: AERODYNAMICS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: SALTZMAN, E. J. TEL. 805-258-3311
TECHNICAL SUMMARY

VARIOUS FLIGHT VEHICLES WILL BE USED TO INVESTIGATE LOCAL AERODYNAMICS THAT ARE ESSENTIALLY INDEPENDENT OF THE AIRCRAFT CONFIGURATION BUT ARE DEPENDENT ON ENVIRONMENTS AND REYNOLDS NUMBERS ACHIEVEABLE THROUGH THE USE OF THE AIRCRAFT AND CANNOT BE ADEQUATELY REPRODUCED IN GROUND FACILITIES. AREAS OF INVESTIGATION WILL INCLUDE SKIN FRICTION, BASE DRAG, ROUGHNESS EFFECTS, AN ASSESSMENT OF

BOUNDARY-LAYER PARAMETERS AS AFFECTED BY PRESSURE GRADIENT AND THE FLIGHT PERFORMANCE OF ADVANCED AIRFOILS INCLUDING THE SUPERCRITICAL WING CONCEPT. INTERACTIONS BETWEEN THE NORMAL WING, TAIL, AND FUSELAGE FLOWS AND THE VARIOUS PROPULSION SYSTEM FLOWS SUCH AS COWL SPILLAGE, BOUNDARY-LAYER BLEEDS, AND INLET BYPASSES WILL BE INVESTIGATED IN APPROPRIATE SITUATIONS WHICH WILL INCLUDE THE YF-12C AND FUTURE AIRCRAFT SUCH AS THE F-14 AND F-15 WHEN AVAILABLE.

RTOP NO. 136-13-01 TITLE: AERODYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS RESEARCH IS DIRECTED AT IMPROVING THE UNDERSTANDING OF BASIC AERODYNAMIC PHENOMENA SUCH AS FLOW SEPARATION, AERODYNAMIC NOISE, ETC. THE OBJECTIVE IS TO DEVELOP IMPROVED METHODS FOR PREDICTION OF AIRCRAFT CHARACTERISTICS. THE SPECIFIC AREAS OF STUDY ARE (1) BOUNDARYLAYER FLOWS INCLUDING: FLOW SEPARATION INDUCED NATURALLY, OR BY SHOCK WAVE IMPINGEMENT, BOUNDARY LAYER CHARACTERISTICS AT HIGH REYNOLDS NUMBER, AND DEFINITION OF BOUNDARY LAYER DEVELOPMENT; (2) NEWLY FORMULATED DYNAMIC STABILITY CRITERIA FOR AIRCRAFT IN ORDER TO IDENTIFY WHICH STABILITY DERIVATIVES ARE MOST IMPORTANT IN THE VARIOUS MACH NUMBER REGIMES; (3) CORRELATION BETWEEN EXPERIMENT AND THEORY OF AERODYNAMIC CHARACTERISTICS SO AS TO PROVIDE MORE MEANINGFUL COMPUTATIONAL METHODS; AND (4) THE EFFECTS OF AIRFOIL SECTION AND PLANFORM VARIATION ON THE HIGH LIFT PERFORMANCE OF LOW ASPECT RATIO WING AT HIGH SUBSONIC SPEEDS. THE RESEARCH STUDIES ARE BOTH ANALYTICAL AND EXPERIMENTAL, AND INVOLVE INHOUSE AND CONTRACTUAL EFFORTS, INCLUDING GRANTS TO THREE UNIVERSITIES TO CONDUCT A GRADUATE RESEARCH PROGRAM IN AERONAUTICS AND AIR TRANSPORT.

RTOP NO. 136-13-01 TITLE: AERODYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO ACHIEVE A BASIC UNDERSTANDING OF THE FLUID FLOW AND OF THE HEAT TRANSFER ASSOCIATED WITH SHOCK WAVE-BOUNDARY LAYER INTERACTIONS IN FLOW REGIMES RELEVANT TO HYPERSONIC INLETS. INCLUDED IS THE DEVELOPMENT AND THE REFINEMENT OF PREDICTION METHODS AND THE CORRELATION OF EXPERIMENTAL RESULTS FOR CONVENIENT PRACTICAL USE AS WELL AS FOR COMPARISON WITH THEORY. THE CRITICAL CONDITIONS FOR WHICH INSUFFICIENT KNOWLEDGE IS AVAILABLE FOR MAKING PREDICTIONS OF HEAT TRANSFER ARE THOSE THAT OCCUR WHEN SHOCK WAVES INTERACT WITH A BOUNDARY LAYER THAT IS TURBULENT OR TRANSITIONAL, OR A BOUNDARY LAYER THAT MAY SEPARATE AS A CONSEQUENCE OF THE INTERACTION. MOST OF THE EMPHASIS WILL BE PLACED ON TURBULENT BOUNDARY LAYER FLOW.

RTOP NO. 136-13-02 TITLE: SONIC BOOM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL STUDIES ARE IN PROGRESS TO MINIMIZE SONIC BOOM. ADVANCED THEORETICAL METHODS ARE BEING DEVELOPED FOR USE IN ESTABLISHING FLIGHT PROFILES THAT WILL PRODUCE ACCEPTABLE LEVELS OF SONIC BOOM PRESSURES ON THE GROUND. RESULTS FROM THESE STUDIES WILL BE USED IN THE DESIGN OF SUPERSONIC AIRCRAFT WHICH GENERATE ONLY MINIMUM SONIC BOOM INTENSITIES.

RTOP NO. 136-13-02 TITLE: SONIC BOOM
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN IMPROVED UNDERSTANDING OF SONIC BOOM PHENOMENA, TO PROVIDE MORE ACCURATE AND MORE CONVENIENT PREDICTION TECHNIQUES, AND TO DEVELOP DESIGN METHODS THAT WILL LEAD TO ADVANCED LOW-BOOM SST AND HST CONFIGURATIONS WHICH RETAIN ATTRACTIVE ECONOMIC FEATURES. ALTHOUGH THE PRIMARY EMPHASIS CONTINUES TO BE DIRECTED TO STEADY LEVEL FLIGHT, INCREASING ATTENTION WILL BE DEVOTED TO A STUDY OF ATMOSPHERIC AND TOPOGRAPHICAL FOCUSING, THE EFFECTS OF ATMOSPHERIC TURBULENCE, AND THEINFLUENCE OF AIRCRAFT ACCELERATION AND MANEUVERS. THE RESEARCH WILL BE ACCOMPLISHED BY WIND-TUNNEL AND LABORATORY EXPERIMENTATION, BY THE CONDUCT OF THEORETICAL STUDIES, AND BY THE ACQUISITION AND ANALYSIS OF DATA FROM FLIGHT TEST PROGRAMS.

RTOP NO. 136-13-03 TITLE: HIGH REYNOLDS NUMBER EFFECTS IN TRANSONIC FLOW
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO IMPROVE TEST TECHNIQUES AND CORRELATION BETWEEN VISCOSITY-DEPENDENT DATA OBTAINED FROM SCALE MODEL TESTS IN WIND TUNNELS WITH FLIGHT DATA OBTAINED AT FULL SCALE REYNOLDS NUMBERS AT TRANSONIC SPEEDS. THROUGH ANALYSIS AND SUPPORTING TESTS, DETERMINE PRACTICAL LOWER LIMIT OF REYNOLDS NUMBER FOR TESTING OF AIRCRAFT SHAPES AT TRANSONIC SPEEDS, AND DETERMINE THE INFLUENCE OF FACTORS SUCH AS TUNNEL WALL DESIGN, STING-SUPPORT AND FLOW IRREGULARITIES ON THE CORRELATION OF TRANSONIC AERODYNAMIC DATA AS AFFECTED BY OPERATION OVER A RANGE OF REYNOLDS NUMBERS.

RTOP NO. 136-13-03 TITLE: HIGH REYNOLDS NUMBER EFFECTS IN TRANSONIC FLOW
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RESEARCH EFFORT IS TO PROVIDE INFORMATION LEADING TO AN IMPROVED BASIC UNDERSTANDING OF THE REYNOLDS NUMBER SENSITIVITY OF TRANSONIC FLOW AND TO THE MEANS FOR CORRECT SIMULATION OF FULL-SCALE FLOW CHARACTERISTICS IN WIND TUNNEL TESTING. THE SECONDARY OBJECTIVE IS TO ACHIEVE RELIABLE HIGH REYNOLDS NUMBER AERODYNAMIC DATA AT SUBSONIC AND TRANSONIC SPEEDS THROUGH THE USE OF A DENSE GAS, OR A MIXTURE OF DENSE GASES.

RTOP NO. 136-13-03 TITLE: HIGH REYNOLDS NUMBER EFFECTS IN TRANSONIC FLOWS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THIS IS AN EXPERIMENTAL AND THEORETICAL PROGRAM AIMED AT GAINING AN UNDERSTANDING OF THE EFFECTS OF VISCOSITY IN TRANSONIC FLOW FIELDS AND AN INVESTIGATION OF INTERFERENCE EFFECTS IN TRANSONIC WIND TUNNEL TESTING. AREAS OF SPECIAL INTEREST ARE THOSE OF BOUNDARY LAYER SHOCK WAVE INTERACTION, INCLUDING SHOCK-INDUCED BOUNDARY LAYER SEPARATION, REYNOLDS NUMBER SCALING FOR VISCOUS TRANSONIC FLOWS AND PROBLEMS RELATING TO SUPPORT INTERFERENCE IN WIND TUNNEL TESTS. EMPHASIS DURING THE COMING YEAR WILL BE PLACED ON DEVELOPING EXPERIMENTAL TECHNIQUES FOR EXAMINING THE RELATIVE IMPORTANCE AND REYNOLDS NUMBER DEPENDENCE OF WAVE DRAG AND SKIN FRICTION. EXPERIMENTAL DETERMINATION OF THE EXISTENCE AND MAGNITUDE OF INTERFERENCE SOURCES ON THE AERODYNAMIC CHARACTERISTICS OF SIMPLE MODELS IN WIND TUNNEL TESTS WILL ALSO BE INVESTIGATED. FURTHER EXPERIMENTS WILL BE DIRECTED AT THE DETERMINATION OF FLOW FIELD GEOMETRIES WHICH ARE OF INTEREST TO AND REQUIRED BY THEORETICAL ANALYSTS FOR VERIFICATION AND EXTENSION OF EXISTING THEORIES. THE GOALS OF THIS TASK ARE TO DEFINE QUANTITATIVELY THE POSSIBLE INTERFERENCE EFFECTS WHICH MAY OCCUR DURING TRANSONIC TESTS IN WIND TUNNELS AND TO GAIN AN UNDERSTANDING OF THE FUNDAMENTAL PHYSICS OF VISCOUS TRANSONIC FLOWS IN ORDER TO PROVIDE THE AIRCRAFT DESIGNER WITH A SOUND BASIS FOR WIND TUNNEL TESTING OF TRANSONIC AIRCRAFT AND COMPONENTS.

RTOP NO. 136-13-04 TITLE: BOUNDARY LAYER TRANSITION PROBLEM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RESEARCH IS TO PROVIDE THEORETICAL PROCEDURES, ALONG WITH EXPERIMENTAL VERFICATION, FOR PREDICTING AND UNDERSTANDING THE PROCESS BY WHICH THE BOUNDARY LAYER FLOW MAKES THE TRANSITION FROM LAMINAR TO TURBULENT CONDITIONS. THE DEVELOPMENT OF KINETIC THEORIES OF NONEQUILIBRIUM CORRELATION OFFER PROMISE OF PREDICTING TRANSITION AND DESCRIBING SHEAR-FLOW TURBULENCE. THE

INITIAL EFFORT, WHICH IS CONFINED TO TWO-DIMENSIONAL FLOW, WILL BE EXTENDED TO THE CASE OF THREE-DIMENSIONAL FLOW.

RTOP NO. 136-13-04 TITLE: BOUNDARY LAYER TRANSITION PROBLEM
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

FUNDAMENTAL INVESTIGATIONS OF BOUNDARY LAYER TRANSITION WILL BE UNDERTAKEN TO DETERMINE THE EFFECT OF ENVIRONMENTAL AND SURFACE DISTURBANCES IN WIND TUNNELS AND FLIGHT AT SUPERSONIC AND HYPERSONIC SPEEDS ON IDEALIZED SHAPES TO ESTABLISH A BASE OF INFORMATION FOR DESIGN APPLICATIONS. BOTH THEORETICAL AND EXPERIMENTAL APPROACHES ARE EMPLOYED AND THE EFFORT FOR THE PRESENT FISCAL YEAR CAN BE CHARACTERIZED BY THE FOLLOWING ACTIVITIES: THEORETICAL STUDY OF BOUNDARY LAYER STABILITY USING THE COMPLETE VISCOUS FLOW CONSERVATION EQUATIONS, MEASUREMENT OF WIND TUNNEL NOISE LEVEL AND SPECTRA WITH HOT WIRE AND FLUSH MICROPHONES AND CORRELATION WITH TRANSITION ON MODELS, COOPERATIVE PROGRAM WITH AMES RESEARCH CENTER TO DETERMINE SOURCE OF ANOMALOUS TRANSITION BEHAVIOR BETWEEN CERTAIN WIND TUNNELS AT THESE CENTERS, INVESTIGATIONS TO ESTABLISH GROUNDWORK FOR A QUIET HYPERSONIC WIND TUNNEL, SURFACE ROUGHNESS EFFECTS, THREE-DIMENSIONAL AND SEPARATION EFFECTS ON TRANSITION, AND TRANSITION IN FREE SHEAR LAYERS. RESULTS WILL INCREASE THE UNDERSTANDING OF BOUNDARY LAYER BEHAVIOR AND TRANSITION ON SIMPLE AND COMPLEX SHAPES SO THAT PREDICTIONS OF THESE PHENOMENA CAN BE IMPROVED.

RTOP NO. 136-13-04 TITLE: BOUNDARY LAYER TRANSITION PROBLEM
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVED UNDERSTANDING OF THE FLUID MECHANICAL PROCESSES INVOLVED IN THE TRANSITION TO TURBULENCE WITHIN SUPERSONIC BOUNDARY LAYERS. THROUGH COORDINATED THEORETICAL AND EXPERIMENTAL STUDIES, THE RELATIONSHIP BETWEEN BOUNDARY LAYER STABILITY AND TRANSITION IS INVESTIGATED, AND OTHER MECHANISMS RELATING TO THE ONSET OF TURBULENCE ARE EXPLORED, WITH A VIEW TOWARD GAINING INSIGHT INTO THE RELATION BETWEEN LABORATORY AND FREE-FLIGHT OBSERVATIONS OF TRANSITION. THE PROGRAM RELIES HEAVILY ON THE UNIQUE PERFORMANCE OF THE JPL WIND TUNNELS AND UPON COMPUTER PROGRAMS PERFECTED THROUGH LENGTHY DEVELOPMENT.

RTOP NO. 136-13-05 TITLE: COMPUTATIONAL FLUID DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

NUMERICAL APPROACHES WILL BE APPLIED TO THE CALCULATION OF TWO- AND THREE-DIMENSIONAL FLOWS ABOUT AERODYNAMIC BODIES IN SUBSONIC, TRANSONIC, SUPERSONIC, AND HYPERSONIC FLIGHT. ANALYTIC AND NUMERICAL

PROCEDURES WILL BE DEVELOPED FOR THE PREDICTION OF PRESSURE DISTRIBUTIONS, AERODYNAMIC CHARACTERISTICS, FLOW FIELDS AND HEAT TRANSFER IN VISCOUS FLOW WITH ATTACHED BOUNDARY LAYERS, DETACHED LEE SIDE FLOWS WITH VORTEX FORMATION AND CONTROL AND OTHER INTERACTIONS. THESE STUDIES WILL LEAD TO THE UNDERSTANDING OF THE FLUID MECHANICS AND AERODYNAMICS OF AIRCRAFT AND MISSILES OVER THEIR FLIGHT PROFILE. GENERALLY, NONLINEAR NUMERICAL METHODS WILL BE APPLIED, SUCH AS CHARACTERISTICS, METHOD OF LINES, FINITE DIFFERENCE, INTEGRAL, TIME-ASYMPTOTIC, AND RELAXATION. LINEAR THEORIES (SUCH AS VORTEX LATTICE, FINITE-ELEMENT, ETC.,) MAY BE APPLIED WHERE APPROPRIATE. BECAUSE OF COMPUTER LIMITATIONS IN 3-D PROBLEMS THE TECHNIQUE OF PATCHING SOLUTIONS WILL BE UTILIZED.

RTOP NO. 136-13-05 TITLE: COMPUTATIONAL FLUID DYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, JOHN W. TEL. 213-354-4530
TECHNICAL SUMMARY

IN THIS RESEARCH, WE WILL APPLY A NEWLY DEVELOPED THEORY OF DIFFERENTIAL SYSTEMS, AND A UNIQUE CAPABILITY FOR SYMBOLIC MANIPULATION BY COMPUTER, TO THE DISCOVERY OF THE MOST GENERAL SIMILARITY SOLUTIONS OF IMPORTANT EQUATIONS OF CONTINUUM MECHANICS. SUCH SOLUTIONS PREVIOUSLY HAVE BEEN FOUND BY AD HOC METHODS, WHICH SEVERELY LIMITED THEIR NUMBER AND GENERALITY, AND DOMAIN OF APPLICATION. UNDER A FORMER OART CODE RR MATHEMATICS TASK, A GENERAL THEORY HAS BEEN DEVELOPED OF THE STRUCTURE OF SETS OF PARTIAL DIFFERENTIAL EQUATIONS, AND A METHOD FOR FINDING THE MOST GENERAL EXACT SIMILARITY SOLUTIONS OF SUCH SETS. THE METHOD IS BASED ON THE MODERN CALCULUS OF EXTERIOR DIFFERENTIAL FORMS, AND IS ESPECIALLY APPROPRIATE FOR NONLINEAR EQUATIONS SUCH AS OCCUR IN DESCRIBING FLUID FLOWS. A PRACTICAL ADVANTAGE IN COMPLICATED CASES IS THE FACT THAT THE SYSTEMATIC STRUCTURE OF THE THEORY ALLOWS THE USE OF COMPUTER ANALYSIS. IN JOINT WORK AT IIT AND JPL A UNIQUE SERIES OF COMPUTER PROGRAMS HAS BEEN DEVELOPED FOR NON-COMMUTATIVE SYMBOLIC CALCULATION WITH EXTERIOR DIFFERENTIAL FORMS. THESE HAVE NOW BEEN APPLIED AT JPL TO THE DERIVATION OF THE EQUATIONS FROM WHICH THE MOST GENERAL SIMILARITY SOLUTIONS ARE FOUND. UNDER THIS TASK, THE FIRST EQUATIONS TO BE TREATED WILL BE THOSE FOR INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS, TO DETERMINE ALL POSSIBLE FREE-STREAM VELOCITY FUNCTIONS FOR WHICH SIMILARITY SOLUTIONS EXIST, AND TO SET UP THE ORDINARY DIFFERENTIAL EQUATIONS FOR THE LATTER. THE NEXT MORE COMPLICATED CLASSES OF FLOWS TO BE CONSIDERED WILL BE TIME DEPENDENT, OR THREE DIMENSIONAL. FOR THESE NO EXACT SIMILARITY SOLUTIONS ARE NOW KNOWN. AN IMPORTANT THEORETICAL ADVANCE TO BE----

RTOP NO. 136-13-05 TITLE: COMPUTATIONAL FLUID DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE PURPOSE IS TO DEVELOP NUMERICAL METHODS AND COMPUTER PROGRAMS WHICH CAN BE USED RELIABLY, ACCURATELY, AND EFFICIENTLY FOR

STUDY OF FLUID DYNAMIC PROBLEMS BOTH TWO AND THREE DIMENSIONAL THROUGHOUT THE RANGE OF FLIGHT SPEEDS BY BOTH SERIAL AND PARALLEL PROCESSING COMPUTERS. INTENDED APPLICATIONS ARE THE NUMERICAL SIMULATION OF SUBSONIC, SUPERSONIC, HYPERSONIC, VISCOUS, AND INVISCID FLOW FIELDS. PROPOSED METHODS WILL BE ANALYZED TO DETERMINE THEIR ORDER OF ACCURACY, STABILITY, CONVERGENCE, DISSIPATION AND DISPERSIVE PROPERTIES. PROMISING METHODS WILL THEN BE TESTED BY COMPUTING SIMPLE FLOW FIELDS. A GRAPHICS SYSTEM HAVING AN INTERACTIVE CAPABILITY DISPLAYING THE SOLUTION AS THE COMPUTATIONS ARE BEING EXECUTED WILL BE THE PRIMARY TOOL USED TO DETERMINE THE ABILITY OF EACH METHOD TO COMPUTE SIGNIFICANT FEATURES OF THE FLOW PROCESSING. INVISCID TRANSONIC FLOW OVER THIN AIRFOILS AND SLENDER AXISYMMETRIC BODIES HAS ALREADY BEEN STUDIED USING LINEARIZED SURFACE BOUNDARY CONDITIONS. EXTENSION TO THICK, ROUND-NOSED AND LIFTING AIRFOILS IS BEING MADE WITH VARIOUS COORDINATE SYSTEMS AND A MORE PRECISE TREATMENT OF THE BOUNDARY CONDITIONS. THE ILLIAC IV SYSTEM WILL PERMIT EXTENSION TO THREE-DIMENSIONAL FLOWS OVER WINGS AND YAWED AXISYMMETRIC BODIES. VISCOUS EFFECTS WILL BE TREATED INITIALLY BY INCLUDING THE DISPLACEMENT EFFECT OF THE BOUNDARY LAYER. GRAPHICS DISPLAY UNITS WILL BE UTILIZED TO SHOW SIMULTANEOUSLY THE FLOW FIELD PROPERTIES WITH AND WITHOUT VISCOUS EFFECTS. METHODS TO TREAT THE INTERACTION OF SEPARATED FLOWS WITH THE INVISCID FLOW WILL BE DEVELOPED. GRAPHICS DISPLAY UNITS WILL BE MONITORED, NOT ONLY TO FACILITATE INTERACTIONWITH THE COMPUTER BUT TO PROVIDE AN INSTANEOUS----

RTOP NO. 136-13-07 TITLE: GENERAL AERODYNAMIC RESEARCH TO PROVIDE IMPROVED UNDERSTANDING OF VORTEX FLOWS AND WAKE TURBULENCE
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS RESEARCH IS DIRECTED AT IMPROVING THE BASIC UNDERSTANDING OF VORTEX FLOWS IN GENERAL AND AIRCRAFT WAKE TURBULENCE IN PARTICULAR. THE OBJECTIVE IS TO PROVIDE IMPROVED PREDICTION METHODS FOR VORTEX FLOWS, AND MEANS FOR ALLEVIATION OF THE HAZARDS ASSOCIATED WITH WAKE TURBULENCE. THEORETICAL STUDIES WILL BE CONDUCTED ON THE STABILITY AND DISSIPATION CHARACTERISTICS OF VORTEX FLOW. EXPERIMENTAL STUDIES WILL BE CONDUCTED IN THE 7X10 FT. AND 40X80 FT. WIND TUNNELS AND TOWING TANKS.

RTOP NO. 136-13-08 TITLE: OVERALL PERFORMANCE OF HIGH-SPEED AIRCRAFT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WASHINGTON, H. P. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS RTOP WILL HAVE AS ITS PURPOSE THE CONTINUING EFFORT OF DETERMINING THE PERFORMANCE CHARACTERISTICS OF FULL-SCALE HIGH-SPEED AIRCRAFT USING VARIOUS NEW TECHNIQUES. THE RESULTS OBTAINED FROM THE USE OF NEW AND VARIED TECHNIQUES WILL BE COMPARED WITH THE RESULTS OF WIND-TUNNEL INVESTIGATIONS AND/OR THEORETICAL PREDICTIONS. THESE

KINDS OF COMPARISONS WILL HELP IN RECOGNIZING WHEN NEW PREDICTION METHODS ARE NEEDED TO AID IN PRELIMINARY ESTIMATES. THIS RTOP IS ALSO DESIGNED TO PROVIDE COVERAGE FOR THE FINAL ANALYSIS AND REPORTING OF FLIGHT-TEST DATA ON PROJECTS AFTER THE FLIGHT-TEST PROGRAM IS OVER.

RTOP NO. 136-14-01 TITLE: AERODYNAMIC LOADS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BOBBITT, P. J. TEL. 703-827-3561
TECHNICAL SUMMARY

INVESTIGATION OF LOADS AND PRESSURES USING BOTH ANALYTICAL AND EXPERIMENTAL TECHNIQUES. ANALYTICAL TECHNIQUES WILL BE INTEGRATED INTO COMPUTER PROGRAMS TO FACILITATE ANALYSES AND PARAMETRIC STUDIES ON COMPONENTS OR THE ENTIRE VEHICLE. REFINED METHODS FOR PREDICTING THE FLIGHT LOADS AND PRESSURES WILL BE INCORPORATED INTO THE PROGRAM AS DEVELOPED. CONCURRENTLY, EXPERIMENTAL TECHNIQUES AND INVESTIGATIONS WILL BE DEVELOPED USING SUCH FACILITIES AS WIND TUNNELS, FULL-SCALE VEHICLES, AND DRONES TO ASSESS LOADS PROBLEMS, VERIFY PREDICTION TECHNIQUES, AND INVESTIGATE DETAILS NOT READILY ADAPTABLE TO THEORETICAL ANALYSIS.

RTOP NO. 136-14-02 TITLE: AEROELASTICITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RTOP IS INTENDED TO PROVIDE IMPROVEDCAPABILITY FOR ANALYTICAL TREATMENT OF AEROELASTIC CHARACTERISTICS OF AIRCRAFT, WITH PRIMARYEMPHASIS ON THE AREA OF FLUTTER. THE PRIMARY THRUST OF IN-HOUSE EFFORTS _WILL BE DIRECTED TOWARD THE DEVELOPMENT OF NEW OR IMPROVED UNSTEADY _AERODYNAMIC THEORY AND THE ACQUISITION OF ADVANCED UNSTEADY AERODYNAMIC ANALYTICAL CAPABILITY AVAILABLE FROM OTHERSOURCES. CONTRACT AND GRANT ACTIVITY RELATESTO AEROELASTICANALYSIS INCLUDES DEVELOPMENT OF CAPABILITY TO BE COUPLED TO THE NASTRAN STRUCTURAL ANALYSIS PROGRAM. THE NASTRAN AEROELASTIC CAPIBILITY, IN ADDITION TO PROVIDING ADVANCED FLUTTER ANALYSIS METHODS, WILL ALSO COVER SUCH AEROELASTIC PROBLEM AREAS AS AIRCRAFT RESPONSE TO TURBULENCE AND ELASTIC EFFECTS ON STABILITY AND CONTROL. OTHER GRANTS AND CONTRACTS WILL BE CONCERNED WITH DEVELOPMENT OF ADVANCED UNSTEADY AERODYNAMIC METHODS AND STRUCTURAL OPTIMIZATION WITH AEROELASTIC RESTRAINTS. THE EFFORT WILL ALSO INCLUDE AN IN-HOUSE PROGRAM FOR THE DEVELOPMENT OF EXPERIMENTAL TECHNIQUES OF STUDYING TRANSONIC FIGHTER MANEUVERABILITY EMPLOYING DYNAMIC MODELS ON THE LANGLEY TWO-CABLE MOUNT SYSTEM. RELATED AEROELASTIC TOPICS SUCH AS APPLICATION OF ACTIVE CONTROLS FOR MODE SUPPRESSION, MEASUREMENT OF UNSTEADY AERODYNAMIC DERIVATIVES, AND DEVELOPMENT OF EXPERIMENTAL TECHNIQUES WILL BE CONDUCTED UNDER VEHICLE-RELATED RTOP'S SUCH AS SPACE SHUTTLE, V/STOL, AND SUPERCRITICAL TECHNOLOGY.

RTOP NO. 136-14-02 TITLE: AEROELASTICITY AND DYNAMIC LOADS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

ALTHOUGH AIRCRAFT STRUCTURES ARE USUALLY DETERMINED BY THE MAGNITUDE AND DISTRIBUTION OF THE STEADY STATE AERODYNAMIC FORCES, OTHER FACTORS MUST BE CONSIDERED. FOR EXAMPLE, DISTORTION OF THE AIRFRAME UNDER LOAD CAN INFLUENCE THE LOADING PATTERN IN A LARGE DEGREE, AND UNSTEADY FORCES (SUCH AS BUFFET) MAY PROVE OF CONSIDERABLE IMPORTANCE. ONE OBJECTIVE OF THIS RESEARCH PROGRAM IS TO PROVIDE (VIA INDUSTRY CONTRACT) A COMPREHENSIVE ANALYSIS OF AEROELASTICITY AS IT AFFECTS STATIC AND DYNAMIC STABILITY DERIVATIVES. INCLUDED WILL BE A COMPUTER PROGRAM TO ALLOW RAPID DETERMINATION OF AEROELASTIC EFFECTS. ANOTHER OBJECTIVE OF THE PROGRAM IS TO STUDY, IN GREATER DETAIL THAN PAST RESEARCHES, THE MECHANISM OF AIRCRAFT BUFFET, THE INTENSITY OF ITS INPUT TO THE AIRFRAME, METHODS OF BUFFET ALLEVIATION, AND THE CONSEQUENCES OF CONTINUING FLIGHT IN A BUFFET CONDITION. 1. THIS RTOP RECODED FROM 136-14-01 TO 136-14-02 BECAUSE OF EMPHASIS ON UNSTEADY LOADS. 2. 100K OVERGUIDELINE FUNDING APPROVED TOWARD SUPPORT OF ITEMS (A) AND (B) OF LINE 18 ON PAGE 6.

RTOP NO. 136-14-02 TITLE: LOADS ALLEVIATION AND MODE SUPPRESSION PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: KORDES, E. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS STUDY IS DIRECTED TOWARD PRACTICAL SOLUTIONS TO IMPROVE FATIGUE AND/OR SERVICE LIFT, REDUCE FLIGHT LOADS, AND IMPROVE RIDE QUALITIES OF LARGE FLEXIBLE VEHICLES. THE STUDY IS BASED ON THE USE OF AUTOMATIC CLOSED-LOOP CONTROL SYSTEM TECHNIQUES TO ACTIVELY REDUCE THE DYNAMIC RESPONSE OF THE TOTAL AIRFRAME DURING DYNAMIC DISTURBANCES SUCH AS BUFFET AND TURBULENCE. THE PAST EFFORT WAS CONDUCTED UNDER CONTRACT TO LOCKHEED AS A FEASIBILITY STUDY FOR FLIGHT TESTING A SYSTEM ON THE YF-12 AIRPLANE, AND THE FINAL PROGRESS REPORT ON THIS STUDY WAS SUBMITTED JULY 8, 1970.

RTOP NO. 136-14-03 TITLE: FLIGHT LOADS MEASUREMENT TECHNIQUES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: JENKINS, J. M. TEL. 805-258-3311
TECHNICAL SUMMARY

PROBLEMS HAVE OCCURRED WHEN FLIGHT-LOADS MEASUREMENTS HAVE BEEN REQUIRED ON AIRCRAFT WHICH ARE SUBJECT TO SIGNIFICANT AERODYNAMIC HEATING. THE AERODYNAMIC HEATING OF FLIGHT STRUCTURES INDUCES NONUNIFORM TEMPERATURE FIELDS THROUGHOUT THE STRUCTURE. THE NONUNIFORM TEMPERATURE FIELDS LEAD TO LARGE INDUCED THERMAL STRESSES WHICH ARE SENSED BY THE STRAIN GAGES. IF THE OBJECTIVE IS TO MEASURE AERODYNAMIC LOADS ONLY, THEN THE UNWANTED TEMPERATURES INDUCED STRAIN-GAGE OUTPUTS MUST BE ACCOUNTED FOR AND DEDUCTED FROM FLIGHT DATA. THIS OPERATION IS TO BE CONDUCTED BY GROUND-TEMPERATURE

SIMULATION OF THE AERODYNAMIC HEATING, MEASURING THE THERMAL RESPONSES OF THE STRAIN GAGES AND THEN UTILIZING THIS INFORMATION AS A THERMAL CALIBRATION FOR CORRECTION PURPOSES. THIS GENERAL CONCEPT IS CURRENTLY BEING EXPLORED UTILIZING THE YF-12 (A/C NO. 936) AS A TEST BED. IN ADDITION TO THE THERMAL ASPECTS, DEFLECTION MEASURING SYSTEMS FOR INFLIGHT USE ARE BEING INVESTIGATED USING THIS AIRCRAFT.

RTOP NO. 136-62-01 TITLE: HANDLING QUALITIES
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: REDIESS, H. A. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO STUDY AND DOCUMENT THE RELATIONSHIP BETWEEN THE STABILITY AND CONTROL CHARACTERISTICS OF AIRPLANES IN GENERAL AND THE PILOT'S ASSESSMENTS OF THE HANDLING QUALITIES, THROUGH THE USE OF SIMULATORS (BOTH FIXED-BASED AND AIRBORNE) AND THE ACTUAL AIRPLANES. EFFECTS OF TURBULENCE ON THE FLYING AND RIDE QUALITIES WILL BE OF MAJOR CONCERN.

RTOP NO. 136-62-01 TITLE: HANDLING QUALITIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827-3285
TECHNICAL SUMMARY

TO STUDY ANALYTICALLY AND BY THE USE OF FLIGHT SIMULATORS THE HANDLING QUALITIES (ASSOCIATED WITH VEHICLE DYNAMICS AND CONTROL EFFECTIVENESS) AND CONTROL SYSTEMS OF PROPOSED SUPERSONIC AND TACTICAL AIRCRAFT AND OTHER AEROSPACE VEHICLES. TO DEVELOP COMPUTER PROGRAMS WHICH IMPROVE CONTROL SYSTEM DESIGN PROCEDURES. TO INCLUDE DIGITAL SIMULATIONS AND THEORETICAL ANALYSES OF THE AERIAL COMBAT PROBLEM AND THE CONTROL OF AIRCRAFT IN TURBULENCE. ALL OF THESE INVESTIGATIONS ARE DESIGNED TO EXPAND FUNDAMENTAL KNOWLEDGE ON AIRCRAFT HANDLING QUALITIES AS THEY ARE IMPORTANT TO THE ADVANCEMENT OF AERODYNAMIC FLIGHT.

RTOP NO. 136-62-01 TITLE: HANDLING QUALITIES AND FLIGHT DYNAMICS THEORY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

RESEARCH IS PLANNED IN TWO AREAS: THE FIRST IS CENTERED ON THE MODELING OF TURBULENCE AND THE PREDICTION OF ITS EFFECT ON RIDE QUALITIES. THE SECOND AREA CONCERNS THE EFFECTS OF STRUCTURAL FLEXIBILITY. THE STUDIES OF TURBULENCE ARE DIRECTED TOWARDS THE MODELING OF TURBULENCE, AND PREDICTION OF ITS EFFECTS ON AIRPLANE CONTROLLABILITY AND RIDE QUALITIES. A MORE REALISTIC (NON-GAUSSIAN) MODEL OF ATMOSPHERIC TURBULENCE WILL BE DEVELOPED AS A RESULT OF STUDIES AT THE UNIVERSITY OF WASHINGTON ON A GRANT FROM AMES. THIS MODEL WILL INCLUDE THE EFFECTS OF DISTRIBUTED GUSTS TO ENHANCE THE REALISM OF THE AIRPLANE RESPONSE IN ALL DEGREES OF FREEDOM. THIS

MODEL WILL HAVE APPLICATION TO ALL AIRCRAFT, BUT WILL BE PARTICULARLY IMPORTANT TO STOL AND LIGHT-WING-LOADING AIRCRAFT. THE CONTROLLABILITY AND RIDE QUALITIES STUDIES ARE AIMED AT DEVELOPING HANDLING AND RIDE QUALITIES CRITERIA FOR STOL AIRCRAFT WHEN OPERATING IN TURBULENCE. PILOTED SIMULATOR STUDIES WILL BE MADE USING THE MOST RECENTLY MEASURED DATA ON TURBULENCE AND WIND SHEAR IN THE VICINITY OF AIRPORTS. A SEPARATE INVESTIGATION IS IN PROGRESS TO DETERMINE THE EFFECT OF COCKPIT MOTIONS DUE TO STRUCTURAL FLEXIBILITY ON THE PILOT'S ABILITY TO PERFORM CONTROL AND GUIDANCE TASKS. ANALYTICAL TECHNIQUES ARE UNDER DEVELOPMENT FOR THE SYNTHESIS OF AUTOMATIC AND MANUAL CONTROL SYSTEMS FOR LARGE FLEXIBLE AIRCRAFT WHERE THE PILOT STATION, DUE TO ITS DISTANCE FROM THE CENTER OF GRAVITY, WILL EXPERIENCE EXAGGERATED OSCILLATION AMPLITUDES.

RTOP NO. 136-62-02 TITLE: DYNAMIC STABILITY AND CONTROL
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: REDIESS, H. A. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS TO ADVANCE THE FUNDAMENTAL KNOWLEDGE OF FLIGHT DYNAMICS AND TO EXPLOIT THIS KNOWLEDGE TO DEVELOP METHODS FOR OPTIMIZING SPECIFIC FLIGHT CONTROL OR PERFORMANCE GOALS AND TO IMPROVE FLIGHT TEST ANALYSIS TECHNIQUES. ANALYTICAL STUDIES, COMPUTER SIMULATIONS AND FLIGHT TEST INVESTIGATIONS ARE BEING PERFORMED BOTH IN-HOUSE AND UNDER RESEARCH CONTRACTS AND GRANTS TO MEET THIS OBJECTIVE. THE RANGE OF COMMAND RESPONSES OF AUGMENTED AEROSPACE VEHICLES THAT OPTIMIZES THE PILOT-VEHICLE PERFORMANCE FOR SPECIFIC MISSIONS OR A SPECIFIC TASK WITHIN A MISSION. THE MAIN EMPHASIS WILL BE TO INVESTIGATE CRITERIA FOR DESIRED COMMAND RESPONSES THAT ARE MEANINGFUL TO THE SYSTEMS DESIGNER AND NOT NEEDLESSLY RESTRICTIVE AS TO THE SYSTEM CONCEPT EMPLOYED.

RTOP NO. 136-62-02 TITLE: DYNAMIC STABILITY AND CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BROAD OBJECTIVE IS TO EXPAND FUNDAMENTAL KNOWLEDGE OF THE DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF AIRCRAFT, INCLUDING SPINNING, AND TO DETERMINE THE EFFECTS OF THESE CHARACTERISTICS IN TERMS OF PILOTING THE AIRCRAFT. SPECIFIC OBJECTIVES ARE TO INVESTIGATE THE FUNDAMENTAL NATURE OF THE SPIN INCLUDING THE DEVELOPMENT OF METHODS FOR THEORETICAL ANALYSIS, INCLUDING EXTRACTION OF STABILITY DERIVATIVES FROM FLIGHT TEST DATA, AND TO INVESTIGATE THE PROBLEMS PRODUCED BY OPERATION OUTSIDE THE NORMAL FLIGHT ENVELOPE, AND BY DEVIATIONS FROM CONFIGURATION NORMS. THE METHODS OF APPROACH INCLUDE WIND-TUNNEL FORCE TESTS, THEORETICAL ANALYSIS, PILOTED SIMULATOR TESTS, AND DYNAMIC MODEL TESTS.

RTOP NO. 136-62-03 TITLE: FLIGHT CONTROL SYSTEMS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: BURKE, M. E. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OVERALL OBJECTIVES OF THIS EFFORT ARE TO DESIGN, DEVELOP AND FLIGHT TEST AN ADVANCED FLY-BY-WIRE FLIGHT CONTROL SYSTEM UTILIZING DIGITAL COMPUTATIONAL ELEMENTS. THE SYSTEM FLIGHT TESTED IN PHASE 1 WILL CONSIST OF A PRIMARY SINGLE CHANNEL, THREE AXIS DIGITAL MECHANIZATION WITH REDUNDANCY PROVIDED THROUGH MULTICHANNEL BACKUP MODES WHICH ARE SIMPLE TRANSFER FUNCTIONS FOR COMMANDED SURFACE POSITION. THE PRIMARY CHANNEL WILL UTILIZE AVAILABLE SPACE HARDWARE FROM THE APOLLO PROGRAM. PHASE 2 WILL BE A MULTICHANNEL DIGITAL SYSTEM, UTILIZING HARDWARE THAT IS MORE REPRESENTATIVE OF WHAT IS AVAILABLE ON THE MARKET TODAY.

RTOP NO. 136-62-04 TITLE: GPAS DEVELOPMENT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: PERRY, J. J. TEL. 805-258-3311
TECHNICAL SUMMARY

TO DEVELOP THE GENERAL PURPOSE AIRBORNE SIMULATOR (GPAS) HARDWARE IN SUPPORT OF THE FLIGHT DYNAMICS RESEARCH EFFORTS IN THE IMPROVEMENT OF AIRCRAFT FLYING AND RIDE QUALITIES IN TURBULENCE. INSTALL DIRECT LIFT CONTROL (DLC) AND SIDE FORCE GENERATOR (SFG) CONTROLS THAT WILL BE USED IN ADDITION TO CONVENTIONAL CONTROL SURFACES IN ORDER TO PROVIDE REALISTIC TURBULENCE SIMULATION IN THE GPAS. INSTALL TURBULENCE MEASURING INSTRUMENTATION IN THE JETSTAR TO RECORD THE JETSTAR'S RESPONSE TO LIGHT AND MODERATE TURBULENCE, AND, IF FEASIBLE, INSTALL BALLAST SYSTEM TO ENABLE THE MEASUREMENT OF THESE RESPONSES OVER A RANGE OF C.G. POSITIONS. INSTALL A PULSE CODE MODULATION (PCM) DATA ACQUISITION SYSTEM (DAS) IN ORDER TO BE ABLE TO DIGITALLY ANALYZE THE DATA FROM THE TURBULENCE PROGRAMS.

RTOP NO. 136-63-01 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WHITESIDE, W. W. TEL. 805-258-3311
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION ARE PROVIDED FOR ALL AIRCRAFT SYSTEMS INCLUDING INSTRUMENTATION, FOR THE FOLLOWING AIRCRAFT: #802 F8C, #809 B-57B, #811 F-104N, #812 F-104N, #814 JETSTAR, #815 T-33A, #817 C-47H, #818 F-104A, #820 F-104A, AND #57-1303 F-104B. THESE EFFORTS ARE ACCOMPLISHED MAINLY IN-HOUSE, WITH ASSISTANCE AS REQUIRED BY SUPPORT PROVIDED BY THE MILITARY SERVICES AND BY CONTRACTORS. THIS EFFORT IS REQUIRED TO PROVIDE FOR ADEQUATE PILOT PROFICIENCY, CHASE AIRCRAFT SUPPORT, R AND D SUPPORT OF RESEARCH INVESTIGATIONS AND GENERAL AIRCRAFT OPERATIONAL AND INSTRUMENTATION SUPPORT TO PERMIT CONTINUATION OF A BROAD-BASED AIRCRAFT AND SPACE TECHNOLOGY PROGRAM.

RTOP NO. 136-63-01 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BEHEIM, M. A. TEL. 216-433-6374
TECHNICAL SUMMARY
LEWIS-BASED AIRCRAFT, INCLUDING RESEARCH AIRPLANES, CHASE AIRPLANES AND TRANSPORTS MUST BE SERVICED AND MAINTAINED IN FLIGHTWORTHY STATUS. MANPOWER AND FUNDING ESTIMATED FOR THIS PURPOSE ARE ALLOCATED IN THIS RTOP.

RTOP NO. 136-63-01 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY
MAINTENANCE AND OPERATION OF AIRCRAFT FOR RESEARCH AND DEVELOPMENT, PROFICIENCY, CHASE AND GENERAL RESEARCH AND DEVELOPMENT SUPPORT.

RTOP NO. 136-63-01 TITLE: AIRCRAFT OPERATIONAL SUPPORT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY
RESEARCH FLIGHT INVESTIGATIONS ARE CONDUCTED USINGTHE FOLLOWING TEST AIRCRAFT: CONVAIR 990; CONVAIR340; LEAR JET; T-33; UH-1B. PROVISION TO BE MADE FOR MAINTENANCE AND OPERATING COSTS FOR THESE AIRCRAFT.

RTOP NO. 136-63-02 TITLE: RESEARCH SUPPORT OF OTHER ORGANIZATIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY
WITH DUE CONSIDERATION OF AVAILABLE MANPOWER, FUNDS, AND OBLIGATIONS TOWARDS NASA RESEARCH AND PROJECTS, AMES SUPPORTS OTHER GOVERNMENTAL AGENCY AND INDUSTRY PROGRAMS IN AERONAUTICS. THE SUPPORT CONSISTS OF CONSULTATION, ASSIGNMENT OF PERSONNEL TO ADVISORY COMMITTEES OR BOARDS, AND THE CONDUCT OF TESTS IN WIND TUNNELS, OR OTHER FACILITIES. THE MAJOR PORTION OF THIS EFFORT IS IN SUPPORT OF THE DEPARTMENT OF DEFENSE ALTHOUGH THE ALLOTMENT OF TIME TO OTHER GOVERNMENTAL AGENCIES (IN PARTICULAR, THE DEPARTMENT OF TRANSPORTATION) HAS INCREASED CONSIDERABLY. IN GENERAL, MANPOWER AND TEST TIME IS ALLOCATED ONLY WHEN THE NEED FOR SPECIAL UNIQUE CAPABILITIES OF THE PERSONNEL OR THE EQUIPMENT IS EVIDENT, AND THE REQUEST IS IN THE NATIONAL INTEREST. CURRENTLY THE FAA HAS REQUESTED SUPPORT IN THE DEVELOPMENT OF IMPROVED CERTIFICATION CRITERION AND SAFER METHODS FOR DEMONSTRATING COMPLIANCE FOR CERTAIN AIRCRAFT TYPES. THESE INCLUDE SUPERSONIC TRANSPORT CONFIGURATIONS, WIDE BODY JETS, AND STOL TRANSPORT AIRCRAFT. IN THE CASE OF THE STOL TRANSPORT, THESE CRITERION ARE A BIG FACTOR IN DEVELOPMENT OF A COMMERCIAL STOL SYSTEM. THE ARMY HAS REQUESTED TESTS IN THE 40' X

80' WIND TUNNEL TO DETERMINE THE STRUCTURAL CHARACTERISTICS REQUIRED FOR AN INFLATABLE TENT IN HIGH WINDS.

RTOP NO. 136-63-02 TITLE: RESEARCH SUPPORT OF OTHER ORGANIZATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE NASA HAS A UNIQUE TEST CAPABILITY REPRESENTED AT THE LANGLEY RESEARCH CENTER BY A NUMBER OF LARGER WIND TUNNELS AND OTHER FACILITIES. THESE FACILITIES ARE USED TO PROVIDE SUPPORT TO OTHER GOVERNMENT AGENCIES. INVESTIGATIONS ARE CONDUCTED AS REQUIRED AT THE REQUEST OF THE COGNIZANT AGENCY; FOR EXAMPLE, FOR THE DOD IN THE DEVELOPMENT OF NEW MILITARY AIRCRAFT AND MISSILE SYSTEMS; AND FOR DOT IN SUPPORT OF AIRCRAFT PROGRAMS AND HIGH-SPEED GROUND TRANSPORTATION. THIS SUPPORT RTOP INCLUDES SPECIAL DOD SUPPORT FOR THE F-14, F-15 AND B-1.

RTOP NO. 136-63-03 TITLE: UPDATING AND SUPPORT OF TEST FACILITIES--HEAT FACILITY
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: SEFIC, W. J. TEL. 805-258-3311
TECHNICAL SUMMARY

AS PRESENT AND FUTURE VEHICLES REACH HIGHER-STRUCTURAL TEMPERATURES, THE RELIABILITY OF PRESENT METHODS FOR DETERMINING THE STRUCTURAL RESPONSES WILL DECREASE; AND NEW AND DIFFERENT CONFIGURATIONS AND MATERIALS WILL PRESENT MORE DIFFICULT PROBLEMS OF LOAD AND STRESS DETERMINATION. THE HIGH TEMPERATURE LOADS CALIBRATION LABORATORY IS BEING USED FOR STRUCTURAL TESTS, LOADS CALIBRATIONS, AND DEFLECTION MEASUREMENTS OF PRESENT AND FUTURE HIGH-PERFORMANCE VEHICLES. THE OBJECTIVES OF THIS TASK ARE TO PROVIDE THE PROFESSIONAL AND TECHNICAL SUPPORT NECESSARY FOR THE OPERATION OF THE FACILITY AND ITS SUPPORT EQUIPMENT. SUPPORT FOR THE LABORATORY INVOLVES PLANNING AND SCHEDULING OF TESTS, DESIGN AND FABRICATION OF TEST FIXTURES AND JIGS, INSTALLATION AND CHECKOUT OF RADIANT HEATERS, LOADING AND INSTRUMENTATION EQUIPMENT, OPERATION OF TEST AND DATA ACQUISITION EQUIPMENT, AND ACQUISITION, REDUCTION, AND ANALYSIS OF MECHANICAL AND THERMAL-LOADS DATA. PROCUREMENT OF NECESSARY MATERIALS AND EQUIPMENT IS ALSO REQUIRED AND INVOLVES SPECIFICATION PREPARATION, PROPOSAL EVALUATION, AND TESTING FOR VERIFICATION OF SPECIFICATIONS.

RTOP NO. 136-63-03 TITLE: UPDATING AND SUPPORT OF TEST FACILITIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A CONTINUOUS EFFORT IS REQUIRED TO MAINTAIN THE CAPABILITIES AND OPERATIONAL EFFICIENCY OF EXISTING WIND TUNNEL AND STRUCTURAL TEST FACILITIES VITAL TO CONTINUING NASA AND GOVERNMENT-WIDE RESEARCH AND

DEVELOPMENT NEEDS. YEARLY MAINTENANCE AND REPAIR IS REQUIRED ON ALL MAJOR TEST FACILITIES. INSTRUMENTATION MUST BE UPDATED TO INCREASE THE QUALITY AND SCOPE OF THE TEST DATA OBTAINABLE. A MAJOR EFFORT IS NOW IN PROGRESS TO PROVIDE ADVANCED DATA ACQUISITION, REDUCTION, AND READOUT SYSTEMS. IN ADDITION MAJOR RENOVATION AND REPAIR ARE REQUIRED TO AUXILIARY EQUIPMENT SUCH AS COMPRESSORS, STING SUPPORT SYSTEMS, AND HIGH PRESSURE AIR SYSTEMS. EQUIPMENT AND UPDATING INCLUDE: A. BLOCK I DATA ACQUISITION SYSTEMS FOR IRD, 7 X 10 HS, V/STOL, AND UNITARY PLAN TUNNELS. B. WALLOPS SUPPORT IN THE AREAS OF GUIDANCE RADAR, AND COMMUNICATIONS. SERVICE CONTRACTS FOR TOWER OPERATION, RESCUE, AND WEATHER.

RTOP NO. 136-63-03 TITLE: UPDATING AND SUPPORT OF TEST FACILITIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

IN CONDUCTING AERONAUTICAL RESEARCH IN WIND TUNNELS IT IS NECESSARY TO CARRY ON A CONTINUOUS REVIEW OF THE EQUIPMENT AND INSTRUMENTATIONEMPLOYED, AND ALSO THE TESTING TECHNIQUES, IN ORDER TO MAINTAIN AND REPLACE ITEMS, AND IN ORDER TO INCORPORATE NEW EQUIPMENT AND CONCEPTS INTO THE OPERATION WHENEVER THEY PROVE DESIRABLE. THE INCREASING DEMAND FOR WIND TUNNEL TEST TIME, PARTICULARLY IN THE TRANSONICSPEED RANGE, OBLIGATES WIND TUNNEL OPERATORS TO MAKE MAXIMUM USE OF THE AVAILABLE TEST HOURS, RESULTING IN A CONSTANT SEARCH FOR APPARATUS OR METHODS THAT WILL PRODUCE MORE DATA PER TEST HOUR. ANOTHER AREA REQUIRING CONSTANT VIGILANCE IS THE ACCURACY OF THE TEST RESULTS, INVOLVING SUCH MATTERS AS INTERFERENCE EFFECTS, BLOCKAGE, FLOW FIELD CORRECTIONS, AND CHARACTERISTICS OF THE DATA SENSING AND RECORDING EQUIPMENT. OF PARTICULAR IMPORTANCE IS THE NECESSITY OF PROVIDING ON-LINE DATA PROCESSING AND DISPLAY FOR TESTS INVOLVING POTENTIALLY DANGEROUS SITUATIONS (E.G., TESTS OF ROTOR DYNAMIC STABILITY AND LOADS, FLUTTER, ETC.). THE FULL CAPABILITIES OF MODERN DATA PROCESSING AND DISPLAY TECHNIQUES SHOULD BE UTILIZED IN THESE SITUATIONS TO AVOID COSTLY FAILURES AND DAMAGE TO FACILITIES.

RTOP NO. 136-63-04 TITLE: UPGRADING AND SUPPORT OF SIMULATION FACILITIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

RESEARCH ON FLIGHT DYNAMICS PROBLEMS IN SIMULATOR FACILITIES REQUIRES CONTINUOUS EFFORTS IN RE-CONFIGURING AND UPGRADING SIMULATORS; IMPROVING COMPUTATIONAL CAPABILITIES; AND PROVIDING ADDITIONAL CUES AND IMPROVED CUE FIDELITY AS DICTATED BY THE VARIOUS RESEARCH PROGRAM REQUIREMENTS. THIS RTOP PROVIDES FOR THE PROCUREMENT OF SPECIAL PURPOSE COMPUTERS AND PERIPHERAL EQUIPMENT; THE DEVELOPMENT AND PROCUREMENT OF COMPUTER SOFTWARE; THE DEVELOPMENT AND/OR PROCUREMENT OF MOTION, VISUAL, AURAL, AND FEEL SYSTEMS AND COMPONENTS; AND THE DEVELOPMENT AND PROCUREMENT OF INSTRUMENTATION AND DATA ACQUISITION SYSTEMS. THIS RTOP ALSO PROVIDES FOR THE

MAINTENANCE AND MODIFICATION OF FLIGHT SIMULATION FACILITIES.
FUNDING FOR CONTRACT SUPPORT SERVICES NOT INCLUDED IN THIS RTOP.

RTOP NO. 136-63-04 TITLE: SIMULATOR OPERATION AND UPDATING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO SUPPORT INVESTIGATION OF PROPOSED FLIGHT VEHICLE DESIGNS AND MODIFICATIONS, AND TO INDICATE THE DIRECTION OF FUTURE AERODYNAMIC RESEARCH, THROUGH SIMULATION RESEARCH. TO ADVANCE SIMULATION TECHNOLOGY THROUGH CORRELATION OF FLIGHT AND SIMULATION RESULTS, AND TO UPDATE EXISTING FACILITIES. THE DIFFERENTIAL MANEUVERING SIMULATOR WILL PROVIDE A UNIQUE CAPABILITY FOR STUDYING A WIDE RANGE OF AERONAUTICAL AND SPACE-ORIENTED PROBLEMS WHICH INVOLVE THE RELATIVE MOTION OF TWO VEHICLES. PLANNED INVESTIGATIONS CONSIST OF STUDIES OF REQUIRED CHARACTERISTICS OF HIGH PERFORMANCE AIRCRAFT, AIRCRAFT MANEUVERING AND AIRCRAFT COLLISION AVOIDANCE.

RTOP NO. 136-63-04 TITLE: SIMULATOR OPERATION AND UPGRADING
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: SMITH, J. P. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE AND OPERATE THE GROUND-BASED SIMULATION FACILITIES REQUIRED FOR SUPPORT OF FLIGHT DYNAMICS RESEARCH. THIS EFFORT WILL BE ACCOMPLISHED BY THE ANALYSIS OF PROGRAM REQUIREMENTS, AND THE DESIGN, DEVELOPMENT, CONSTRUCTION, MAINTENANCE AND REPAIR OF THE NECESSARY GROUND-BASED SIMULATION FACILITIES AND EQUIPMENT.

RTOP NO. 742-73-01 TITLE: ADVANCED TRANSPORT TECHNOLOGY: PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BEHEIM, M. A. TEL. 216-433-4000
TECHNICAL SUMMARY

THE NASA HAS INITIATED AN EFFORT TO EVALUATE THE APPLICATION OF ADVANCED TECHNOLOGY TO THE IMPROVEMENT OF FUTURE COMMERCIAL TRANSPORT AIRCRAFT. A DESIRABLE FEATURE OF SUCH AN AIRCRAFT IS TO HAVE ENGINES WHICH ARE CLEANER AND QUIETER THAN THOSE PRESENTLY AVAILABLE. THESE ENGINES MUST ALSO BE INTEGRATED PROPERLY WITH THE AIRFRAME TO PROVIDE MAXIMUM ECONOMIC RETURN TO THE USER. THE PROJECT LEAD CENTER FOR THE SYSTEM STUDIES IS LANGLEY, AND LEWIS WILL BE RESPONSIBLE FOR THE PROPULSION SYSTEM STUDIES. IN THE LEWIS EFFORT THE INITIAL REQUIREMENT IS TO DEFINE THE PROPULSION SYSTEM CHARACTERISTICS WHICH ARE DESIRED FOR AN ADVANCED CCMMERCIAL TRANSPORT BY MEANS OF IN-HOUSE AND CONTRACT EFFORT. THE REQUIREMENTS RELATED TO CRITICAL AREAS SUCH AS NOISE, POLLUTION, AIRFRAME INTEGRATION, AND COMPONENT PERFORMANCE WILL BE IDENTIFIED, AND FURTHER RESEARCH WILL BE CONDUCTED IN EACH OF THESE AREAS TO PROVIDE THE TECHNOLOGY BASE FOR THESE FUTURE ENGINES. IN THE EVENT THAT THE LANGLEY AIRFRAME STUDIES INDICATE THE NEED FOR AN EXPERIMENTAL AIRCRAFT, THE APPROPRIATE ENGINE WILL BE DEFINED WITH THESE RESULTS.

RTOP NO. 742-73-01 TITLE: ADVANCED TRANSPORT TECHNOLOGY:
FUNDAMENTAL TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: TOLL, T. A. TEL. 703-827-3831
TECHNICAL SUMMARY

THE BASIC OBJECTIVE OF THIS RTOP IS TO EXPEDITE THE TECHNOLOGY ADVANCES THAT WILL MOST LIKELY PERMIT DEVELOPMENT OF A SUPERIOR NEXT-GENERATION LONG-HAUL TRANSPORT AIRCRAFT IN TERMS OF PERFORMANCE, ECONOMICS, SAFETY, AND COMFORT WHILE ATTAINING ACCEPTABLE LEVELS OF NOISE AND POLLUTANT EMISSIONS. FORMULATION OF THE IN-HOUSE AND CONTRACT ACTIVITIES WAS BASED ON THE FOLLOWING GUIDELINES: (1) PROVIDE REQUIRED INPUTS TO CURRENT CONTRACTOR TRADE STUDIES OF THE APPLICATION OF ADVANCED TECHNOLOGIES TO LONG-RANGE TRANSPORT AIRCRAFT; (2) INITIATE AN EARLY, BALANCED, AND ACCELERATED TECHNOLOGY DEVELOPMENT IN AREAS SELECTED AS PARTICULARLY PROMISING ON THE BASIS OF PRELIMINARY FINDINGS IN THE CONTRACTOR TRADE STUDIES; AND (3) EXPEDITE RESEARCH IN AREAS THAT ARE CLEARLY PROBLEM AREAS FOR A HIGH SUBSONIC-SPEED AIRCRAFT.

RTOP NO. 742-73-02 TITLE: SUPERCRITICAL WING PROGRAM - FLIGHT
RESEARCH
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311
TECHNICAL SUMMARY

THE SUPERCRITICAL WING WAS DELIVERED ON NOVEMBER 3, 1970 TO THE NASA FRC. UPON DELIVERY PROOF LOAD AND GROUND VIBRATION TESTS WERE PERFORMED. AT THE COMPLETION OF THESE TESTS FINAL ASSEMBLY TO THE FUSELAGE WAS ACCOMPLISHED AND THE STABILITY AND LOADS INSTRUMENTATION WAS COMPLETED. THE INITIAL FLIGHT WAS PERFORMED ON MARCH 9, 1970 WITH 6 ADDITIONAL FLIGHTS PERFORMED TO DATE. THESE FLIGHTS HAVE BEEN DIRECTED TOWARD EVALUATING THE STABILITY HANDLING QUALITIES, FLUTTER BOUNDRIES AND LOADS WITHIN A FLIGHT ENVELOPE TO M=0.95 AND AN

ALTITUDE OF 40,000 FEET. THE AIRPLANE WILL BE REMOVED FROM FLIGHT STATUS BEGINNING IN THE LATTER PART OF MAY FOR APPROXIMATELY SIX WEEKS. THIS PERIOD WILL BE USED TO COMPLETE THE INSTALLATION OF THE PERFORMANCE AND PRESSURE DISTRIBUTION INSTRUMENTATION AND ASSOCIATED GROUND TESTS PERTINENT TO THE NEXT PHASE.

RTOP NO. 742-73-02 TITLE: ADVANCED TRANSPORT TECHNOLOGY: EXPLORATORY FLIGHT VEHICLES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: TOLL, T. A. TEL. 703-827-3285
TECHNICAL SUMMARY

THE FLIGHT VEHICLES SUPPORTED BY THIS RTOP ARE DESIGNED TO DETERMINE THE EXTENT OF IMPROVEMENTS IN AIRCRAFT CRUISE PERFORMANCE AND BUFFET CHARACTERISTICS IN THE TRUE FLIGHT ENVIRONMENT (INCLUDING THE INFLUENCE OF FULL-SCALE REYNOLDS NUMBERS AND PRACTICAL-CONSTRUCTION METHODS), AND TO PROVIDE A BASIS FOR CORRELATION WITH WIND-TUNNEL RESULTS. ADDITIONAL EXPLORATORY FLIGHT VEHICLES TO FURTHER DEVELOP THE SUPERCRITICAL AERODYNAMIC TECHNOLOGY AND TO INVESTIGATE OTHER DISCIPLINARY TECHNOLOGY ADVANCES RELATING TO ADVANCED TRANSPORT TECHNOLOGY CONCEPTS WILL BE STUDIED. CURRENT ACTIVE PROGRAMS INCLUDE: T-2C, EQUIPPED WITH THE 17 PERCENT-THICK SUPERCRITICAL WING: FLYING AND HANDLING QUALITIES CHARACTERISTICS AND DETAILED WING BOUNDARY-LAYER SURVEYS IN THE PRESENCE OF THE WING SHOCK WAVE. F8-1, WITH A TRANSPORT-TYPE SUPERCRITICAL WING: PROOF-OF-CONCEPT FLIGHT TESTS AT FRC TO DEFINE THE FLIGHT ENVELOPE, PERFORMANCE AND FLYING AND HANDLING QUALITIES CHARACTERISTICS, AND THE WING LOADS AND THEIR DISTRIBUTION. DIRECT LANGLEY SUPPORT WILL BE PROVIDED IN THE FORM OF ANALYSIS OF SELECTIVE FLIGHT DATA, AND THE APPLICATION OF AERODYNAMIC IMPROVEMENTS SUCH AS PROVIDING A NEW SET OF FUSELAGE FAIRINGS TO INCREASE THE DRAG DIVERGENCE MACH NUMBER OF THE AIRCRAFT.

RTOP NO. 742-73-03 TITLE: ADVANCED TRANSPORT TECHNOLOGY: SYSTEMS STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: TOLL, T. A. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS RTOP COVERS THE CONTINUATION OF STUDIES WHICH WILL IDENTIFY THE ADVANCED TECHNOLOGY APPLICABLE TO THE NEXT GENERATION, LONG HAUL, TRANSPORT AIRCRAFT SYSTEMS AND DETERMINE HOW THESE ADVANCEMENTS CAN BEST BE EXPLOITED TO IMPROVE SUCH CHARACTERISTICS AS PERFORMANCE, ECONOMICS AND PASSENGER APPEAL AND ALSO THOSE CHARACTERISTICS SUCH AS NOISE, POLLUTION, ETC., WHICH INTERACT WITH THE SOCIAL COMMUNITY. IN-HOUSE AND CONTRACTUAL SYSTEM STUDIES WILL EVALUATE ADVANCED TECHNOLOGY IN AERODYNAMICS, PROPULSION, STRUCTURES, MATERIALS, FLIGHT CONTROLS AND AVIONICS IN ORDER TO: DEFINE THE ADVANTAGES ACHIEVABLE BY APPLYING THE ADVANCEMENTS CONCEIVED FOR THE 1975 TO 1985 TIME PERIOD; DEFINE THE STATE OF READINESS AND HIGH RISK AREAS AND DEFINE ACTIONS NECESSARY TO RESOLVE THESE HIGH RISK AREAS. THESE SYSTEM STUDIES WILL BE SUPPORTED BY DATA GENERATED IN COMPLEMENTARY PROGRAM ELEMENTS UNDER LANGLEY RESEARCH CENTER, FLIGHT RESEARCH CENTER, LEWIS RESEARCH CENTER, AND AMES RESEARCH CENTER RTOP'S COVERING FUNDAMENTAL TECHNOLOGY, EXPLORATORY FLIGHT RESEARCH, PROPULSION, WIND-TUNNEL MODEL TESTS AND SIMULATION.

RTOP NO. 760-71-01 TITLE: GENERAL AVIATION AERODYNAMIC AND STABILITY CHARACTERISTICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE TECHNOLOGY NECESSARY TO EFFECT AN OVERALL IMPROVEMENT IN THE AERODYNAMIC AND STABILITY AND CONTROL CHARACTERISTICS OF THE GENERAL AVIATION CLASS OF AIRPLANES. THIS WILL BE DONE BY MEANS OF ANALYTICAL STUDIES, FLIGHT TESTS AND BOTH FULL-SCALE AND SMALL-SCALE WIND-TUNNEL TESTS OF REPRESENTATIVE AIRCRAFT AND OF CONFIGURATION CHANGES DESIGNED TO IMPROVE THESE CHARACTERISTICS.

RTOP NO. 760-71-02 TITLE: SUMMARY OF RESEARCH APPLICABLE TO GENERAL AVIATION AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827 3285
TECHNICAL SUMMARY

AVAILABLE INFORMATION PERTINENT TO GENERAL AVIATION AIRCRAFT HAS BEEN ASSEMBLED, REVIEWED, AND SUMMARIZED. AN ANALYSIS WILL BE MADE OF RESEARCH RESULTS AVAILABLE FOR PREDICTION OF AIRCRAFT STALLING CHARACTERISTICS, HANDLING QUALITIES, PROPELLER PERFORMANCE, GUST AND MANEUVER LOADS, ETC.

RTOP NO. 760-71-03 TITLE: HANDLING QUALITIES AND FLIGHT CHARACTERISTICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827 3285
TECHNICAL SUMMARY

THE OBJECTIVES ARE (1) TO STUDY FACTORS AFFECTING FLIGHT SAFETY, AND (2) TO IMPROVE THE LEVEL OF SAFETY THROUGH ANALYSIS, WIND-TUNNEL STUDIES, AND FLIGHT INVESTIGATIONS OF VARIOUS MEANS FOR SIMPLIFYING THE PILOTING TASK FROM TAKE-OFF THROUGH TO LANDING.

RTOP NO. 760-71-04 TITLE: AVIONICS FOR GENERAL AVIATION AIRCRAFT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827 3285
TECHNICAL SUMMARY

CONTRIBUTIONS WILL BE MADE TO GENERAL AVIATION FLIGHT SAFETY, AIR TRAFFIC FLOW, AIRCRAFT HANDLING QUALITIES, AND REDUCTION OF PILOT WORKLOAD THROUGH THE INVESTIGATION, ANALYSIS, AND EVALUATION OF AVIONIC CONCEPTS, SYSTEMS APPROACHES, AND TECHNOLOGY. TO THIS END, FLUIDIC "WING-LEVELER" TYPE STABILITY AUGMENTATION SYSTEMS WILL BE DEVELOPED. METHODS OF AFFECTING MODIFICATION OF ALTIMETERS IN CURRENT USE WILL BE DEVELOPED TO PROVIDE ALTITUDE DATA TO AIR TRAFFIC CONTROL (ATC) TRANSPONDERS. ANALYTICAL STUDIES, SIMULATIONS, AND HARDWARE EVALUATION WILL ESTABLISH THE TECHNICAL FEASIBILITY OF PARTICIPATION BY GENERAL AVIATION IN A TIME-ORDERED SYSTEM CONCEPT

WHICH INCLUDES NAVIGATION, SEPARATION ASSURANCE, DATA LINK, AND COLLISION AVOIDANCE. THE PRACTICAL REALIZATION OF THESE GOALS IS DEPENDENT UPON THE EVENTUAL COST TO THE GENERAL AVIATION AIRCRAFT OWNER; THEREFORE, EMPHASIS WILL BE ON THE POTENTIAL FOR LOW IMPLEMENTATION COST.

RTOP NO. 760-71-05 TITLE: GENERAL AVIATION COCKPIT PROTECTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827 3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BASIC TECHNOLOGY DATA FOR IMPROVED ACOUSTICAL ENVIRONMENT WITHIN THE COCKPIT AND COCKPIT CRASH PROTECTION (FIRE PROTECTION AND IMPACT ATTENUATION) FOR GENERAL AVIATION AIRCRAFT. AN ACOUSTICAL PERFORMANCE EVALUATION WILL BE MADE OF FIRE PROTECTION MATERIALS SUCH AS POLYISOCYANURATE FOAM USING REPRESENTATIVE GENERAL AVIATION AIRCRAFT WILL BE MODIFIED TO OBTAIN COCKPIT SOUND LEVEL MEASUREMENTS AND EXPERIENCE IN APPLICATION OF THE PROTECTIVE MATERIAL. TESTS OVER A PERIOD OF TIME WILL DETERMINE WHETHER THE INSTALLED MATERIAL DEGRADES WITH USE. IT IS ALSO PLANNED TO DETERMINE THE IMPACT ATTENUATION PROPERTIES OF THE PROTECTIVE MATERIAL.

RTOP NO. 760-71-06 TITLE: GENERAL AVIATION PILOTING AND FLIGHT SAFETY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827 3285
TECHNICAL SUMMARY

FLIGHT STUDIES WILL BE PERFORMED TO EXAMINE PILOTING PERFORMANCE INVOLVED IN THE OPERATION OF GENERAL AVIATION AIRCRAFT AND TO DEFINE THE RELATED MAN-MACHINE PROBLEM AREAS AFFECTING FLIGHT SAFETY. EVALUATION OF NEW TECHNIQUES AND ADVANCED CONCEPT FOR DEVICES AND DISPLAYS TO IMPROVE PILOT PERFORMANCE AND AIRCRAFT FLIGHT CHARACTERISTICS WILL BE CARRIED OUT. FLIGHT TESTS INVOLVE BOTH RESEARCH AND PRIVATE PILOTS OPERATING AIRCRAFT, PREDOMINATELY OF THE LIGHTPLANE CATEGORY, FROM TYPICAL AIRFIELDS. STUDIES INCLUDE THE EVALUATION OF HANDLING QUALITIES AND FLIGHT CHARACTERISTICS OF THE AIRCRAFT INVOLVED WITH PARTICULAR EMPHASIS PLACED ON THE LANDING AND TAKE-OFF PHASES OF FLIGHT. GROUND-BASED AND AIRBORNE INSTRUMENTATION WILL OBTAIN MEASUREMENTS FROM BOTH THE AIRPLANE AND THE PILOT. CORRELATION OF FLIGHT TEST MEASUREMENTS AND EXPERIENCE WITH THOSE OBTAINED WITH A GROUND-BASED FLIGHT SIMULATOR WILL BE CARRIED OUT TO HELP IN THE DEVELOPMENT AND EVALUATION OF ADDITIONAL PILOT HANDLING QUALITIES CRITERIA INTENDED TO IMPROVE THE FLIGHT SAFETY OF GENERAL AVIATION.

RTOP NO. 760-71-07 TITLE: GENERAL AVIATION FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961 2280
TECHNICAL SUMMARY

FLIGHT INVESTIGATIONS ARE CURRENTLY UNDERWAY TO DEVELOP NEW TECHNOLOGY THAT CAN IMPROVE THE SAFETY AND UTILITY OF GENERAL AVIATION AIRCRAFT. SPECIFICALLY, USE OF WING SPOILERS FOR APPROACH AND LANDING FLIGHT PATH CONTROL AND THE USE OF THE LEARJET AIRCRAFT TO ASSESS WAKE AND ATMOSPHERIC TURBULENCE EFFECTS ARE DIRECTED TOWARD THE GOAL OF IMPROVED FLIGHT SAFETY. WING-SPOILERS ARE CURRENTLY UTILIZED IN A FLIGHT STUDY UTILIZING A TYPICAL LOW-WING, GENERAL AVIATION AIRCRAFT AND ARE PLANNED TO BE STUDIED UTILIZING A TYPICAL HIGH-WING, GENERAL AVIATION AIRCRAFT WITH A HIGHER-THAN-AVERAGE WING LOADING. THE LEARJET AIRCRAFT IS EQUIPPED WITH INSTRUMENTATION FOR VALIDATING ATMOSPHERIC TURBULENCE MODELS AS THEY APPLY TO GENERAL AVIATION AIRCRAFT AND TO SURVEY TRAILING VORTICES RESPONSIBLE FOR WAKE TURBULENCE UPSETS.

RTOP NO. 760-72-01 TITLE: V/STOL AERODYNAMICS AND PRELIMINARY DESIGN STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS RTOP COVERS ALL V/STOL AERODYNAMIC RESEARCH AND AIRPLANE DESIGN STUDIES NOT DIRECTLY CONNECTED WITH THE AUGMENTOR WING CONCEPT, LIFT FAN AIRCRAFT, OR EXTERNALLY BLOWN FLAP CONCEPT. INCLUDED IS RESEARCH ON PROPULSIVE FLAPS SUCH AS SMALL FANS IN BIPLANE FLAP SYSTEMS, AND LOW PRESSURE JET FLAPS. STUDIES OF PROPELLER POWERED STOL CONFIGURATIONS ARE COMPLETED EXCEPT FOR PUBLICATIONS. SOME WORK ON V/STOL PROPELLERS HAS BEEN CONDUCTED IN SUPPORT OF THE AIR FORCE. WORK ON JET LIFT V/STOL IS COMPLETED EXCEPT FOR REPORTING. A STUDY OF THE APPLICATION OF V/STOL TECHNOLOGY TO THE AIR TAXI AND BUSINESS AIRCRAFT MARKET WILL BEGIN IN FY 1972. THIS STUDY IS INTENDED TO DEFINE RESEARCH REQUIREMENTS FOR THIS TYPE OF AIRCRAFT.

RTOP NO. 760-72-01 TITLE: V/STOL AERODYNAMICS AND PRELIMINARY DESIGN STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BASIC RESEARCH OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR IMPROVED PERFORMANCE AND STABILITY AND CONTROL OF STOL AND V/STOL AIRCRAFT CONFIGURATIONS THAT WOULD HAVE APPLICATION IN CIVIL AND MILITARY AIR TRANSPORT AND IN MILITARY AGGRESSIVE AND DEFENSE MISSIONS. INCLUDED IN THIS RESEARCH IS THE DEVELOPMENT OF IMPROVED EXPERIMENTAL AND ANALYTICAL METHODS FOR ACQUIRING VEHICLE DESIGN INFORMATION AND THE CONSIDERATION OF OPERATIONAL REQUIREMENTS THAT WILL INFLUENCE THE ACHIEVEMENT OF DESIRABLE AERODYNAMIC CHARACTERISTICS. AERODYNAMIC STUDIES OF MODELS OF PROMISING STOL AND

V/STOL CONCEPTS (EXCLUSIVE OF ROTORCRAFT, LIFT-FAN V/STOL, AND JET-AUGMENTOR-WING CONCEPTS) WILL BE CONDUCTED IN APPROPRIATE WIND TUNNELS, AND WILL INCLUDE DETERMINATION OF THE OPTIMUM INTEGRATION OF THE AIRFRAME AND THE POWERED-LIFT SYSTEM, AS WELL AS METHODS FOR THE ALLEVIATION OF ADVERSE GROUND EFFECTS. DYNAMIC STABILITY CHARACTERISTICS OF THE MOPE PROMISING CONCEPTS WILL BE DETERMINED. SUPPORTING ANALYTICAL STUDIES WILL BE CARRIED OUT, IN-HOUSE AND UNDER CONTRACT. EXPERIMENTAL AND ANALYTICAL STUDIES (INCLUDING THOSE UNDER UNIVERSITY GRANTS) WILL BE CONTINUED TO IMPROVE THE UNDERSTANDING OF TUNNEL WALL EFFECTS AND MEANS OF MINIMIZING THEM, ESPECIALLY FOR V/STOL MODELS. IN-HOUSE AND CONTRACT STUDIES OF EFFECTS OF VARIOUS OPERATIONAL CONSIDERATIONS ON VEHICLE DESIGN WILL BE CONTINUED.

RTOP NO. 760-72-02 TITLE: V/STOL VEHICLE NOISE REDUCTION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THIS DOCUMENT COVERS NOISE REDUCTION RESEARCH THAT IS AIRCRAFT CONFIGURATION OR AIRFRAME ORIENTED. A PART OF THIS TASK INCLUDES VERIFICATION OF WIND TUNNEL NOISE MEASUREMENTS. NOISE GENERATED BY THE OV-10 AND XV-5 WILL BE MEASURED IN THE WIND TUNNEL AND IN FLIGHT. DEVELOPMENT OF THE WIND TUNNEL NOISE MEASUREMENT TECHNIQUE WILL ALLOW EVALUATION OF FLYOVER NOISE PRIOR TO THE EXISTANCE OF AN AIRCRAFT AND MAKE DESIGN FOR LOW FLYOVER NOISE FEASIBLE. THE RESEARCH EFFORT FALLS INTO TWO AREAS, ONE IS THE DOCUMENTATION OF THE SIDELINE NOISE, FLYOVER NOISE, AND INSTALLED NOISE OF V/STOL CONFIGURATIONS. LARGE SCALE MODELS, DESIGNED FOR THE 40- BY 80-FOOT WIND TUNNEL, USE ACTUAL POWER PLANTS AND ACT AS THE NOISE GENERATORS FOR THIS TASK. SIDELINE NOISE MEASUREMENTS ARE MADE WITH THE AIRCRAFT MODEL LOCATED ON THE GROUND SIMILAR TO THE BEGINNING OF THE TAKE-OFF GROUND ROLL. FLYOVER NOISE MEASUREMENTS ARE MADE IN THE 40-BY 80-FOOT WIND TUNNEL TO SIMULATE THE EFFECT OF FORWARD SPEED AND THE DIFFERENT DIRECTIONALITY. THIS WORK IS IN PROGRESS FOR THE AUGMENTOR WING, EXTERNALLY BLOWN FLAP, AND LIFT FAN AIRPLANE CONCEPTS. EVENTUALLY, IT IS PLANNED TO STUDY AIRCRAFT CONFIGURED TO REDUCE NOISE. ANOTHER AREA OF THIS RESEARCH IS ON AIRPLANE COMPONENTS OR THE NOISE PRODUCING FLOW MECHANISMS. THIS INCLUDES RESEARCH TO REDUCE THE NOISE OF THE THRUST AUGMENTORS ON THE AUGMENTOR WING, THE INSTALLED NOISE OF LIFT FANS, THE "SCRUBBING NOISE" ASSOCIATED WITH THE EXTERNALLY BLOWN FLAP, AND THE ROTATIONAL NOISE OF PROPELLERS AND ROTORS. RESEARCH TO REDUCE AUGMENTOR NOISE AND THE INSTALLED NOISE OF LIFT FANS IS IN PROGRESS. WORK WITH SERRATED LEADING-EDGES TO REDUCE ROTATIONAL NOISE IS CONTINUING.

RTOP NO. 760-72-03 TITLE: V/STOL FLIGHT DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

V/STOL AIRCRAFT HAVE THE POTENTIAL FOR SAFE FOUL-WEATHER OPERATION, EVEN INTO SMALL AREAS AS ON TO ROOFTOPS IN CONGESTED

LOCATIONS. TACTICAL V/STOL AIRCRAFT, BOTH JET AND ROTOR TYPES, HAVE THE POTENTIAL FOR USE OF THEIR VERTICAL-LIFT CHARACTERISTICS IN TACTICAL OPERATIONS TO ENHANCE MISSION CAPABILITY. CONVENTIONAL OPERATING TECHNIQUES, CURRENT MANEUVER LIMITATIONS, CURRENTLY AVAILABLE INSTRUMENTATION AND GUIDANCE PRACTICES, AND THE GENERAL FLIGHT CHARACTERISTICS OF EXISTING V/STOL VEHICLES DO NOT PRESENTLY PERMIT ADEQUATE REALIZATION OF THESE POTENTIALS. THE RESEARCH PROJECTS WILL PROVIDE THE BACKGROUND KNOWLEDGE NEEDED TO ESTABLISH V/STOL OPERATIONAL REQUIREMENTS WITH RESPECT TO THE AIRCRAFT CONTROL AND STABILITY, FLIGHT-CONTROL SYSTEM CHARACTERISTICS, MANEUVER ENVELOPES AND LIMITATIONS, GUIDANCE INFORMATION, COCKPIT DISPLAYS, AIRSPACE REQUIREMENTS, PILOTING TECHNIQUES AND WORKLOADS. PARTICULAR EMPHASIS WILL BE ON THE OPERATIONAL REQUIREMENTS FOR CONVERSION FROM WINGBORNE TO POWERED-LIFT FLIGHT AND IN-FLIGHT DECELERATION TO LOW TOUCHDOWN SPEEDS OR HOVER DURING PRECISION-GUIDED INSTRUMENT APPROACHES TO THE LANDING AREA AND IN IMPROVING THE ABILITY TO PREDICT AND REALIZE SATISFACTORY MANEUVER ENVELOPES AS DICTATED BY OPERATIONAL REQUIREMENTS. ANALYTICAL, SIMULATION, WIND-TUNNEL, AND FLIGHT STUDIES WITH AVAILABLE VEHICLES WILL BE MADE TO ACCUMULATE THE DATA AND UNDERSTANDING REQUIRED TO ESTABLISH APPROPRIATE CRITERIA AND POSSIBLE MEANS FOR IMPROVED FLIGHT CHARACTERISTICS FOR THE VARIOUS V/STOL AIRCRAFT CONCEPTS.

RTOP NO. 760-72-03 TITLE: V/STOL AND STOL AIRCRAFT FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

ALL V/STOL AND STOL AIRCRAFT DESIGNS UNDER CONSIDERATION TO MEET CIVIL AND MILITARY TRANSPORTATION REQUIREMENTS HAVE SERIOUS DEFICIENCIES IN HANDLING QUALITIES AND RIDE QUALITIES. THE CRITERIA FOR CERTIFICATION FOR THESE CLASSES OF AIRPLANE NEED DEVELOPMENT, ESPECIALLY IN THE AREA OF LANDING PERFORMANCE. INVESTIGATIONS ARE BEING CONDUCTED TO DEVELOP SOLUTIONS TO THESE PROBLEMS SO THAT COMMERCIAL AND MILITARY PILOTS CAN EASILY AND SAFELY MANUALLY CONTROL V/STOL AND STOL TRANSPORTS, PARTICULARLY IN THE CRITICAL PHASES OF TERMINAL OPERATIONS. MANUAL CONTROL OF V/STOL AND STOL AIRCRAFT IS BEING STUDIED THROUGH AN INTEGRATED EFFORT USING ANALYSIS, GROUND-BASED SIMULATORS, AND VARIOUS CONCEPTUAL TYPES OF AIRCRAFT. SPECIFIC GOALS ARE TO EXTEND THE KNOWLEDGE OF V/STOL AND STOL STABILIZATION REQUIREMENTS AND TO DEVELOP INFORMATION ON DISPLAYS AND INTEGRATION OF CONTROLS TO PROVIDE MANUAL CONTROLLABILITY AT REDUCED LEVELS OF PILOT WORKLOAD. THE STUDIES EMPHASIZE THE RELATIONSHIP OF COCKPIT DISPLAYS AND HUMAN OPERATOR CONTROL CHARACTERISTICS IN DEFINING THE COMPLETE FLIGHT SYSTEM AND ARE INTIMATELY RELATED TO OPERATION UNDER TERMINAL AREA GUIDANCE AND TO LANDING AND TAKEOFF. GROUND-BASED SIMULATION WILL BE USED TO STUDY THE PERFORMANCE OF COMPLETE SYSTEMS WITH VARIOUS DISPLAYS AND LEVELS OF AUTOMATION IN CRITICAL TASKS SUCH AS PRECISION HOVER, TRANSLATIONAL MANEUVERS, AND CURVED AND DECELERATING APPROACHES. FOR EACH SYSTEM, SIMULATORS PERMIT A WIDE RANGE OF PARAMETERS TO BE COVERED. FLIGHT INVESTIGATIONS WILL BE USED TO VERIFY SIMULATOR RESULTS FOR SELECTED SYSTEMS TO IDENTIFY PROBLEMS FOR FURTHER STUDY.

RTOP NO. 760-72-04 TITLE: V/STOL AIRCRAFT SUPPORT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

TO PROVIDE OPERATIONAL SUPPORT AND MAINTENANCE FOR OPERATION OF STOL, ROTORCRAFT AND VTOL RESEARCH AIRCRAFT USED IN FLIGHT STUDIES DESCRIBED UNDER RTOP 760-72-03.

RTOP NO. 760-72-04 TITLE: V/STOL AIRCRAFT SUPPORT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE FOLLOWING AIRCRAFT ARE USED IN FLIGHT INVESTIGATIONS OF VTOL AND STOL AIRCRAFT: X-14B JET-LIFT VTOL AIRCRAFT WITH A THREE-AXIS MODELFOLLOWING VARIABLE-STABILITY SYSTEM; XV-5BFAN-IN-WING VTOL AIRCRAFT; C-8A STOL AIRCRAFT;UH-12E HELICOPTER; OV-10A STOL AIRCRAFT, MODIFIEDTO INCORPORATE A ROTATING CYLINDER FLAP; HU-1HELICOPTER.

RTOP NO. 760-72-05 TITLE: JET AUGMENTOR WING VEHICLE SYSTEMS AND AERODYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE AUGMENTOR WING JET STOL TRANSPORT PROGRAM IS DIRECTED TOWARD THE DEVELOPMENT OF STOL TECHNOLOGY RELATED TO APPLICATION OF THE AUGMENTOR WING CONCEPT TO TRANSPORT AIRCRAFT AND THUS ALLOW GREATER CONFIDENCE IN ULTIMATE DESIGN OF COMMERCIAL OR MILITARY STOL TRANSPORT AIRCRAFT. PRELIMINARY DESIGN STUDIES ARE UNDERWAY OF AUGMENTOR WING STOL TRANSPORTS TO DEFINE VARIOUS METHODS OF APPROACH FOR INTEGRATION OF THE WING, PROPULSION SYSTEM, DUCTING, AND CONTROL FOR QUIET AUGMENTOR FLAP DEVELOPMENTS. CONCURRENTLY, TESTS ARE UNDERWAY WITH THE BOEING COMPANY WITH A LARGE-SCALE MODEL OF THE AUGMENTOR WING FLAPS TO DETERMINE METHODS OF QUIETING AUGMENTOR WING FLAPS AND ATTAINING HIGHER EFFICIENCY. LARGE-SCALE WIND TUNNEL TESTS IN THE 40- BY 80-FOOT WIND TUNNEL OF A SWEPT-BACK WING MODEL ARE IN PROGRESS TO DEFINE THE AERODYNAMICS, STOL PERFORMANCE, STABILITY AND CONTROL IN AND OUT OF GROUND EFFECT. STUDIES ARE UNDERWAY TO ASSESS THE EFFECT OF RELATIVELY THICK SUPERCRITICAL WINGS ON THE AUGMENTOR WING FLAP PERFORMANCE, WING WEIGHTS, DUCTING AND AIRFLOW LOSSES, AND ON THE AIRCRAFT CRUISE PERFORMANCE. SIMULATION OF AUGMENTOR WING TRANSPORTS WILL BE CONTINUED WITH THE INTRODUCTION OF THE SWEPT-BACK WING CHARACTERISTICS AND GROUND EFFECT. THIS ACTIVITY IS RELATED DIRECTLY TO THE AUGMENTOR NOISE RESEARCH 760-72-02 AND AUGMENTOR WING JET STOL RESEARCH AIRCRAFT (MODIFIED C-8A) 763-72-02.

RTOP NO. 760-72-06 TITLE: LIFT-FAN V/STOL AERODYNAMICS AND VEHICLE SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE LIFT-FAN RESEARCH AIRCRAFT PROGRAM IS DIRECTED TOWARD THE ADVANCEMENT OF LIFT-FAN V/STOL AIRCRAFT TECHNOLOGY TO THE POINT WHERE THE DESIGN OF COMMERCIAL OR MILITARY AIRCRAFT CAN BE UNDERTAKEN WITH GREATER CONFIDENCE. TO ACHIEVE THIS GOAL, AN OVER-ALL TECHNOLOGY PROGRAM HAS BEEN INITIATED TO ESTABLISH THE TECHNOLOGICAL BASE REQUIRED FOR FUTURE PROCUREMENT OF A LIFT-FAN V/STOL PROOF-OF-CONCEPT FLIGHT RESEARCH AIRCRAFT. COMPETITIVE STUDY CONTRACTS HAVE BEEN AWARDED TO THREE CONTRACTORS TO (1) DEFINE A PRACTICAL COMMERCIAL DIRECT-LIFT FAN V/STOL TRANSPORT, (2) ESTABLISH A PRELIMINARY DESIGN OF A MINIMUM SIZE PROOF-OF-CONCEPT LIFT-FAN RESEARCH AIRCRAFT, (3) PROVIDE A PROGRAM PLAN FOR DEVELOPMENT OF THE PROOF-OF-CONCEPT RESEARCH AIRCRAFT, AND (4) DEFINE RESEARCH AND DEVELOPMENT PROGRAMS REQUIRED FOR DEVELOPMENT OF THE AIRCRAFT. STUDIES OF THE FEASIBILITY OF MODIFYING THE DC-9-10 AIRCRAFT WITH G.E. 460 TIP-TURBINE-DRIVEN LIFT FANS WERE COMPLETEDFY 71 AND INDICATED THAT A 60,000 LB V/STOL V/STOL RESEARCH AIRCRAFT WAS POSSIBLE WITH UTILIZATION OF AN ENERGY TRANSFER CONTROL SYSTEM.EXPERIMENTAL INVESTIGATIONS ARE UNDERWAY UTILIZING 2 YJ-97 GAS GENERATORS DURING FY 71 AND FY 72 THAT WILL EVALUATE THE RESPONSE RATES, TRANSIENTS, AND OTHER DYNAMIC PARAMETERS OF THE ENERGY TRANSFER CONTROL SYSTEM TO BE USED IN CONTROL OF THE TIP-TURBINE-DRIVEN FAN SPEED. LARGE-SCALE WIND-TUNNEL TESTS OF LIFT-FAN MODELS OF VARIOUS ARRANGEMENTS OF LIFT FANS ON THE FUSELAGE AND WINGS HAVE BEEN UNDERWAY TO DEFINE THE V/STOL PERFORMANCE, STATIC STABILITY AND CONTROL REQUIREMENTS IN AND OUT OF GROUND EFFECT. SIMULATION STUDIES DIRECTED AT THE POTENTIALPROOF-OF-CONCEPT AIRCRAFT ARE UNDERWAY----

RTOP NO. 760-72-06 TITLE: LIFT-FAN V/STOL AERODYNAMICS AND VEHICLE SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3611
TECHNICAL SUMMARY

THE BASIC RESEARCH OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR IMPROVED PERFORMANCE AND STABILITY AND CONTROL OF POSSIBLE ADVANCED V/STOL LIFT-FAN AIRCRAFT CONFIGURATIONS THAT WOULD HAVE APPLICATION IN MILITARY AND CIVIL TRANSPORT AND IN MILITARY FIGHTER AND ATTACK MISSIONS. THE RESEARCH IS DIRECTED ALONG TWO LINES. THE MORE FUNDAMENTAL LINE IS TO PROVIDE A BASIC UNDERSTANDING OF THE AERODYNAMIC PHENOMENA INVOLVED AND TO DEVELOP THEORETICAL OR SEMI-EMPIRICAL MEANS OF PREDICTING THE AERODYNAMIC CHARACTERISTICS OF THE VEHICLES. THE OTHER LINE IS TO EXPLORE EXPERIMENTALLY THE AERODYNAMIC CHARACTERISTICS OF THE MORE NOVEL TYPES OF VEHICLES INVOLVED WITH A VIEW TOWARD DEFINING THEIR GROSS CHARACTERISTICS, THE PERTINENT VARIABLES, AND THE PROBLEM AREAS AND GENERAL METHODS OF SOLUTION. WIND-TUNNEL AND THEORETICAL STUDIES WILL BE USED TO IMPROVE THE CAPABILITY TO PREDICT THE AERODYNAMIC PERFORMANCE AND STABILITY AND CONTROL CHARACTERISTICS OF ADVANCED LIFT-FAN-POWERED

VTOL AND STOL CONCEPTS AS THEY ARE PRESENTLY ENVISIONED, AND TO EXPLORE NEW AIRFRAME-PROPULSION INTEGRATION CONCEPTS AIMED AT IMPROVEMENT IN PERFORMANCE.

RTOP NO. 760-73-01 TITLE: AERODYNAMICS OF ADVANCED SUBSONIC/TRANSONIC TRANSPORTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

CONSIDERATION OF THE TYPES OF AIRCRAFT THAT COULD BE UTILIZED TO EXTEND THE CRUISING SPEED AND RANGE OF COMMERCIAL AIR TRANSPORTS BEYOND THAT CURRENTLY AVAILABLE WITH SUBSONIC JETS RESULTS IN THE CONCEPT (AMONG OTHERS) OF A LOW-SUPERSONIC SPEED CRUISE AIRCRAFT. A CRUISE SPEED OF APPROXIMATELY M = 1.1 IS VISUALIZED. SUCH AN AIRCRAFT WOULD PROVIDE A CONSIDERABLE REDUCTION IN TRANSIT TIME WITHOUT INCURRING A SONIC BOOM PROBLEM OF THE MAGNITUDE ASSOCIATED WITH HIGHER SUPERSONIC SPEEDS. ANALYTICAL STUDIES AND TESTS IN GROUND-BASED FACILITIES WILL BE PERFORMED TO DERIVE THE INPUTS NEED FOR MISSION STUDIES TO ASSESS THE POTENTIAL OF LOW SUPERSONIC TRANSPORTS.

RTOP NO. 760-73-02 TITLE: SUBSONIC/TRANSONIC AIRCRAFT FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

A COOPERATIVE PROGRAM IS IN PROGRESS WITH THE FAA TO DEVELOP MORE RATIONAL CRITERIA AND FLIGHT MANEUVERS FOR CERTIFICATION OF TRANSPORT AIRCRAFT. NEAR TERM PLANS INCLUDE RESEARCH TO EFFECT REVISION OF THE LONGITUDINAL STABILITY REQUIREMENTS, PRIMARILY FOR THE LANDING APPROACH AND CLIMB. FUTURE PLANS INCLUDE INVESTIGATIONS OF THE HANDLING QUALITIES OF ADVANCED TRANSONIC TRANSPORT CONCEPTS, WITH EMPHASIS ON THE TRANSONIC CRUISE WHERE LARGE CHANGES IN THE STABILITY AND CONTROL PARAMETERS ACCOMPANY SMALL VARIATIONS IN SPEED. THE FLIGHT SIMULATOR FOR ADVANCED AIRCRAFT (FSAA) WILL BE USED IN THE RESEARCH NOTED ABOVE. INCREASES IN THE HAZARD OF TRAILING VORTEX SYSTEMS IS A CONSEQUENCE OF INCREASES IN TRANSPORT SIZE. PRACTICAL MEANS ARE BEING SOUGHT TO ACCELERATE THE DISSIPATION OF VORTEX WAKES TO IMPROVE FLIGHT SAFETY AND TO REDUCE THE REQUIRED SEPARATION DISTANCES BETWEEN AIRCRAFT.

RTOP NO. 760-74-01 TITLE: SUPERSONIC AIRCRAFT AERODYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE AERODYNAMIC, STRUCTURES, AND PROPULSION SYSTEM TECHNOLOGY SUCH THAT IMPROVED OVERALL PERFORMANCE CAN BE ACHIEVED BY COMMERCIAL AIRCRAFT, MILITARY AIRCRAFT, AND

MISSILE CONFIGURATIONS IN BOTH THE SUBSONIC AND SUPERSONIC FLIGHT REGIMES. THE FURTHER OBJECTIVE IS TO FIND MEANS TO PROVIDE IMPROVED LIFT-OFF CHARACTERISTICS FOR OPTIMUM SUPERSONIC CRUISE VEHICLES AND TO ASSURE THAT ADEQUATE CONTROL POWER, MANEUVERABILITY, AND INLET PERFORMANCE ARE ACHIEVED AT ALL FLIGHT CONDITIONS. THE FEASIBILITY AND IMPORT OF THE RESEARCH DEVELOPMENTS WILL BE ASSESSED BY APPLICATION TO PRACTICAL COMMERCIAL, MILITARY, AND MISSILE CONFIGURATIONS. THE RESEARCH APPROACH WILL INVOLVE THE USE OF AUTOMATED ANALYTIC TECHNIQUES AND CAREFULLY CONTROLLED WIND-TUNNEL EXPERIMENTS OF BASIC AIRPLANE, MISSILE, AND INLET CONFIGURATIONS, AND BY TESTS AND ANALYSES OF SOPHISTICATED COMPLETE CONFIGURATIONS. EFFORTS WILL BE CONTINUED TO COMBINE EXISTING AND IMPROVED METHODS FOR AERODYNAMIC ANALYSIS WITH SIMILAR METHODS FOR STRUCTURAL WEIGHT AND BALANCE ANALYSES.

RTOP NO. 760-74-01 TITLE: SUPERSONIC AIRCRAFT AERODYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RESEARCH EFFORT IS TO PROVIDE INFORMATION IN AREAS WHERE FLIGHT EXPERIENCE HAS REVEALED INCOMPLETE DESIGN KNOWLEDGE, OR WHERE INNOVATIVE THINKING HAS INDICATED POTENTIAL GAINS. SPECIFICALLY, THE IMMEDIATE OBJECTIVES ARE CONCERNED WITH (1) FLOW FIELDS ABOUT ARBITRARY FUSELAGE SHAPES, PARTICULARLY AT LARGE ANGLES OF ATTACK AND SIDESLIP (2) THE CORRELATION OF WIND TUNNEL AND FLIGHT DATA OBTAINED AT SUPERSONIC SPEEDS, (3) TO PROVIDE THE DESIGN GUIDELINES FOR PRACTICAL LOW SONIC BOOM AIRCRAFT CONFIGURATIONS FOR SUPERSONIC FLIGHT, (4) AN ASSESSMENT OF POSSIBLE INCREASES IN AIRCRAFT PERFORMANCE ACHIEVED BY ACCEPTING THE PREMISE OF LITTLE OR NO AERODYNAMIC STABILITY. THE APPROACH FOLLOWED WILL BE: OBJECTIVE (1) - EXAMINE MODIFICATIONS TO METHODS SUCH AS THE NAVIER-STOKES EQUATIONS TO ALLOW EVALUATIONS OF CROSS-FLOW; OBJECTIVE (2) - OBTAIN SUPERSONIC WIND TUNNEL DATA WITH A MODEL OF THE XB-70 AIRPLANE AS IDENTICAL AS PRACTICABLE TO THE CONFIGURATION CORRESPONDING TO AVAILABLE FLIGHT DATA; OBJECTIVE (3) - CONDUCT FEASIBILITY STUDIES TO DETERMINE THE AIRCRAFT CONFIGURATIONS THAT WILL PROVIDE LOW SONIC BOOMS; OBJECTIVE (4) - PERFORM ANALYSES OF CONCEPTUAL AIRCRAFT AND COMPARE THEIR PERFORMANCE WITH THAT OF CURRENT AIRPLANES OF THE SAME CLASS.

RTOP NO. 760-74-04 TITLE: SUPERSONIC AIRCRAFT FLIGHT DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

VARIOUS FACTORS THAT CONTRIBUTE TO THE HANDLING QUALITIES OF CIVIL AND MILITARY AIRCRAFT DESIGNS ARE BEING INVESTIGATED IN GROUND-BASED SIMULATIONS. PRINCIPLE INTEREST IS CENTERED ON THE LOW-SPEED AREAS OF APPROACH, LANDING, TAKEOFF, AND CLIMB, AND IN THE HIGH SPEED AREAS OF TRANSONIC FLIGHT, CRUISE, AND OVERSPEED. VARIATIONS IN AIRCRAFT PARAMETERS, AUGMENTATION SYSTEMS, AND COCKPIT

DISPLAYS, AND THE EFFECTS OF TURBULENCE, POOR VISIBILITY, CROSS WINDS, AND AUGMENTATION SYSTEM FAILURES ARE BEING INVESTIGATED. THIS WORK IS DIRECTED AT IMPROVING THE GENERAL KNOWLEDGE OF HANDLING QUALITIES CRITERIA FOR SUPERSONIC AIRCRAFT, PARTICULARLY FOR TASKS IN LOW-SPEED FLIGHT. A STRUCTURAL MODEL SUITABLE FOR USE IN PILOTED SIMULATION IS UNDER DEVELOPMENT AND WILL BE EMPLOYED IN AN EVALUATION OF STRUCTURAL DYNAMICS WITH THE AIM OF FINDING PRACTICAL MEANS TO MINIMIZE THEM. ALTHOUGH THE MODEL IS FOR A SUPERSONIC TRANSPORT, THIS WORK WILL APPLY GENERALLY TO ALL LARGE TRANSPORT AIRCRAFT. THE RESEARCH WILL BE COORDINATED WITH THE RESULTS OF ANALYTICAL STUDIES IN PROGRESS WHICH ARE AIMED AT PREDICTING AND IMPROVING PILOT-VEHICLE-CONTROL SYSTEM PERFORMANCE AND RIDE COMFORT (RTOP 136-62-01). RESEARCH WILL BE CONDUCTED TO ESTABLISH THE LEVEL OF INSTABILITY THAT IS ACCEPTABLE WITH DEGRADED STABILITY AUGMENTATION, AS A FUNCTION OF CONTROL POWER, LONGITUDINAL MOMENT OF INERTIA, AND FLIGHT TASKS. STUDY WILL ALSO DEFINE APPLICATIONS AND LIMITATIONS OF CONTROL CONFIGURED VEHICLE CONCEPT.

RTOP NO. 760-74-05 TITLE: TRANSONIC MANEUVERABILITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K. TEL. 703-827-3285
TECHNICAL SUMMARY

TO IDENTIFY PROBLEMS CONCERNED WITH MANEUVERING EFFECTIVENESS OF MILITARY AIRCRAFT, CONDUCT ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS TO PROVIDE SOLUTIONS TO THESE PROBLEMS, AND PROVIDE CRITERIA FOR ADVANCED DESIGN CONFIGURATIONS. ASSESS VARIOUS PARAMETERS WHICH INFLUENCE THE MANEUVERING/COMBAT EFFECTIVENESS OF FIGHTER AIRCRAFT AND DETERMINE TRADE OFF AND SENSITIVITY INFORMATION WHICH CAN BE USED TO GUIDE WIND-TUNNEL RESEARCH. DEVELOP APPROPRIATE THEORY AND EXPAND THROUGH THE USE OF COMPUTERIZED TECHNIQUES. EVALUATE THRUST VECTORING BY MEANS OF FLIGHT TESTS USING THE HAWKER-SIDDELEY KESTREL AIRCRAFT AND EVALUATE THE STABILITY AND CONTROL PROBLEMS ENCOUNTERED BY THE PILOT WHILE CONDUCTING A TRACKING TASK INVOLVING HIGH MANEUVERABILITY. DEVELOP SYSTEMATIC DESIGN INFORMATION FOR AIRCRAFT WHICH REQUIRE HIGH THRUST-TO-WEIGHT RATIOS, MODERATE WING LOADINGS AND HIGH USABLE LIFT COEFFICIENTS AT TRANSONIC AND LOW SUPERSONIC SPEEDS.

RTOP NO. 760-74-05 TITLE: TRANSONIC MANEUVERABILITY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RESEARCH EFFORT IS TO PROVIDE INFORMATION CONCERNED WITH IMPROVING THE MANEUVERING EFFECTIVENESS OF MILITARY AIRCRAFT IN THE TRANSONIC SPEED RANGE. THIS IMPLIES THE NEED TO FIND MEANS FOR DEVELOPING WING CONCEPTS WHICH LEAD TO THE BUFFET-FREE GENERATION OF HIGH LIFT. AS PART OF A JOINT ARC-FRC STUDY, AMES WILL CONDUCT WIND TUNNEL INVESTIGATIONS OF THE USE OF TWIN HINGE LEADING EDGE FLAPS ON THE NORTHROP F-5. THE RESULTS FROM THE WIND TUNNEL STUDY WILL BE USED IN SELECTING THE DESIGN

MODIFICATIONS FOR THE FLIGHT TEST AIRCRAFT AND IN CORRELATIONS WITH THE FLIGHT DATA.

RTOP NO. 760-74-05 TITLE: FIGHTER AIRCRAFT OPTIMIZATION FOR TRANSONIC MANEUVERABILITY
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: SISK, T. R. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS PROGRAM IS A COORDINATED FLIGHT/WIND-TUNNEL INVESTIGATION OF FIGHTER AIRCRAFT TRANSONIC MANEUVERABILITY UTILIZING SUCH AIRCRAFT AS THE F-5, F-104, F-8, AND F-111. THE INVESTIGATION INCLUDES THE EVALUATION OF EFFECTS OF MANEUVER FLAP DEFLECTION ON BUFFET ALLEVIATION AND HANDLING QUALITIES OF EXISTING A/C AS WELL AS VALIDATION OF MODEL RESULTS OF AERODYNAMIC INNOVATIONS SUCH AS THE NORTHROP DOUBLE-HINGED LEADING-EDGE FLAP AND APPLICATION OF THE SUPERCRITICAL AIRFOIL TO FIGHTER AIRCRAFT. ALSO INCLUDED IS AN ASSESSMENT OF HIGH ANGLE-OF-ATTACK (A IS GREATER THAN 20 DEGREES) FLYING QUALITIES AND A REVIEW OF APPROPRIATE HANDLING QUALITIES CRITERIA AND SPECIFICATIONS. FLIGHT RESULTS WILL BE CLOSELY COORDINATED WITH MODEL RESULTS TO ASSIST IN DEVELOPING PREDICTION TECHNIQUES AND ESTABLISHING ADVANCED DESIGN CRITERIA.

RTOP NO. 760-74-06 TITLE: DESIGN GUIDELINES FOR LOW SONIC-BOOM AIRCRAFT CONFIGURATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK WILL BE TO PROVIDE THE DESIGN GUIDELINES FOR PRACTICAL LOW SONIC-BOOM AIRCRAFT CONFIGURATIONS FOR SUPERSONIC FLIGHT; TO DETERMINE DESIGN PROCEDURES AND PRACTICAL AIRCRAFT DESIGN LIMITATIONS THAT WILL INDICATE HOW REAL AIRCRAFT CAN BE DESIGNED TO PROVIDE ACCEPTABLE SONIC BOOMS, AND THUS MAKE POSSIBLE DOMESTIC VERSIONS OF THE SUPERSONIC TRANSPORTS; AND TO PROVIDE WIND-TUNNEL SUPPORT AND RELATED TECHNICAL ASSISTANCE FOR TESTING ADVANCED LOW BOOM CONFIGURATIONS.

RTOP NO. 760-74-07 TITLE: SUPPORT OF THE F-14, F-15, AND B-1 DEVELOPMENT PROGRAMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

TO PROVIDE TEST AND CONSULTATION SUPPORT TO THE DEPARTMENT OF DEFENSE IN CONNECTION WITH THE DEVELOPMENT OF THE F-14, F-15, AND B-1 AIRPLANES. TESTS WILL BE PERFORMED IN AMES FACILITIES CONSISTENT WITH THE AVAILABILITY OF TEST TIME AND THE NEED FOR UTILIZING THE PARTICULAR FACILITIES REQUESTED.

RTOP NO. 760-74-08 TITLE: DOT SUPPORT - THE BOEING 2707-300
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO ADVANCE THE KNOWLEDGE IN SUPERSONIC AIRCRAFT DESIGN BY CAPITALIZING ON THE KNOWLEDGE AND EXPERIENCE ACQUIRED IN THE COURSE OF DEVELOPING THE SST DESIGN. MUCH OF THE WORK PERFORMED BY THE BOEING COMPANY REPRESENTS AN ADVANCEMENT IN THE STATE-OF-THE-ART IN SUPERSONIC AIRCRAFT DESIGN WHICH COULD BENEFIT OTHERS. THE PROCEDURE TO BE FOLLOWED IS TO HAVE BOEING COMPLETE AND DOCUMENT CERTAIN PHASES OF THE RESEARCH AND DEVELOPMENT WORK THEY CONDUCTED UNDER THE DOT-SST PROGRAM.

RTOP NO. 760-74-09 TITLE: F-111 SUPERCRITICAL WING RESEARCH PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO EVALUATE AND FLIGHT TEST A VARIABLE SWEEP SUPERCRITICAL WING WHICH IS BELIEVED CAPABLE OF IMPROVED AERODYNAMIC EFFICIENCY IN THE TRANSONIC REGION. (1) DEMONSTRATE THE IMPROVED TRANSONIC DRAG RISE AND LIFT LEVELS FOR BUFFET ONSET SHOWN IN WIND-TUNNEL INVESTIGATIONS. (2) IDENTIFY PROBLEM AREAS IN STRUCTURAL AND AERODYNAMIC DESIGN AND FLIGHT OPERATIONS AND (3) ESTABLISH THE DESIRED LEVEL OF CONFIDENCE IN PREDICTION TECHNIQUES FOR FUTURE APPLICATIONS.

RTOP NO. 760-75-01 TITLE: HYPERSONIC AIRCRAFT CONFIGURATIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO PROVIDE THE TECHNOLOGY FOR THE DESIGN OF EFFICIENT, PRACTICAL, HYPERSONIC AIRBREATHING AIRCRAFT. A NUMBER OF AIRCRAFT SYSTEMS ARE BEING STUDIED. THESE INCLUDE HYPERSONIC TRANSPORTS, MILITARY STRIKE AND RECONNAISSANCE VEHICLES, HYPERSONIC RESEARCH AIRPLANES, AND THE AIRBREATHING LAUNCH VEHICLE. THE AIRBREATHING LAUNCH VEHICLE WHICH IS CAPABLE OF PROVIDING A TRULY LOW-COST SPACE LOGISTICS SYSTEM CAN FILL AN EXPECTED NEED IN THE NASA/DOD PROGRAM IN THE 1985-1995 TIME PERIOD. THE HYPERSONIC TRANSPORT, WITH ITS LONG-RANGE CAPABILITY AND CRUISE SONIC BOOM LEVELS THAT MAY BE ACCEPTABLE OVER POPULATED AREAS, HAS THE POTENTIAL OF PROVIDING A MAJOR STEP IN AIR TRANSPORTATION IN THE LATTER PART OF THE CENTURY. THE TECHNOLOGY FOR ALL THREE SYSTEMS NEEDS TO BE DEMONSTRATED IN FLIGHT BEFORE COMMITMENT TO MISSION HARDWARE IS MADE. A PROGRAM FOR HYPERSONIC TECHNOLOGY DEMONSTRATOR AIRCRAFT FOR OPERATION IN THE EARLY 1980 PERIOD WILL BE DEVELOPED AND THIS VEHICLE WILL BE USED AS A FOCAL POINT IN THE TECHNOLOGY DEVELOPMENT. AIRBREATHING VEHICLE SYSTEMS MUST FULLY EXPLOIT THE INTERACTIONS BETWEEN AERODYNAMICS, PROPULSION, STRUCTURES, TRAJECTORY SELECTION, ETC., TO ACHIEVE MAXIMUM OVERALL EFFICIENCY AND OPERATIONAL FLEXIBILITY. DETAILED WORK ON CONFIGURATION CONCEPTS, RELIABLE

PREDICTION TECHNIQUES, FULL-SCALE REYNOLDS NUMBER EFFECTS, ENGINE-AIRFRAME INTEGRATION, ETC., WILL BE VIGOROUSLY PURSUED TO PROVIDE THE TECHNOLOGICAL BASE NECESSARY FOR DESIGNING AN AIRBREATHING LAUNCH SYSTEM TO MEET THESE REQUIREMENTS.

RTOP NO. 760-75-01 TITLE: HYPERSONIC AIRCRAFT AERODYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

NASA AND AIRCRAFT INDUSTRY STUDIES HAVE INDICATEDTHAT HYDROGEN-FUELED HYPERSONIC AIRCRAFT OFFERATTRACTIVE PERFORMANCE CAPABILITIES FOR CIVIL ANDMILITARY MISSIONS. TO SUPPLEMENT AND VERIFY THESESTUDIES, WIND TUNNEL TESTS ARE BEING PERFORMED ONPOTENTIAL HYPERSONIC CONFIGURATIONS FROMSUBSONIC TO HYPERSONIC SPEEDS. A PROGRAM INCLUDESWING-BODY, AND ALL-BODY CONCEPTS.IN ADDITION TO PROVIDING INFORMATION USEFUL INESTABLISHING THE ACCURACY OF VARIOUS PERFORMANCEPREDICTION TECHNIQUES, WIND TUNNEL TESTS PROVIDEEXPERIMENTAL DATA ON CONFIGURATIONS OF GENERALINTEREST.----

RTOP NO. 760-76-01 TITLE: ROTORCRAFT AERODYNAMICS AND NOISE REDUCTION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

A CONTINUING RESEARCH EFFORT WILL BE MAINTAINED TO ASCERTAIN THE EFFECTIVENESS OF EXISTING THEORIES, EXTEND THE CAPABILITIES OF THEORETICAL METHODS, AND PROVIDE PROCEDURES FOR ANALYZING AND PREDICTING THE AERODYNAMIC, PERFORMANCE, AND NOISE CHARACTERISTICS OF ROTORS AND PROPELLERS. EXPERIMENTAL STUDIES OF ADVANCED ROTOR CONCEPTS, INCLUDING SOME BASED ON NEW AIRFOIL TECHNOLOGY, WILL BE UNDERTAKEN TO PROVIDE IMPROVED PERFORMANCE CHARACTERISTICS. EMPHASIS WILL ALSO BE PLACED ON EXPERIMENTAL STUDIES OF THE UNSTEADY AERODYNAMIC PARAMETERS WHICH AFFECT ROTOR BLADE-SECTION LIFT GENERATION, SUCH AS CHANGES IN ANGLE OF ATTACK, MACH NUMBER, AND YAW ANGLE. IN ADDITION, DEFINITIVE STUDIES WILL BE MADE OF THE SOURCE AND CHARACTERISTICS OF ROTOR AERODYNAMIC-NOISE GENERATION. WORK WILL BE CONTINUED TO EXAMINE THE ROTOR-WAKE/TAIL-ROTOR INTERFERENCE PROBLEM.

RTOP NO. 760-76-01 TITLE: ROTORCRAFT AERODYNAMICS AND NOISE REDUCTION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE SIGNIFICANT ADVANCES IN OVERALL ROTOR/PROPELLER PERFORMANCE IN RECENT YEARS REQUIRES A FOCUSING ON BASIC AERODYNAMIC PHENOMENON TO PROVIDE A RATIONAL BASE FOR FUTURE ROTORCRAFT DESIGN. TO IMPLEMENT THIS ACTIVITY WILL REQUIRE PROCUREMENT FROM CONTRACTORS OF

SEVERAL EXISTING ROTOR THEORIES TO FORM A BASE FOR PLANNED IN-HOUSE RESEARCH. RFP'S WILL BE PREPARED TO ACQUIRE A FORWARD FLIGHT ROTOR PERFORMANCE PROGRAM INCLUDING VARIABLE INFLOW AND A HOVER PERFORMANCE THEORY WITH A FREE WAKE. APPLICATION OF THESE THEORIES WILL PROVIDE TIMELY IN-HOUSE EVALUATION OF CANDIDATE ROTOR DESIGNS FOR TESTS ON THE HIGH PERFORMANCE ROTOR RIG NOW STARTING DEVELOPMENT. DEVELOPMENT OF A THREE DIMENSIONAL, COMPRESSIBLE, LIFTING SURFACE THEORY FOR ROTORS/PROPELLERS IN HOVER IS REQUIRED TO ADEQUATELY DEFINE BLADE LOADING IN THE TIP REGION. USE OF SUCH THEORY WITH A VORTEX WAKE REPRESENTATION IS REQUIRED TO ENABLE RATIONAL AND ACCURATE PREDICTION OF HOVER PERFORMANCE AS REQUIRED FOR VTOL AIRCRAFT. DESIGN AND FABRICATION OF A ROTOR TO MEASURE ABSOLUTE SURFACE PRESSURE DISTRIBUTIONS ON AN OUTBOARDSECTION WITH VARIOUS PLANFORM SHAPES FOR TESTING ON THE HPR IN CONJUNCTION WITH ROTOR NOISE MEASUREMENTS IN THE 40X80. TEST RESULTS WILL PROVIDE NOISE/PERFORMANCE TRADE-OFFS AND PROVIDE DATA FOR CORRELATION WITH PERFORMANCE AND ACOUSTIC THEORY. DESIGN STUDIES WILL BE CONDUCTED TO OPTIMIZE A ROTOR FOR HOVERING, AS REQUIRED FOR HLH TYPES AND FULL SCALE WIND TUNNEL TESTS CONDUCTED. RESULT OF FY 71 JET FLAP ROTOR AND ABC ROTOR TESTS WILL BE ANALYZED AND REPORTED. THE REVERSE VELOCITY ROTOR CONCEPT WILL BE INVESTIGATED, BOTH ANALYTICALLY ANDEXPERIMENTALLY, TO DETERMINE IF THE POTENTIAL----

RTOP NO. 760-76-02 TITLE: ROTORCRAFT DYNAMIC LOADS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE DYNAMIC INSTABILITY PROBLEMS, BOTH AEROMECHANICAL AND FLIGHT VEHICLE, ASSOCIATED WITH THE LARGE CONTROL POWER AND DAMPING POTENTIAL OF EDGEWISE FLYING HINGELESS ROTORS WILL BE INVESTIGATED. ONE MATHEMATICAL MODEL OF A HINGELESS ROTOR HAS BEEN DERIVED, INCLUDING A STABILIZING GYROSCOPE IN THE CONTROL SYSTEM, AND PROGRAMMED FOR DIGITAL COMPUTER SOLUTION AS A FIRST STEP IN PROVIDING SEVERAL MATH MODELS TO SUIT THE COMPLEXITY OF GIVEN SYSTEMS. CORRELATION OF THE THEORY WITH EXISTING DATA FROM FULL-SCALE TESTS ON ROTOR/CONTROL SYSTEM STABILITY WILL IDENTIFY THE DEGREE OF RELIABILITY OF EXISTING ANALYSES. PARAMETER IDENTIFICATION STUDIES WILL PINPOINT THOSE PARAMETERS REQUIRING MORE PRECISE DEFINITION TO PERMIT RATIONAL CONTROL SYSTEM SYNTHESIS TO BE ACCOMPLISHED TO INHIBIT INSTABILITIES AND MINIMIZE AIRFRAME VIBRATION. FULL-SCALE WIND-TUNNEL TESTS OF PROMISING CONTROL SYSTEMS ARE PLANNED UTILIZING THE HIGH-PERFORMANCE ROTOR TEST RIG. A CONTRACT WILL BE INITIATED TO DEVELOP A COMPUTER PROGRAM, MODIFIED TO NASA SPECIFICATIONS, WHICH IS CAPABLE OF OPEN-FORM SOLUTION OF THE COUPLED FLATWISE, EDGEWISE, AND TORSIONAL BLADE AEROELASTIC MOTIONS. FOLLOWING CORRELATION WITH EXISTING AND PLANNED TEST DATA, THIS WILL PROVIDE A POWERFUL TOOL FOR PLANNING ROTOR LOADS AND AIRFRAME RESEARCH PROGRAMS, AND WILL PROVIDE A BASIS FOR AIRFRAME VIBRATION PREDICTION.

RTOP NO. 760-76-02 TITLE: ROTORCRAFT DYNAMIC LOADS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS RESEARCH PLAN IS TO INVESTIGATE, DEFINE, CONTROL, AND ALLEVIATE ROTOR-SYSTEM DYNAMIC LOADS, VIBRATION, AND OSCILLATORY STRESSES. THE ANALYTICAL AND EXPERIMENTAL RESEARCH WILL BE PERFORMED IN-HOUSE WITH SUPPORTING PROGRAMS CONDUCTED UNDER LIMITED CONTRACT STUDIES. PRIMARY EMPHASIS WILL BE PLACED UPON ROTOR LOADS IN EXTREME OPERATING CONDITIONS, VERIFICATION OF ANALYTICAL METHODS FOR ROTOR DYNAMIC-RESPONSE PREDICTION, INVESTIGATION OF ADVANCED VARIABLE-GEOMETRY ROTOR CONFIGURATIONS, AND BASIC STUDIES TO DETERMINE ROTOR-BLADE STRUCTURAL DAMPING CHARACTERISTICS.

RTOP NO. 760-76-03 TITLE: TILT ROTOR AERODYNAMICS AND VEHICLE SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE PROGRAM IS DIRECTED TOWARD THE ADVANCEMENT OF TECHNOLOGY OF THE TILT-ROTOR AIRCRAFT CONCEPT TO THE POINT WHERE THE DESIGN OF A COMMERCIAL OR MILITARY TRANSPORT EMPLOYING A TILT ROTOR CAN BE UNDERTAKEN WITH CONFIDENCE. WIND-TUNNEL TESTS WILL BE MADE, USING THE LANGLEY TRANSONIC DYNAMICS TUNNEL, WITH MODELS HAVING SOME FREE-BODY DEGREES OF FREEDOM TO DETERMINE THE EFFECT OF VEHICLE DEGREES OF FREEDOM ON PROP-ROTOR WHIRL FLUTTER. CORRELATION WILL BE ATTEMPTED WITH WHIRL FLUTTER-VEHICLE STABILITY THEORIES DEVELOPED IN-HOUSE. THE PERFORMANCE LIMITING PROBLEM OF STALL FLUTTER WILL BE STUDIED EXPERIMENTALLY AND ANALYTICALLY.

RTOP NO. 760-76-03 TITLE: TILT-ROTOR AERODYNAMIC AND VEHICLE SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE TILT-ROTOR PROGRAM IS DIRECTED TOWARD THE ADVANCEMENT OF THE TILT-ROTOR AIRCRAFT CONCEPT TO THE POINT WHERE THE DESIGN OF A COMMERCIAL OR MILITARY AIRCRAFT CAN BE UNDERTAKEN WITH CONFIDENCE. TO ACHIEVE THIS GOAL A JOINT NASA/ARMY EFFORT HAS BEEN INITIATED TO ESTABLISH THE TECHNOLOGICAL BASE REQUIRED FOR FUTURE PROCUREMENT OF A TILT-ROTOR PROOF-OF-CONCEPT FLIGHT RESEARCH AIRCRAFT. COMPETITIVE STUDY CONTRACTS WILL BE AWARDED TO 1) DEFINE A PRACTICAL COMMERICIAL OR MILITARY TILT-ROTOR AIRCRAFT, 2) ESTABLISH A PRELIMINARY DESIGN OF A MINIMUM SIZE PROOF-OF-CONCEPT RESEARCH AIRCRAFT, 3) PROVIDE A PROGRAM PLAN FOR THE TILT-ROTOR RESEARCH AIRCRAFT AND, 4) DEFINE IN DETAIL THE NEXT MAJOR STEP (A FULL-SCALE FULL-SPAN WIND TUNNEL MODEL TEST) IN THE OVERALL PROGRAM. JOINT NASA/ARMY/AIR FORCE FULL-SCALE TILT-ROTOR EXPERIMENTAL INVESTIGATIONS ARE UNDERWAY. TESTS OF A FULL-SCALE FLIGHTWORTHY SEMI-ARTICULATED TILT ROTOR IN THE AMES 40- BY 80-FOOT WIND TUNNEL HAVE SUCCESSFULLY DEMONSTRATED THE DYNAMIC AND PERFORMANCE CHARACTERISTICS OF THIS DESIGN. A FULL-SCALE HINGELESS

TILT-ROTOR IS CURRENTLY BEING FABRICATED FOR SIMILAR TESTS. THE FULL-SCALE PROGRAM INCLUDES THE FABRICATION AND TEST OF A FOLDABLE TILT ROTOR OF THE SEMI-ARTICULATED TYPE. A CONTINUATION OF THE NASA/ARMY/ONERA TILT-ROTOR PERFORMANCE PROGRAM PROVIDES FOR ADDITIONAL HOVER TESTS IN THE AMES 40- BY 80-FOOT WINDTUNNEL AND FURTHER HIGH MACH NUMBER CRUISE PERFORMANCE INVESTIGATIONS IN THE ONERA MODANE 26-FT. WIND TUNNEL. A THEORETICAL DESCRIPTION OF THE ROTOR, ROTOR/WING, AND AIRCRAFT DYNAMICS WILL BE DEVELOPED. THE STABILITY, CONTROL, AND VIBRATION CHARACTERISTICS OF THE AIRCRAFT WILL BE STUDIED AND AN

RTOP NO. 760-76-04 TITLE: ROTOR TEST VEHICLE STUDIES
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THE BASIC OBJECTIVE IS TO DEVELOP AN ADVANCED ROTOR-RESEARCH CAPABILITY, INCLUDING A FLIGHT VEHICLE, TO BE USED IN OBTAINING THE NECESSARY UNDERSTANDING AND DATA TO SUPPORT A MORE REALISTIC ROTOR-AERODYNAMIC AND DYNAMIC ANALYSIS. THE LONG-TERM OBJECTIVE IS TO DEVELOP BETTER METHODS OF PREDICTING THE OPERATIONAL LIMITS OF ROTORCRAFT. THE TEST VEHICLE IS INTENDED TO HAVE (1) A PERFORMANCE CAPABILITY IN EXCESS OF PRESENT OPERATIONAL HELICOPTERS, (2) ADDITIONAL LIFT AND PROPULSIVE-FORCE CAPABILITIES ABOVE THAT PROVIDED BY THE ROTOR, (3) A COMPUTERIZED FLIGHT-CONTROL SYSTEM TO PROVIDE PREDETERMINED FLIGHT-TEST CONDITIONS, AND (4) EXTENSIVE AND UNIQUE RESEARCH-INSTRUMENTATION CAPABILITY. THE ROTOR-TEST SYSTEM WILL BE DIRECTED AT GENERATING BASIC RESEARCH INFORMATION ON ROTOR AERODYNAMICS, NOISE, VIBRATION, STRUCTURAL DYNAMICS, AND FLIGHT DYNAMICS IN REGIONS OF THE OPERATIONAL ENVELOPE WHERE PRESENT INFORMATION IS INADEQUATE FOR USE IN PREDICTING LIMITATIONS OR INDICATES A POTENTIAL FOR IMPROVEMENTS IN THE OPERATIONAL ENVELOPE. THE PROGRAM TO DEVELOP THE ROTOR TEST VEHICLE IS A JOINT NASA (LANGLEY)-ARMY (U.S. AAMR&DL, LANGLEY DIRECTORATE) ENDEAVOR.

RTOP NO. 761-72-01 TITLE: ROTATING-CYLINDER-FLAP STOL RESEARCH AIRCRAFT - OV-10B
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE PROGRAM IS A JOINT NASA/ARMY EFFORT TO DETERMINE, IN FLIGHT, THE PREDICTED CHARACTERISTICS OF THE ROTATING CYLINDER FLAP CONCEPT AS APPLIED TO PROPELLER-DRIVEN AIRCRAFT OF RELATIVELY LOW GROSS WEIGHTS AND WING LOADINGS, AND TO DEFINE AND RESOLVE OPERATIONAL PROBLEMS. MODIFICATIONS ARE TO BE MADE TO THE AMES OV-10B AIRCRAFT TO MEET THE PROGRAM OBJECTIVES; THE MODIFICATIONS CONSIST OF A ROTATING-CYLINDER FLAP SYSTEM LARGER ENGINES, PROPELLER INTERCONNECT, AND IMPROVED LOW-SPEED CONTROLS. THE STEPS IN THE PROGRAM ARE: (1)

WIND-TUNNEL TESTS OF A LARGE-SCALE MODEL TO PROVIDE DETAILED AERODYNAMIC DESIGN INFORMATION, (2) DESIGN FEASIBILITY STUDY UNDER CONTRACT, (3) DETAILED DESIGN, FABRICATION OF COMPONENTS, MODIFICATION OF AIRCRAFT, GROUND AND WIND-TUNNEL TESTS OF MODIFIED AIRCRAFT, AIRWORTHINESS FLIGHT TESTS BY CONTRACTOR, AND (4) A PROOF-OF-CONCEPT FLIGHT RESEARCH PROGRAM (CONSISTING OF (A) DETERMINATION OF THE AERODYNAMIC PERFORMANCE OF THE ROTATING-CYLINDER FLAP CONCEPTS, AND (B) A STUDY OF THE STABILITY, CONTROL AND HANDLING QUALITIES OF THE MODIFIED AIRCRAFT.). THE PROGRAM IS BEING UNDERTAKEN BECAUSE OF THE NEED FOR PROPELLER STOL AIRCRAFT TO SOLVE BOTH CIVIL AND MILITARY AIR TRANSPORTATION PROBLEMS. THE ROTATING-CYLINDER FLAP CONCEPT HAS BEEN SELECTED BECAUSE THE RESULTS OF WIND-TUNNEL INVESTIGATIONS OF ADVANCED HIGH-LIFT DEVICES FOR PROPELLER STOL AIRCRAFT HAVE SHOWN THAT THE CONCEPT IS AS EFFECTIVE AS THE MOST EFFECTIVE BOUNDARY-LAYER-CONTROL FLAP AND REQUIRES LESS POWER AT THE REQUIRED TAKE-OFF AND APPROACH SPEEDS.

RTOP NO. 761-72-02 TITLE: JET AUGMENTOR WING STOL RESEARCH AIRCRAFT - MODIFIED C-8A

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FEW, D. TEL. 415-961-3051

TECHNICAL SUMMARY

AN EXISTING C-8A AIRCRAFT WILL BE MODIFIED TO INCORPORATE AN AUGMENTOR-WING POWERED HIGH-LIFT DEVICE AND JET ENGINES TO PROVIDE A PROOF-OF-THE-CONCEPT FOR PROVIDING THE TAKEOFF AND LANDING PERFORMANCE REQUIRED FOR FAN-JET STOL TRANSPORT AIRCRAFT, AND TO MAKE AVAILABLE AN AIRCRAFT FOR CARRYING OUT LIMITED LONG-TERM FLIGHT RESEARCH ON THE JET STOL TYPE OF AIRCRAFT. THE MODIFIED AIRCRAFT IS EXPECTED TO HAVE THE CAPABILITY OF LANDING AND TAKEOFF AT SPEEDS OF 60 TO 65 KNOTS REQUIRED FOR A STOL BALANCED FIELD LENGTH OF 1500 FEET. THE AIRCRAFT WILL HAVE THE PERFORMANCE AND CONTROL CHARACTERISTICS REQUIRED TO ALLOW FLIGHT INVESTIGATIONS OF TAKEOFF AND LANDING APPROACH PROFILES AND PROCEDURES FOR MINIMIZING NOISE OR APPROACH TIME. IT WILL ALSO BE USED TO FURTHER DEVELOP CRITERIA FOR HANDLING QUALITIES, PERFORMANCE REQUIREMENTS, RESOLVE OPERATING PROBLEMS, AND AIR TRAFFIC OPERATION. THE PROGRAM IS A COOPERATIVE EFFORT BY NASA AND THE CANADIAN GOVERNMENT THAT HAS BEEN UNDERWAY SINCE 1965. THE PROGRAM ENCOMPASSES ANALYTICAL STUDIES, WIND-TUNNEL INVESTIGATIONS GROUND-BASED SIMULATION STUDIES, DESIGN FEASIBILITIES STUDIES, DETAIL DESIGN AND MODIFICATION OF AIRCRAFT, AND FLIGHT INVESTIGATIONS. THE PROGRAM WILL PROVIDE MUCH NEEDED INFORMATION FOR THE DESIGNERS OF FAN-JET STOL AIRCRAFT WHICH THE NASA SHORT-HAUL V/STOL TRANSPORT STUDIES SHOWED TO BE ONE OF TWO V/STOL CONCEPTS THAT HAD THE LOWEST DIRECT OPERATING COSTS FOR 500-MILE RANGE COMMERCIAL TRANSPORTS.

RTOP NO. 761-74-01 TITLE: YF-12 INTERDISCIPLINARY RESEARCH
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: LOFTIN, L. R. JR. TEL. 703-827-3285
TECHNICAL SUMMARY

THIS PROGRAM IS PART OF THAT OF THE INTERCENTER RESEARCH PLANNING TEAM WHICH PLANS TO UTILIZE THE YF-12 AIRCRAFT IN A FLIGHT AND LABORATORY TEST PROGRAM THAT WILL ADVANCE THE STATE OF THE ART IN PREDICTING THE DYNAMIC BEHAVIOR AND PERFORMANCE IN THE MACH NUMBER 3.0 REGIME OF LARGE FLEXIBLE AIRCRAFT AND THEIR INTEGRATING PROPULSION SYSTEMS. IN SUPPORT OF THIS INTERCENTER PROGRAM, THE MAJOR EFFORTS AT THE LANGLEY RESEARCH CENTER WILL BE CONCERNED WITH BOUNDARY LAYERS AT SUPERSONIC SPEEDS. THE PRELIMINARY OBJECTIVE OF THE BOUNDARY-LAYER RESEARCH EFFORT WILL BE TO PROVIDE PRECISE LABORATORY MEASUREMENT OF THE VARIETY OF GOVERNING PARAMETERS IN BOUNDARY-LAYER DEVELOPMENT, AND TO ANALYZE AND CORRELATE THESE DATA WITH THOSE OF FLIGHT TESTS OF THE IDENTICAL TEST COMPONENT WITH A VIEW TO PROVIDING A BETTER ANALYTICAL REPRESENTATION OF THE PHYSICS OF THE SUPERSONIC BOUNDARY-LAYER PROCESS.

RTOP NO. 761-74-01 TITLE: YF-12 RESEARCH PROGRAM - INTERDISCIPLINARY RESEARCH
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WATTS, J. D. TEL. 805-258-3311
TECHNICAL SUMMARY

AERODYNAMIC LOADS TWO MAJOR PROBLEMS ARE BEING ATTACKED: THE MEASUREMENT OF AERODYNAMIC LOADS ON A HOT-STRUCTURE FLEXIBLE SUPERSONIC AIRPLANE AND A THOROUGH EVALUATION OF THE BEST AVAILABLE LOADS PREDICTION METHODS. THE PERSON FLIGHT INSTRUMENTATION AND GROUND CALIBRATION FACILITIES WILL BE USED IN THE MEASUREMENTS. CORRELATIONS WILL BE MADE WITH WIND TUNNEL PRESSURE MODEL DATA AND ANALYTICAL METHODS WITH CORRECTIONS FOR HEATING AND AEROELASTICITY EFFECTS. STRUCTURES A 6000-8000 ELEMENT NASTRAN COMPUTER MODEL OF THE YF-12 STRUCTURE WILL PROVIDE CALCULATED DEFLECTIONS, STRESSES, AND THERMAL EFFECTS FOR DIRECT CORRELATION WITH FLIGHT-MEASURED DEFLECTIONS AND STATIC TEST DATA. THIS EFFORT WILL PROVIDE A THOROUGH EVALUATION OF FINITE ELEMENT STRUCTURAL ANALYSIS AS APPLIED TO FULL-SCALE FLEXIBLE HOT-STRUCTURE AIRCRAFT. A SYSTEM FOR ACCURATELY MEASURING STRUCTURAL DEFLECTIONS IN FLIGHT WILL BE TESTED ON THE YF-12. PROPULSION PREDICTABILITY OF STEADY-STATE SUPERSONIC INLET PERFORMANCE, INLET FLOW DYNAMICS, AND INTERACTIONS OF ENGINE, INLET, AND AIRCRAFT CONTROL SYSTEMS IS THE MAJOR PROBLEM TO BE EVALUATED ON THE YF-12 AIRPLANE. THE EFFORT INVOLVES SIMULATIONS, WIND TUNNEL TESTS OF A 1/12 SCALE AIRPLANE MODEL, A 1/3 SCALE INLET MODEL, AND A FULL-SCALE INLET, AND FLIGHT TESTS WITH THE YF-12 PROPULSION SYSTEM. OTHER RESEARCH INCLUDES BOUNDARY-LAYER EXPERIMENTS, INFRARED TV REMOTE TEMPERATURE MEASURING SYSTEM TESTS, ADVANCED AUTOPILOT DEVELOPMENT AND TESTING, AND MODAL SUPPRESSION.

RTOP NO. 761-74-01 TITLE: YF-12 RESEARCH PROGRAM - DISCIPLINARY RESEARCH
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY
THE UNIQUE PERFORMANCE CAPABILITIES OF THE YF-12 AIRPLANE PROVIDES AN OPPORTUNITY TO OBTAIN HERETOFORE UNAVAILABLE FLIGHT DATA. THESE DATA ARE INVALUABLE FOR THE ASSESSMENT OF THE THEORETICAL AND EMPIRICAL PREDICTION METHODS, AND AN EVALUATION OF WIND TUNNEL TESTS OF THAT AIRPLANE OR ITS COMPONENTS. COMPREHENSIVE WIND TUNNEL TESTS WILL BE MADE IN THE AREAS OF (1) THE ENGINE-AIR INLET AND INTERNAL FLOW SYSTEM, (2) THE EFFECTS ON THE AIRCRAFT AERODYNAMICS PRODUCED BY THE VARIOUS MODES OF OPERATION OF THE PROPULSION SYSTEM, AND (3) AEROELASTIC EFFECTS ON THE AIRCRAFT STABILITY CHARACTERISTICS. FLIGHT TESTS WILL BE CONDUCTED BY THE NASA FLIGHT RESEARCH CENTER FOR CORRELATION WITH PREDICTIONS BASED PURELY ON AERODYNAMIC THEORY.
NOTE: AS A RESULT OF YF-12 INTERCENTER MEETING, AUGUST 3-4, 1971, IT WAS AGREED THAT THE YF-12 FLIGHT TEST PROGRAM AND FUNDING SHOULD BE REVIEWED ABOUT FEBRUARY, 1972 TO DETERMINE WHETHER 1/12-SCALE PRESSURE MODEL TESTS, 1/3-SCALE INLET MODEL TESTS, AND EXTENSIVE FLEXSTAB CALCULATIONS SHOULD BE FUNDED IN FY 72 OR POSTPONED TO FY 73. THUS, CURRENT FUNDING TO SUPPORT YF-12 PROGRAM HAS BEEN REDUCED FROM 963K TO 502K.

RTOP NO. 761-74-01 TITLE: YF-12 DISCIPLINARY RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: DUSTIN, M. O. TEL. 216-433-4000
TECHNICAL SUMMARY
THE OBJECTIVES ARE: (1) TO EVALUATE THE CAPABILITY OF CURRENTLY AVAILABLE COMPUTER SIMULATION TECHNIQUES TO DETERMINE DYNAMIC CHARACTERISTICS OF A HIGH MACH NUMBER AIRCRAFT, (2) TO INVESTIGATE ADVANCED CONCEPTS FOR IMPROVING INLET STABILITY MARGINS, AND (3) TO STUDY THE EXISTING AIRCRAFT CONTROL SYSTEMS AND INVESTIGATE ALTERNATE CONTROL METHODS WHICH CAN BOTH IMPROVE THE PROPULSION SYSTEM PERFORMANCE AND MINIMIZE PROPULSION SYSTEM-AIRFRAME INTERACTION.
NOTE: APPROVAL OR CANCELLATION OF YF-12 SHOCK STABILITY PROGRAM WILL BE DEFERRED UNTIL A DECISION IS REACHED AS TO WHETHER A FLIGHT TEST PROGRAM WILL BE CONDUCTED. THE COST ESTIMATE OF A FLIGHT TEST PROGRAM IS REQUIRED BEFORE A DECISION CAN BE MADE. THUS, THE CURRENT FY 72 FUNDING HAS BEEN REDUCED FROM 470K TO 70K.

RTOP NO. 761-74-02 TITLE: YF-12 RESEARCH PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: MATRANGA, G. J. TEL. 805-258-3311
TECHNICAL SUMMARY
THE YF-12 TYPE AIRPLANES ARE THE ONLY AIRPLANES IN THE FREE WORLD WHICH ARE CAPABLE OF SUSTAINED MACH 3 FLIGHT. MAJOR AREAS OF RESEARCH INCLUDE THE EXAMINATION OF THE HOT, FLEXIBLE STRUCTURE; DYNAMIC INLET BEHAVIOR; AIRFRAME/PROPULSION INTERACTION; AND GENERAL PROBLEMS RELATED TO HIGH SPEED AND HIGH ALTITUDE FLIGHT. IN THE

STRUCTURES AREA, THERMOCOUPLES AND STRAIN GAGES HAVE BEEN INSTALLED IN AIRPLANE 935. GROUND CALIBRATIONS WILL ALLOW FOR THE MEASUREMENT OF HOT LOADS IN FLIGHT. FLIGHT RESULTS WILL BE COMPARED WITH NASTRAN PREDICTED INFORMATION. DYNAMIC INLET INFORMATION OBTAINED IN FLIGHT WILL BE COMPARED WITH RESULTS FROM A 1/3 SCALE INLET MODEL AND A FULL SCALE INLET OPERATED IN THE WIND TUNNEL. AIRFRAME/PROPULSION INTERACTION FLIGHT INFORMATION WILL BE RELATED TO DATA PREDICTED USING A 1/12 SCALE AIRPLANE MODEL.

RTOP NO. 761-74-03 TITLE: F-111 FLIGHT RESEARCH PROGRAM - OPERATIONAL SUPPORT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: GROEN, J. M. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS PROGRAM COVERS THE OPERATIONAL SUPPORT OF F-111A AIRPLANE NO. 12 (SN 639777) WHICH IS ON LOAN TO THE FLIGHT RESEARCH CENTER AND IS BEING USED FOR BASIC RESEARCH ON ENGINE-AIRFRAME INTEGRATION PROBLEMS. THIS RTOP COVERS MAINTENANCE AND REPAIR AND THE OPERATIONAL EFFORT OF THE AIRPLANE AND INSTRUMENT SYSTEMS AND ALSO MINOR MODIFICATIONS AND CHANGES IN THE ENGINE, AIRFRAME, AND INSTRUMENTATION.

RTOP NO. 761-74-04 TITLE: 1/3 SCALE F-15 REMOTE PILOTED VEHICLE PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: REED, R. D. TEL. 805-258-3311
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES THE DESIGN AND CONSTRUCTION OF TWO OR MORE 1/3 SCALE REMOTE PILOTED F-15 FIGHTER AIRCRAFT CONFIGURATIONS TO BE AIRLAUNCHED, FLOWN THROUGH HIGH ANGLE-OF-ATTACK MANEUVERS AND RECOVERED BY HORIZONTAL LANDING ON EDWARDS DRY LAKE OR BY PARACHUTE RECOVERY. THESE VEHICLES ARE TO BE FLOWN TO GATHER NEEDED FLIGHT DATA AT ANGLE-OF-ATTACK VALUES AT, NEAR, AND BEYOND THE AIRCRAFT STALL OR DEPARTURE. THIS PROGRAM IS DESIGNED TO FILL A CURRENT BASIC TECHNOLOGY GAP IN THE COMPLETE DETERMINATION OF THE PILOT/CONTROL-SYSTEM/AIRCRAFT CHARACTERISTIC AND PRODUCE EARLY INFORMATION LEADING TO POSSIBLE MODIFICATIONS, ADJUSTMENTS, OR PROCEDURES WITHOUT RISK TO EXPENSIVE AIRCRAFT AND PILOT LIVES.

RTOP NO. 137-09-01 TITLE: ENVIRONMENTAL EFFECTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE TO ASSESS THE CHANGES CAUSED BY ENVIRONMENTAL FACTORS COMMON TO AERONAUTICS, E.G., NOISE, FLIGHT

STRESS, FATIGUE, PSYCHOPATHOLOGY ON PILOT WELL-BEING, PERFORMANCE AND DECISION MAKING AND TO DEVISE MEANS OF PREDICTING AND CORRECTING SUCH CHANGES. THE DISTURBING EFFECTS OF AIRCRAFT NOISE ON THE GENERAL POPULATION WILL ALSO BE INVESTIGATED.

RTOP NO. 127-09-02 TITLE: HUMAN RESPONSE TO NOISE AND VIBRATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B., JR. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO FURTHER THE UNDERSTANDING OF PSYCHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF NOISE AND VIBRATION, TO ESTABLISH TECHNIQUES FOR MEASURING SUBJECTIVE RESPONSES, AND TO APPLY THE RESPONSE INFORMATION IN ESTABLISHING PASSENGER ACCEPTANCE CRITERIA AND IN MINIMIZING POTENTIAL ANNOYANCE OF MAN BY MODIFICATIONS OF NOISE AND VIBRATION CHARACTERISTICS. STUDIES WILL INCLUDE SUBJECTIVE NOISE COMPARISON TESTS, ABSOLUTE JUDGEMENT TESTS, SLEEP INTERFERENCE TESTS, AUDITORY AND NON-AUDITORY ACOUSTIC TESTS, STARTLE TESTS, TASK PERFORMANCE TESTS, AND VIBRATION TESTS. THE TESTS WILL BE ACCOMPLISHED IN LABORATORIES AND UNDER REAL LIFE CONDITIONS OF EXPOSURE TO AIRCRAFT AND OTHER VEHICLE NOISE AND VIBRATIONS. SPECIAL ATTENTION WILL BE DIRECTED TO BRIDGING THE GAP BETWEEN THE REAL LIFE EXPOSURE SITUATION AND LABORATORY TESTS. THE TESTS WILL BE COMPLEMENTED BY SURVEY STUDIES (INVOLVING SOCIAL, ECONOMIC, AND ATTITUDINAL FACTORS) AND BY SPECIAL ANALYTICAL PROGRAMS. THE DATA OBTAINED WILL BE USED TO DEVELOP AN INFORMATION BASE HAVING APPLICATION TO ESTABLISHING INTERNATIONAL NOISE STANDARDS, TO PREDICTION OF PUBLIC REACTIONS TO FUTURE AIRCRAFT/AIRPORT OPERATIONS, TO THE EVALUATION OF AIRCRAFT NOISE REDUCTION APPROACHES, TO QUANTITY DEFINITION OF HUMAN ACCEPTANCE THRESHOLDS FOR TRANSPORTATION SYSTEM RIDE QUALITY, AND TO DEVELOP IMPROVED VIBRATION SUPPRESSION SYSTEMS PRIMARILY FOR NEW FLIGHT VEHICLES WITH ADDITIONAL APPLICATION FOR SURFACE VEHICLES.

RTOP NO. 137-09-03 TITLE: AIRCREW STRESS AND PERFORMANCE MEASUREMENT
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: WINTER, W. R. TEL. 805-258-3311
TECHNICAL SUMMARY

"ADEQUATE PERFORMANCE" UNDER THE STRESSES OF RESEARCH FLIGHT HAS NEVER BEEN QUANTITATIVELY DEFINED. THIS STUDY IS BEING MADE IN AN ATTEMPT TO DETERMINE THOSE CHARACTERISTICS OF PERFORMANCE AND PHYSIOLOGICAL RESPONSE WHICH MAY BE CORRELATED. THIS DETERMINATION SHOULD ENABLE GUIDELINES TO BE DRAWN FOR FURTHER PERFORMANCE STUDIES TO PERMIT DEFINITION OF TASK LOADING AND POSSIBLE PREDICTION OF PERFORMANCE DEGRADATION. THIS WILL BE ACCOMPLISHED THROUGH PARALLEL EFFORTS OF MONITORING THE CREW OF HIGH PERFORMANCE AIRCRAFT AND THE STUDY OF PHYSIOLOGICAL BASELINE RESPONSES IN NONSTRESS CONDITIONS.

RTOP NO. 137-51-01 TITLE: ADVANCED DISPLAYS AND CONTROLS FOR AIRCRAFT FLIGHT MANAGEMENT
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, R. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THIS PROGRAM WILL CONSIDER FLIGHT MANAGEMENT REQUIREMENTS AND CREW-SYSTEM INTERFACING FOR ADVANCED AIRCRAFT CONFIGURATIONS. THE ULTIMATE GOAL OF THE PROGRAM IS TO DEFINE A SUITABLE, INTEGRATED AIRBORNE SYSTEM ENCOMPASSING ALL FORMS OF FLIGHT MANAGEMENT. (1) TO DETERMINE THE DISPLAY REQUIREMENTS FOR AIRCRAFT FLIGHT MANAGEMENT IN THE 1980S, DEFINING THE CONTENT, FORMAT, FUNCTION AND PILOT PROCEDURES OF THE FOLLOWING DISPLAY DEVICES: (A) VERTICAL SITUATION DISPLAY (VSD), (B) HORIZONTAL SITUATION DISPLAY (HSD), (C) ALPHANUMERIC COMMUNICATIONS DISPLAY (ACD), AND (D) COLLISION AVOIDANCE DISPLAY (CAD). (2) TO DEFINE THE PILOT/SYSTEM INPUT CONSOLE FOR ENTERING ALPHANUMERIC INFORMATION AND PILOT COMMANDS INTO THE SYSTEM. A FULL-FLIGHT SIMULATION WILL BE DEVELOPED IN THE AMES GPS RESEARCH FACILITY THAT INCLUDES (A) AIRCRAFT DYNAMICS, (B) COMPUTER DRIVEN CRT FLIGHT MANAGEMENT DISPLAY, (C) PILOT ENTRY CONSOLE, (D) ATC COMMUNICATIONS SIMULATION, (E) COLLISION AVOIDANCE SIMULATION, AND (F) AIRCRAFT/ATC MALFUNCTION SIMULATION. AT EACH STAGE OF SIMULATION DEVELOPMENT, PILOT-SUBJECTS WILL FLY FULL MISSION PROFILES FROM TAKE-OFF TO LANDING. THE SIMULATION DEVELOPMENT WILL BE AN IN-HOUSE EFFORT WITH SOME STUDY CONTRACTS TO PROVIDE NECESSARY PROGRAMMING. IN ADDITION, LABORATORY STUDIES IN THE BIOTECHNOLOGY DIVISION FACILITY WILL EVALUATE (1) DISPLAY COMPONENTS FOR LANDING, (2) FLIGHT DIRECTOR DISPLAY COMPONENTS, (3) SCALE, ORIENTATION, PREDICTOR COMPONENTS, AND SYMBOLOGY FOR HORIZONTAL DISPLAYS, (4) KEYBOARDS AND DISPLAY-INTERACTIVE UNITS FOR PILOT ENTRY CONSOLES, (5) TECHNIQUES FOR ASSESSING AND MEASURING PILOT "TAKE-OVER" DECISIONS, (6)----

RTOP NO. 137-51-02 TITLE: ENVIRONMENTAL SYSTEMS TECHNOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, R. P. TEL. 415-961-2735
TECHNICAL SUMMARY

AMES RESEARCH CENTER WILL CONDUCT A PROGRAM TO PERFORM RESEARCH AND DEVELOPMENT IN AIRCRAFT SAFETY ENGINEERING. THE PROGRAM AREAS THAT WILL BE INVESTIGATED ARE: (A) AIRCREW OXYGEN SYSTEM DEVELOPMENT. (B) CHEMICAL OXYGEN GENERATION FOR PASSENGER EMERGENCY SYSTEMS. (C) DEVELOPMENT OF IMPROVED SEAT/RESTRAINT SYSTEMS FOR CIVIL AIR TRANSPORT. (D) LIQUID COOLED COLLAR FOR AIRCREW THERMAL PROTECTION.

RTOP NO. 137-51-02 TITLE: PILOT MODELING AND CREW PERFORMANCE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE PURPOSE OF THIS RESEARCH IS TO DEVELOP MATHEMATICAL MODELS OF THE PILOT THAT CAN BE USED IN A WIDE RANGE OF AIRCRAFT DESIGN AND

OPERATIONAL STUDIES. EXISTING MODELS OF THE CONTROL CHARACTERISTICS OF THE PILOT APPLICABLE TO FIXED SITUATIONS WILL BE EXTENDED TO INCLUDE REPRESENTATION OF THE ADAPTIVE CHARACTERISTICS OF THE HUMAN PILOT. IN ADDITION, THIS PROGRAM WILL EXTEND EXISTING PILOT MODELING RESEARCH TO INCLUDE MULTIPLE AXIS CONTROL TASKS AND STUDIES OF PILOT PERFORMANCE WHEN MONITORING COMPLEX DISPLAYS ON AIRCRAFT WITH AUTOMATIC FLIGHT CONTROL SYSTEMS. ANOTHER EFFORT WILL INVOLVE THE DEVELOPMENT AND EVALUATION OF A FILM-DERIVED CONTACT ANALOG DISPLAY FOR PROVIDING VISUAL CUES TO THE PILOT IN FLIGHT DURING AUTOMATIC LANDINGS UNDER LOW VISIBILITY CONDITIONS.

RTOP NO. 137-67-02 TITLE: ADVANCED SIMULATION TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO INVESTIGATE THE FACTORS REQUIRED TO PRODUCE A REALISTIC SIMULATION OF A PILOT'S TASK IN CONTROLLING A VEHICLE IN VARIOUS SITUATIONS WHILE MINIMIZING THE COMPLEXITY OF THE SIMULATION EQUIPMENT. PRIMARY FACTORS TO BE INVESTIGATED INCLUDE THE AMOUNT OF MOTION REQUIRED, THE DYNAMIC RESPONSE OF THE MOTION BASE, THE DETAIL, RESOLUTION, AND FIELD OF VIEW OF THE VISUAL DISPLAY, AND THE INFLUENCE OF OTHER ENVIRONMENTAL FACTORS SUCH AS NOISE. SIMULATORS WILL BE USED TO EVALUATE MOTION REQUIREMENTS FOR A RANGE OF FLIGHT TASKS RANGING FROM LARGE-AMPLITUDE SUSTAINED MANEUVERS TO PRECISE CONTROL ABOUT A DEFINED FLIGHT PATH. THE REAL-TIME DYNAMIC SIMULATOR (RDS) IS BEING MODIFIED TO ENABLE INVESTIGATIONS INVOLVING LARGE-AMPLITUDE, LOW-FREQUENCY MOTIONS. A NEW FACILITY, THE VISUAL-MOTION SIMULATOR, INCORPORATING A VISUAL DISPLAY MOUNTED IN A COCKPIT CAPABLE OF RAPID MOTIONS ABOUT ALL AXES, WILL BE USED TO INVESTIGATE MANEUVERS INVOLVING HIGHER FREQUENCY MOTIONS. STUDIES WILL BEMADE UTILIZING A COMPUTER-GENERATED DISPLAY TO EVALUATE VISUAL DISPLAY REQUIREMENTS. THE RESULTS OF THESE RESEARCH STUDIES WILL BE USED TO DEFINE MINIMUM SIMULATION REQUIREMENTS FOR VARIOUS TASKS. THESE REQUIREMENTS WILL BE COMPARED WITH THE CAPABILITIES OF EXISTING AIRLINE TRAINING SIMULATORS. PILOT EYE MOTION EQUIPMENT WILL BE DEVELOPED AND USED IN COMBINED VISUAL-MOTION STUDIES TO AID IN EVALUATING THE REALISM OF THE SIMULATION SYSTEMS.

RTOP NO. 138-60-02 TITLE: AIRCRAFT ELECTRICAL POWER SYSTEM TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

THE OBJECTIVE OF THE RESEARCH DESCRIBED HEREIN IS TO REDUCE COST THROUGH IMPROVEMENTS IN THE STATE-OF-THE-ART OF AIRCRAFT ELECTRICAL SYSTEMS TECHNOLOGY. THE IMPROVED TECHNOLOGY WILL PROVIDE A

SUBSTANTIAL INCREASE IN RELIABILITY. INCREASED RELIABILITY WILL REDUCE COSTS THROUGH REDUCED MAINTENANCE REQUIREMENTS AND REDUCED REQUIREMENTS FOR GROUND SUPPORT EQUIPMENT. THE IMPROVED TECHNOLOGY WILL INCREASE THE KW/KG RATIO OF THE AIRBORNE ELECTRICAL SYSTEM. THE WEIGHT SAVED THEREBY PERMITS INCREASED AIRCRAFT PAYLOAD, REDUCING THE COST PER KG OF PAYLOAD. THE TECHNOLOGY DEVELOPED WILL BE APPLICABLE TO ALL COMMERCIAL, MILITARY AND PRIVATE AIRCRAFT. THE APPROACH IS TO GENERATE AN AIRCRAFT ELECTRIC SYSTEM TECHNOLOGY BY THE SIMULTANEOUS OPTIMIZATION OF ELECTRICAL SYSTEM SUBSYSTEMS AND COMPONENTS TO MEET THE PROGRAM OBJECTIVES OF GREATER RELIABILITY AND INCREASED POWER TO MASS RATIO. THE PROGRAM WILL PROCEED IN THE FOLLOWING STEPS: 1. STUDY EXISTING AIRCRAFT ELECTRICAL SYSTEMS TO DEFINE THOSE AREAS WHERE TECHNOLOGICAL ADVANCES WILL BE OF SUBSTANTIAL BENEFIT. 2. CONDUCT RESEARCH TO OBTAIN THE REQUIRED TECHNOLOGY TO REALIZE THE BENEFITS OF 1. ABOVE.

RTOP NO. 138-60-08 TITLE: AIRCRAFT SECONDARY POWER SYSTEMS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MACOSKO, R. P. TEL. 216-433-4000
TECHNICAL SUMMARY

THE SECONDARY-POWER-SYSTEM PROGRAM IS DIRECTED AT PROVIDING THE TECHNOLOGY TO IMPROVE FUTURE COMMERCIAL AIRCRAFT, PRIMARILY FROM LOWER OVERALL AIRCRAFT COST OF OWNERSHIP. IMPROVEMENTS IN THE AREAS OF RELIABILITY, SAFETY, AND NOISE WILL ALSO BE CONSIDERED. THE PROGRAM INCLUDES (A) SECONDARY-POWER-SYSTEM STUDY, (B) COMPONENT DESIGN AND FABRICATION, (C) TESTING OF SUBSYSTEMS AND COMPONENTS AT LEWIS, AND (D) _THE ASSEMBLY AND TEST OF A COMPLETE SECONDARY-POWER SYSTEM, IF REQUIRED. INITIALLY, SECONDARY-POWER REQUIREMENTS FOR THE WIDE-BODY CLASS OF AIRCRAFT (747, DC-10, L-1011) WILL BE USED IN A SYSTEM STUDY TO IDENTIFY KEY SYSTEM AREAS FOR IMPROVEMENT AND THE RELATIVE GAINS TO BE MADE OVER EXISTING COMMERCIAL AIRCRAFT SYSTEMS. THIS STUDY WILL BE _PERFORMED AS PART OF EXISTING CONTRACT NAS3-14367; UNTIL NOW, THIS STUDY HAS BEEN DIRECTED PRIMARILY AT IMPROVEMENTS IN AIRCRAFT ELECTRICAL SYSTEMS. THE FINAL RESULT WILL BE TECHNOLOGY FOR IMPROVED SECONDARY-POWER SYSTEMS. TWO NEEDED AREAS OF COMPONENT IMPROVEMENT HAVE BEEN IDENTIFIED TO DATE: INVESTIGATION OF AN INTEGRATED ENGINE GENERATOR IS BEING PLANNED FOR FY '72, AND IMPROVEMENT OF THE AUXILIARY POWER UNIT IS PLANNED FOR FY '73. BOTH OF THESE PROGRAMS WILL RELAY ON THE ABOVE SYSTEMS STUDY TO DEFINE REQUIREMENTS AND GOALS.

RTOP NO. 112-02-20 TITLE: QUANTUM ELECTRONICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. M. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO PERFORM EXPERIMENTAL AND THEORETICAL STUDIES FOR INCREASING THE POWER AND EFFICIENCY OF SELECTED LASER TYPES, WHICH SHOW PROMISE FOR A JOINT LONG-RANGE PROGRAM BETWEEN LARC, THE UNIV. OF FLORIDA, AND NASA HEADQUARTERS, CONCERNED WITH LASER EXCITATION BY NUCLEAR REACTION PRODUCTS; PROVIDE IMPORTANT ADVANCES TO EXISTING LASER TECHNOLOGY; AND HAVE IMMEDIATE SPIN-OFFS TO NASA. THE ULTIMATE HOPE FOR LASERS WITH NUCLEAR EXCITATION LIES IN THE GASEOUS-CORE FISSION LASER BASED ON THE GASEOUS CORE REACTOR WHICH IS STILL UNDER DEVELOPMENT. IN ORDER TO CHECK THIS ADVANCED CONCEPT AND TO INVESTIGATE THE POSSIBILITY OF LASER EXCITATION WITH NUCLEAR-REACTION PRODUCTS, IT IS OF INTEREST TO STUDY LASERS WHICH SIMULATE CERTAIN PROPERTIES OF THE FISSION MEDIUM. THESE INCLUDE HIGH-PRESSURE CO2 TYPE, AND METAL-VAPOR LASERS AND LIQUID LASERS. CHEMICAL LASERS WILL ALSO BE STUDIED WITH THE HOPE OF PRODUCING NOVEL CHEMICAL REACTIONS THROUGH IRRADIATION WITH NUCLEAR REACTION PRODUCTS. HIGH FLOW RATES OF VARIOUS GAS AND LIQUID MIXTURES WILL BE USED TO PROVIDE CONVECTIVE COOLING OF THE LASING MEDIUM TO PREVENT OVER-POPULATION OF THE LOWER LASER LEVEL AND NONUNIFORM OPTICAL PROPERTIES OF THE LASING MEDIUM. THE LASERS WILL BE BUILT AND TESTED AT LARC AND SUBJECTED TO NUCLEAR IRRADIATION IN THE NUCLEAR REACTOR AT THE UNIV. OF FLORIDA. CONTINUOUS AND PULSED ELECTRIC DISCHARGE EXCITATION SYSTEMS AT LARC WILL BE USED FOR VARYING THE PULSE DURATION FROM NANOSECS. TO MILLISECS (QUASI-CONTINUOUS). FOR OPERATION WITH VERY HIGH PULSE AND REPETITION RATES A UNIQUE LARGE POWER SUPPLY AT THE UNIV. OF FLA. WILL BE USED.

RTOP NO. 112-02-20 TITLE: QUANTUM ELECTRONICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO CONDUCT EXPERIMENTS AND ANALYSES OF SPECIFIC TOPICS IN THE PHYSICS OF QUANTUM ELECTRONICS WITH THE VIEW OF DETERMINING THOSE ASPECTS OF COHERENT EM RADIATION PARTICULARLY APPLICABLE TO SPACE SCIENCE AND/OR TECHNOLOGY. SPECIFICALLY, THE WORK WILL BE CONCERNED WITH QUANTITATIVE EVALUATIONS OF THE PHYSICAL PROCESSES THAT TAKE PLACE DURING THE GENERATION OF THE EM RADIATION WITHIN LASERS AND MASERS, DURING THE TRANSMISSION OF THIS RADIATION THROUGH THE MEDIA OF NATURAL ENVIRONMENTS OR THROUGH MAN-MADE DEVICES, AND IN THE DETECTION OF THIS RADIATION. THE PURPOSE OF THE PROGRAM IS TO PROVIDE THE FUNDAMENTAL KNOWLEDGE NECESSARY FOR THE DEVELOPMENT OF AN OPTICAL TECHNOLOGY WHICH CAN UTILIZE COHERENT RADIATION IN COMMUNICATIONS, POWER TRANSMISSION, DISPLAY DEVICES, AND GENERAL MEASUREMENT INSTRUMENTATION TO BE APPLIED IN PLANETARY EXPLORATION, SPACE PHYSICS, AND AVIONICS.

RTOP NO. 112-02-20 TITLE: QUANTUM ELECTRONICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE LONG-RANGE OBJECTIVE OF THIS PROGRAM IS TO INVESTIGATE EXPERIMENTAL PHENOMENA ASSOCIATED WITH POPULATION INVERSION IN NUCLEAR ZEEMAN LEVELS AND TO STUDY THE FEASIBILITY OF USING THIS PHENOMENA FOR A RADIO FREQUENCY TYPE OF LASER. WE WILL HENCEFORTH REFER TO THIS DEVICE AS A RASER (RADIO FREQUENCY AMPLIFICATION BY STIMULATED EMISSION OF RADIATION). A DEVICE SUCH AS A RASER WOULD HAVE MANY APPLICATIONS SUCH AS A VERY STABLE RADIO FREQUENCY SOURCE AND AS A LOW NOISE RADIO FREQUENCY PREAMPLIFIER FOR SPACE COMMUNICATIONS. THE OPTICAL OSCILLATOR THAT IS A LASER OR RASER REQUIRES A WORKING MEDIUM WITH A NEGATIVE ABSORPTION COEFFICIENT FOR THE DESIRED OUTPUT OF INCIDENT RADIATION. THIS IS USUALLY PROVIDED BY PRODUCING SIGNIFICANT POPULATION INVERSIONS IN AN ELECTRONIC ENERGY LEVEL SYSTEM OF SOME MATERIAL. FOR SUCCESSFUL LASER OR RASER ACTION MERE POPULATION INVERSION IS NOT A SUFFICIENT CONDITION FOR THE OPERATION OF THE DEVICE, BUT THE POPULATION INVERSION MUST BE OF A DEGREE THAT ANY LOSSES IN THE SYSTEM ARE OVERCOME. THE NUCLEAR ZEEMAN LEVELS PROVIDE AN ACTIVE MEDIUM BY WHICH POPULATION INVERSIONS MAY BE SUSTAINED SO AS TO PROVIDE A MEANS OF PRODUCING A QUANTUM RADIO FREQUENCY AMPLIFIER-OSCILLATOR. COUPLING THE INVERTED POPULATION SYSTEM TO THE EXTERNAL ENVIRONMENT CAN BE DONE QUITE EASILY WITH STANDARD TUNED RADIO FREQUENCY CIRCUITS. THE MAIN TECHNICAL PROBLEM AND THE ONE WHICH WE PROPOSE TO INVESTIGATE IS THE METHOD OF PRODUCING A SUFFICIENT POPULATION INVERSION SO AS TO SUSTAIN OSCILLATIONS IN THE SYSTEM.

RTOP NO. 112-02-21 TITLE: ELECTRON WAVE INTERACTION AND ELECTROMAGNETIC RESEARCH
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LAURENCE, J. C. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THE LEWIS PROGRAM IS TO ACHIEVE INTENSE, MAGNETIC FIELDS IN LARGE VOLUME WITH A MINIMUM MASS AND POWER REQUIREMENT. PROGRESS TOWARD THIS OBJECTIVE REQUIRES BOTH BASIC AND APPLIED RESEARCH ON WAYS TO IMPROVE THE CURRENT DENSITY, OPERATING TEMPERATURE, AND STRENGTH OF SUPERCONDUCTING MATERIALS SUITABLE FOR USE IN LARGE COILS. A SECOND OBJECTIVE IS TO ACHIEVE BETTER UNDERSTANDING OF THE PHYSICAL PROCESSES INVOLVED IN CONDUCTION OF ELECTRICITY BOTH IN THE NORMAL AND THE SUPERCONDUCTING STATE, WITH A VIEW TO IMPROVING THE PERFORMANCE OF ELECTRICAL COMPONENTS OF AEROSPACE POWER AND PROPULSION SYSTEMS. SUPERCONDUCTORS WILL BE STUDIED THEORETICALLY AND EXPERIMENTALLY ON BOTH PHYSICS AND ENGINEERING LEVELS. IN NORMAL METALS AND SEMICONDUCTORS THE GALVANOMAGNETIC EFFECTS (MAGNETORESISTANCE, HALL EFFECT, MAGNETOTHERMAL EFFECTS, ETC.) WILL BE STUDIED, ESPECIALLY IN HIGH FIELDS WHERE LANDAU QUANTIZATION IS IMPORTANT. THE PROCESSES OF EXCITATION AND DISSOCIATION OF GASES IN STRONG ELECTRIC AND MAGNETIC FIELDS WILL BE STUDIED. THE INTENT IN EACH AREA WILL BE TO UNDERSTAND AND TO DEVELOP MATERIALS AND PROCESSES WITH UNIQUE

CHARACTERISTICS FOR SPECIFIC APPLICATIONS. VARIOUS FORMS OF SUPERCONDUCTORS (WIRE, RIBBON, COMPOSITES, ETC.) WILL BE TESTED IN SHORT SAMPLES AND IN ACTUAL COILS TO ASCERTAIN RELATIVE MERITS OF DIFFERENT MATERIALS AND CONSTRUCTION TECHNIQUES. IMPROVED SUPERCONDUCTING COMPOSITES WILL BE SOUGHT BY ANALYTIC AND EXPERIMENTAL METHODS IN ORDER TO IMPROVE SUPERCONDUCTING MAGNETS. THE HIGH FIELD SUPERCONDUCTING AND CRYOGENIC MAGNETS, DEVELOPED IN THE LERC MAGNET.

RTOP NO. 112-02-22 TITLE: PLASMADYNAMICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE IS TO ADVANCE UNDERSTANDING OF THE BEHAVIOR OF IONIZED GASES. THE LONG-RANGE PURPOSE IS THE UTILIZATION OF NUCLEAR ENERGY IN SPACECRAFT APPLICATIONS. THE WORK WILL EMPHASIZE ADVANCEMENT OF KNOWLEDGE OF (A) ION MOLECULE INTERACTIONS, (B) ELECTRON IMPACT SPECTROSCOPY, (C) CHEMICAL KINETICS SUCH AS RATES OF DISSOCIATION, IONIZATION, AND RECOMBINATION, (D) THE MOTION OF PLASMAS IN ELECTROMAGNETIC FIELDS, AND (E) THE PHYSICS OF THERMIONIC CONVERTERS. SPECIFIC TOPICS IN FY'72 ARE: (1) ENERGY TRANSFER MECHANISMS IN WEAKLY IONIZED PLASMA, (2) CROSS-SECTIONS FOR ELECTRON-MOLECULE (ATOM) COLLISION PROCESSES, (3) RATE PROCESSES AND RADIATIVE TRANSPORT IN PARTIALLY IONIZED GASES FOR MAGNETOGASDYNAMIC LASERS, NUCLEAR LASERS, AND NONEQUILIBRIUM MHD GENERATORS, (4) PRODUCTION OF POPULATION INVERSIONS FOR HIGH POWER LASERS, (5) IMPROVEMENT OF ELECTRIC OUTPUT, EFFICIENCY AND RELIABILITY OF THERMIONIC CONVERTERS, AND (6) INVESTIGATION OF A THERMIONIC CESIUM DIODE SWITCH. APPLICATIONS ARE FOR MHD GENERATORS FOR NUCLEAR POWER CONVERSION, GAS CORE NUCLEAR REACTORS, NUCLEAR LASERS AND HIGH POWER LASERS, AND THERMIONIC POWER CONVERSION.

RTOP NO. 112-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE FORMATION OF A DENSE PLASMA FOCUS OBTAINED BY MEANS OF A COAXIAL PLASMA ACCELERATOR AND POTENTIAL APPLICATIONS OF THE PLASMA FOCUS WILL BE INVESTIGATED. IN PARTICULAR, THE APPLICATION OF THE PLASMA FOCUS FOR RESEARCH RELATING TO NUCLEAR SPACE PROPULSION WILL BE STUDIED. THE PLASMA PRODUCED IN THE FOCUS IS EXTREMELY HOT, ABOUT 80 MILLION DEGREES K, AND VERY DENSE, 10 TO THE 19TH POWER PARTICLES PER CUBIC CENTIMETER. WHEN DUTERIUM IS USED AS A FILLING GAS THE PLASMA FOCUS IS A COPIOUS SOURCE OF NEUTRONS AND HARD X-RAYS. ADDING TRITIUM WILL RESULT IN AT LEAST TWO ORDERS OF MAGNITUDE INCREASE IN THE NEUTRON PRODUCTION. PRESENTLY THE PLASMA FOCUS HAS THE BEST AVAILABLE FUSION PLASMA AND STUDIES OF THIS PHENOMENA WILL YIELD IMMEDIATELY USEFUL INFORMATION ABOUT THE HEATING MECHANISMS, EFFECTS OF RADIATION, PLASMA-WALL INTERACTIONS, RADIATION SHIELDING, AND MATERIALS TO BE USED FOR A FUSION REACTOR. SINCE THE PLASMA FOCUS

CAN BE PRODUCED WITH A CONSIDERABLE AMOUNT OF IMPURITIES, THE EFFECTS OF FISSION PRODUCTS ON A HOT PLASMA MAY BE STUDIED BY MIXING A URANIUM-RICH GAS WITH DEUTERIUM. SUCH A URANIUM-DETERIUM MIXTURE AS THE WORKING GAS MAY ALSO ALLOW AN EVALUATION OF THE FEASIBILITY OF A FUSION-FISSION HYBRID NUCLEAR REACTOR FOR USE IN A HYBRID NUCLEAR ROCKET. IN ADDITION, THE SPECTRAL EMISSION OF HIGHLY-IONIZED URANIUM WILL BE INVESTIGATED.

RTOP NO. 112-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: RAYLE, W. D. TEL. 216-433-6203
TECHNICAL SUMMARY

RESEARCH IS DIRECTED TOWARD GAINING UNDERSTANDING OF PLASMA BEHAVIOR IN USEFUL RANGES OF DENSITY, TEMPERATURE, AND MAGNETIC FIELD STRENGTHS. THE AIM IS TO GAIN THE ABILITY TO GENERATE, CONFINE, AND MANIPULATE PLASMAS OF DESIRABLE CHARACTERISTICS IN WAYS RELEVANT TO POTENTIAL APPLICATIONS OF IMPORTANCE TO NASA PROGRAMS. THEORETICAL AND EXPERIMENTAL TOOLS WILL BE INVESTIGATED AND DEVELOPED TO IMPROVE OUR UNDERSTANDING AND TO CHECK THAT UNDERSTANDING WITH SPECIFIC EXPERIMENTS. APPLICATIONS FOR THE KNOWLEDGE SOUGHT ARE WIDESPREAD, INCLUDING MHD POWER GENERATION, PLASMA THRUSTERS AND THERMONUCLEAR PLASMAS. EXPERIMENTALLY, THE APPROACH IS FIRST TO IDENTIFY SPECIFIC PLASMA PROCESSES RELEVANT TO SPECIFIC POTENTIAL APPLICATIONS, CONCERNING WHICH THE PRESENT STATE OF KNOWLEDGE IS INADEQUATE. THEN TO DEVISE MEANS BY WHICH A PLASMA DEMONSTRATING SUCH A PROCESS MAY BE GENERATED AND DIAGNOSED. AMONG THE PLASMA PROCESSES BEING STUDIED EXPERIMENTALLY AND/OR THEORETICALLY ARE LOSS-CONE INSTABILITIES, NON-EQUILIBRIUM IONIZATION, INTERACTION OF FLOWING PLASMAS WITH MAGNETIC FIELDS, TURBULENCE AND DIFFUSION, PLASMA WAVE INTERACTIONS FOR PLASMA HEATING AND AS DIAGNOSTIC TOOLS, AND PLASMA ION HEATING PROCESSES.

RTOP NO. 112-02-22 TITLE: PLASMA DYNAMICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ADVANCE THE UNDERSTANDING OF THE GENERATION, CONTAINMENT, AND MANIPULATION OF PLASMA, ELECTROMAGNETIC FIELD INTERACTIONS WITH PLASMAS, AND THE INTERACTION OF SOLAR WIND WITH SPACE MAGNETIC FIELDS. SPECIFICALLY, THE WORK WILL BE CONCERNED WITH THE ADVANCEMENT OF THE PLASMA PHYSICS FOR THE PRODUCTION OF HIGH ENTHALPY GAS FLOWS. IDENTIFICATION OF SPECTRAL LINES AND THE DETERMINATION OF LINE SHAPES, TRANSITION PROBABILITIES, ETC., AND COMPUTER SIMULATIONS OF PLASMA PARTICLE DYNAMICS. THIS INFORMATION WILL HAVE APPLICATION IN MANY FIELDS INCLUDING SIMULATION IN PLANETARY ENTRY HEATING ENVIRONMENTS, ELECTROMAGNETIC PROPULSION, SPACE POWER GENERATION, LASER POWER, LASER COMMUNICATIONS, AND SOLAR PHYSICS.

RTOP NO. 112-02-23 TITLE: NUCLEAR PHYSICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

EXPERIMENTALLY MEASURE THE PROBABILITY OF PRODUCING PIONS, PROTONS, DEUTERONS AND OTHER CHARGED SECONDARIES OF HIGHER MASS, THAT RESULT FROM THE INTERACTION OF INTERMEDIATE ENERGY PROTONS AND ALPHA PARTICLES WITH VARIOUS NUCLEI. EXPERIMENTALLY DETERMINE, FOR THE SAME PARTICLES, THEIR MOMENTUM, ENERGY AND ANGLE OF EMISSION TO OBTAIN ACCURATE VALUES OF THE DIFFERENTIAL NUCLEAR CROSS SECTION. DEVELOP AND MAINTAIN COMPUTATIONAL METHODS OF DATA REDUCTION AND ANALYSIS TO EVALUATE THEORETICAL MODELS THAT TRY TO PREDICT BOTH THE TYPE OF NUCLEAR INTERACTIONS AND THEIR CROSS SECTIONS. DEVELOP A MULTI-DISCRETE WIRE PROPORTIONAL COUNTER, AS PART OF A CHARGED PARTICLE DETECTION SYSTEM, AND THE NECESSARY ELECTRONIC LOGIC AND COMPUTER PROGRAMS, TO BE USED TO IDENTIFY INDIVIDUAL NUCLEI WITH MASS UP TO ABOUT 12 AMU, AND DEDUCE THEIR MOMENTUM AND ENERGY. THE EXPERIMENTS TO MEASURE THE NUCLEAR DIFFERENTIAL CROSS SECTION WILL BE CARRIED OUT AT PARTICLE ACCELERATORS THAT CAN ACCELERATE PROTONS AND ALPHA PARTICLES TO ENERGIES GREATER THAN 500 MEV.

RTOP NO. 112-02-23 TITLE: NUCLEAR PHYSICS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BLUE, J. W. TEL. 216-433-4000
TECHNICAL SUMMARY

PROJECT 1. EFFECTS OF NUCLEAR RADIATIONS ON MATERIALS COVERS CHARGED PARTICLE IRRADIATION OF HYDROGEN GAS FOR CONVERSION STUDIES, FUSED SILICA FOR TRANSPARENCY, UF6 GAS FOR RADIATION FROM FISSION FRAGMENTS AND ION EXCHANGE MATERIAL TO DETERMINE ITS CHANGE IN CAPACITY. PROJECT 2. THEORETICAL STUDIES OF NUCLEAR REACTIONS AIM AT IMPROVING THE ACCURACY WITH WHICH NUCLEAR REACTIONS CAN BE CALCULATED. THE OBJECTIVE IS TO PROVIDE BETTER DATA FOR SHIELDING CALCULATIONS. PROJECT 3. EXPERIMENTAL STUDIES OF NUCLEAR REACTIONS ARE INTENDED TO PROVIDE DATA TO TEST THE THEORIES GENERATED IN PROJECT 2. PROJECT 4. MEASUREMENT OF PHENOMENA RELATED TO REACTOR TECHNOLOGY INVOLVES NEUTRON SPECTRA MEASUREMENTS OF A REACTOR OR OF NEUTRON SOURCES SURROUNDED BY VARIOUS SHIELD AND REFLECTOR CONFIGURATIONS. PROJECT 5. TECHNOLOGICAL APPLICATIONS OF NUCLEAR PHYSICS ARE STUDIED FOR THEIR USE IN SPACE TECHNOLOGY, MEDICAL APPLICATIONS AND POLLUTION PROBLEMS. PROJECT 6. VERY LOW TEMPERATURE STUDIES OF THE PROPERTIES OF HE3 AND HE4 ARE BEING STUDIED AS TEST OF QUANTUM THEORY AND ALSO TO PROVIDE A LOW TEMPERATURE REGIME FOR NUCLEAR ALLIGNMENT.

RTOP NO. 112-27-10 TITLE: ISOTOPE BRAYTON CONVERSION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: PACKE, D. R. TEL. 216-433-4000
TECHNICAL SUMMARY

THE ISOTOPE BRAYTON CONVERSION TECHNOLOGY PROGRAM IS TO PROVIDE A BROAD TECHNOLOGY BASE FOR A HIGHLY RELIABLE, LONG LIVED, AND VERY

EFFICIENT SPACE POWER CONVERSION SYSTEM WITH ELECTRICAL POWER CAPABILITY UP TO THE MULTIPLE KILOWATTS AND WHICH ARE SUITABLE FOR OPERATION WITH ISOTOPE HEAT SOURCES. TYPICAL MISSIONS FOR THIS TYPE OF POWER SYSTEM WOULD INCLUDE MANNED SPACE STATIONS, MANNED LUNAR MISSIONS, AND UNMANNED MISSIONS. DEVELOPMENT UNDER THIS RTOP, UNDER RTOP 112-27-11, AND ISOTOPE HEAT SOURCE DEVELOPMENT UNDER AEC COGNIZANCE WILL PROVIDE A TECHNOLOGY BASE FOR ISOTOPE BRAYTON TO MEET A SPECTRUM OF FUTURE MISSION POWER NEEDS UP TO THE MULTIPLE KILOWATT LEVEL. THE TECHNOLOGY PROGRAM PRESENTLY INVESTIGATES A POWER CONVERSION SYSTEM WHICH PRODUCES 2-15 KILOWATTS OF ELECTRIC POWER. THIS SYSTEM IS PRESENTLY UNDERGOING PERFORMANCE AND ENDURANCE TESTING IN THE PLUM BROOK SPACE POWER FACILITY USING AN ELECTRICALLY HEATED HEAT SOURCE. DURING CY 1972 THE SYSTEM WILL BE INSTALLED AT THE MARSHALL SPACE FLIGHT CENTER FOR TESTING FROM A "USER" VANTAGE AGAINST "USER" REQUIREMENTS. LATER, WHEN THE ISOTOPE HEAT SOURCE (RTOP 112-27-11) IS READY, IT WILL BE MATED TO THE SYSTEM AND TESTED IN THE PLUM BROOK SPACE POWER FACILITY. IN ADDITION TO THE POWER CONVERSION SYSTEM TEST ITSELF, THE IBCT PROGRAM INCLUDES PERFORMANCE AND ENDURANCE TESTING OF INDIVIDUAL COMPONENTS AND SUBSYSTEMS. AS A MINIMUM GOAL FOR ENDURANCE DEMONSTRATION, MOST COMPONENTS WILL BE TESTED FOR 20,000 HOURS AND THE COMPLETE POWER CONVERSION SYSTEM WILL ACCUMULATE 5000 HOURS.

RTOP NO. 112-27-11 TITLE: ISOTOPE BRAYTON THERMAL ENERGY SUBSYSTEM TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: WINTUCKY, W. T. TEL. 216-433-6844

TECHNICAL SUMMARY

THE ISOTOPE BRAYTON (THERMAL) ENERGY SUBSYSTEM TECHNOLOGY PROGRAM IS TO DEVELOP THE TECHNOLOGY FOR LONG-LIFE HIGHLY RELIABLE AND EFFICIENT COMPONENTS NECESSARY TO THE GENERATION AND TRANSFER OF THERMAL ENERGY TO THE WORKING GAS OF THE BRAYTON POWER CONVERSION SYSTEM. THIS PROGRAM DOES NOT INCLUDE THE ISOTOPE-FUELED HEAT SOURCES (CAPSULES) WHICH ARE THE SUBJECT OF AN AEC PROGRAM. THE THERMAL ENERGY SUBSYSTEM LESS THE HEAT EXCHANGER IS TO PROVIDE FOR INTACT REENTRY OF THE ISOTOPE HEAT SOURCES IN CASE OF A FLIGHT ABORT. DEVELOPMENT UNDER THIS RTOP, UNDER RTOP 112-27-10, AND ISOTOPE HEAT SOURCE DEVELOPMENT UNDER AEC COGNIZANCE WILL PROVIDE THE TECHNOLOGY BASE FOR ISOTOPE BRAYTON SYSTEMS TO MEET A SPECTRUM OF FUTURE MISSION POWER NEEDS UP TO THE MULTIPLE KILOWATT POWER LEVEL. THE ISOTOPE BRAYTON THERMAL ENERGY SUBSYSTEM TECHNOLOGY PROGRAM AT LEWIS RESEARCH CENTER IS AN IN-HOUSE EFFORT. A PRELIMINARY DESIGN WAS OBTAINED FROM A CONTRACTED STUDY. THE PRESENT TECHNOLOGY PROGRAM INCLUDING THE HEAT SOURCE REENTRY VEHICLE, HEAT SOURCE HEAT EXCHANGER AND ASSOCIATED DUCTING IS TO IDENTIFY AND ADDRESS AS EARLY AS PRACTICAL THOSE TASKS WHICH ARE ESSENTIAL TO VERIFYING THE THERMAL ENERGY SUBSYSTEM. A THERMAL PROTOTYPE 25 KW THERMAL ENERGY SUBSYSTEM WILL BE FABRICATED IN-HOUSE FOR TECHNOLOGY TESTING WITH EITHER A BRAYTON ENGINE SIMULATOR OR THE BRAYTON POWER CONVERSION SYSTEM IN THE PLUM BROOK SPACE POWER FACILITY USING ELECTRICALLY SIMULATED ISOTOPE HEAT SOURCES.

RTOP NO. 112-27-12 TITLE: REACTOR-BRAYTON CONVERSION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ENGLISH, R. E. TEL. 216-433-6949
TECHNICAL SUMMARY

THE REACTOR-BRAYTON CONVERSION TECHNOLOGY PROGRAM IS DIRECTED AT PROVIDING A BROAD TECHNOLOGY BASE IN THE UTILIZATION OF THE BRAYTON CYCLE FOR CONVERTING THERMAL TO ELECTRICAL POWER. THE TECHNOLOGY TO BE EXPLORED INCLUDES ADVANCED-CONCEPT GAS-LUBRICATED BEARINGS, INORGANIC HIGH TEMPERATURE ALTERNATOR INSULATION, IMPROVED EFFICIENCY TURBINE AND COMPRESSOR, DIFFUSION-BONDED ALTERNATOR ROTOR, LOW-PRESSURE-DROP HEAT EXCHANGERS, LOW-NOISE SPEED CONTROL AND VOLTAGE REGULATOR, AND THE SYSTEM TECHNOLOGY TO DEMONSTRATE ALL COMPONENTS FUNCTIONING IN CONCERT. THIS PROGRAM IS INTENDED TO PROVIDE THE NECESSARY TECHNOLOGY TO PERMIT A MISSION USER TO CONFIDENTLY SELECT A REACTOR-BRAYTON POWER SYSTEM FOR USE IN FUTURE MANNED AND UNMANNED MISSIONS REQUIRING ELECTRICAL POWER LEVELS FROM A FEW TENS OF KILOWATTS TO A FEW HUNDRED KILOWATTS. A REACTOR-BRAYTON SYSTEM WOULD PROVIDE THE MISSION USER A HIGHLY RELIABLE, LONG LIFE (I.E. 5 TO 10 YEARS), HIGH EFFICIENCY, (I.E. 20 TO 25 PERCENT) SPACE POWER SYSTEM WHEN USED WITH A REACTOR HEAT SOURCE. THE PROGRAM INCLUDES (A) TECHNOLOGY, COMPONENT, AND SYSTEM DEFINITION AND ANALYSIS, (B) EARLY PROCUREMENT OF A 100 KWE ROTATING UNIT AND ASSOCIATED HEAT EXCHANGER AND DUCTING ASSEMBLY FOR PERFORMANCE AND LIFE PROOF OF TECHNOLOGY TESTING IN AN EXPERIMENTAL GAS LOOP, (C) EVENTUAL ASSEMBLY OF A POWER CONVERSION SYSTEM USING THIS EQUIPMENT AND ITS CHECKOUT AND TEST USING ELECTRICAL HEAT, AND FINALLY TESTING OF THIS POWER CONVERSION SYSTEM WITH THE ZIRCONIUM-HYDRIDE REACTOR.

RTOP NO. 112-27-13 TITLE: ADVANCED NUCLEAR RANKINE POWER SYSTEM
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ENGLISH, R. E. TEL. 216-433-6949
TECHNICAL SUMMARY

SEVERE BUDGETARY RESTRAINTS IN FY 1972 PRECLUDE THE START OF ANY OUTSIDE OR FUNDED ACTIVITIES. THEREFORE, AN ORDERLY COMPLETION AND DOCUMENTATION OF THE ACTIVE TASKS IS REQUIRED. THE LATTER INCLUDES THE SINGLE-TUBE BOILER DEVELOPMENT PROGRAM AND THE WET-VAPOR STEAM-TURBINE FLOW STUDY. THE BOILER TEST FACILITY WILL BE "MOTH-BALLED" FOR POTENTIAL USE ON HIGH-TEMPERATURE LIQUID-METAL WORK REQUIRED FOR OTHER NUCLEAR POWER SYSTEMS. A LOW-LEVEL IN-HOUSE EFFORT WILL BE CONTINUED ON ANALYSES OF SYSTEMS AND COMPONENTS USING CURRENT AND PROJECTED IMPROVEMENTS IN MATERIALS AND FABRICATION TECHNIQUES.

RTOP NO. 112-27-14 TITLE: THERMIONIC SYSTEM TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: BREITWIESER, R. TEL. 216-433-4000
TECHNICAL SUMMARY

NUCLEAR POWERED THERMIONIC SYSTEMS ARE OF INTEREST FOR SPACE POWER GENERATION. LEWIS WILL CONTINUE ITS SUPPORT OF THE IN-CORE THERMIONIC PROGRAM. MOST OF THE PROGRAM WILL BE FOCUSED ON ACHIEVING

PHYSICAL STABILITY OF TUNGSTEN CLAD FUEL ELEMENTS AT HIGH BURNUP CONDITIONS. THERMIONIC CONVERTER WORK WILL BE DIRECTED TOWARDS ACHIEVING ENHANCED ELECTRICAL PERFORMANCE BY THE USE OF BETTER EMITTER AND COLLECTOR MATERIALS. THE CONVERTERS WILL USE WELL CHARACTERIZED ELECTRODES AND WILL BE EVALUATED BY AN AUTOMATIC DATA PROCESSER THAT PROVIDES AN EXTENSIVE EASILY USED COMPILATION OF PERFORMANCE DATA. WORK WILL CONTINUE ON MATERIALS WORK FOR THERMIONIC SYSTEM COMPONENTS, DEVELOPMENT OF APPROPRIATE REFRACTORY METAL ALLOYS, AND FUEL ELEMENT FABRICATION. BECAUSE THE STATE OF THE ART IS NOT SUCH THAT SUCCESS OF THE IN-CORE INTERNALLY-FUELED REACTOR IS ASSURED, A LOW LEVEL EFFORT IN TERMS OF THE DOLLAR INVOLVEMENT WILL BE CONTINUED ON TECHNOLOGY RELATED TO THE EXTERNALLY FUELED AND THE OUT-OF-CORE REACTOR CONCEPTS.

RTOP NO. 112-27-15 TITLE: NUCLEAR POWER REACTOR TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: KAUFMAN, S. J. TEL. 216-433-6691
TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO DEVELOP THE TECHNOLOGY BASE REQUIRED TO DEVELOP AND SUCCESSFULLY OPERATE A COMPACT FAST REACTOR FOR USE AS THE HEAT SOURCE FOR AN ELECTRICAL POWER GENERATING SYSTEM. THE REACTOR WILL BE COMPATIBLE WITH A VARIETY OF POWER CONVERSION SYSTEMS AND WILL HAVE AN OPERATING LIFE AT RATED CONDITIONS OF 5 YEARS. MANNED ORBITING STATION MISSIONS WILL BE USED TO ESTABLISH PERFORMANCE, OPERATING AND SAFETY REQUIREMENTS. THE REACTOR COOLANT OUTLET TEMPERATURE WILL BE SET TO ENABLE THE TURBINE INLET TEMPERATURE OF A BRAYTON TURBOGENERATING CONVERSION SYSTEM TO REACH 1600 DEGREES F. THE THERMAL OUTPUT CAPACITY OF THE REACTOR WILL BE IN EXCESS OF 2 MEGAWATTS. THE MAJOR EFFORT CENTERS AROUND AN IN-PILE FUEL AND MATERIAL TESTING PROGRAM, FAST SPECTRUM NEUTRONICS EXPERIMENTS AND MATERIALS INVESTIGATIONS. THE TECHNOLOGY PROGRAM SHOULD BE FAR ENOUGH ADVANCED BY LATE FY '73 TO ESTABLISH A FIRM BASIC UNDERSTANDING OF THE FUEL/CLAD/COOLANT SYSTEM.

RTOP NO. 112-27-16 TITLE: NUCLEAR MERCURY RANKINE SYSTEM (SNAP-8)
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SAARI, M. J. TEL. 216-433-6638
TECHNICAL SUMMARY

THE GOAL OF THE SNAP-8 PROGRAM HAS BEEN THE DEVELOPMENT OF A LONG-LIVED REACTOR POWER SYSTEM CAPABLE OF PRODUCING MORE THAN 35 KWE BY USE OF THE ZRH REACTOR. EVERY MAJOR COMPONENT OF THE POWER CONVERSION SYSTEM HAS OPERATED SUCCESSFULLY FOR MORE THAN 10,000 HOURS; A COMPLETE POWER CONVERSION SYSTEM OPERATED FOR 1,320 HOURS WITHOUT FAILURE AND A SECOND PCS WAS STARTED AND SHUT DOWN 135 TIMES. THE DESIGN OF AN UPGRADED SYSTEM FOR COMBINED SYSTEM TESTS IN THE SPACE POWER FACILITY WAS INITIATED. DUE TO FUNDING LIMITATIONS, THE SNAP-8 DEVELOPMENT PROGRAM WAS TERMINATED ON OCTOBER 13, 1970, IN ORDER TO APPLY THESE RESOURCES TO THE REACTOR-BRAYTON SYSTEM. TERMINATION ACTIVITIES HAVE BEEN INITIATED ON ALL CONTRACT AND IN-HOUSE EFFORTS ASSOCIATED WITH THE PROGRAM.

RTOP NO. 112-27-18 TITLE: MHW REENTRY TESTING
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

TO APPRAISE REENTRY PERFORMANCE OF A MULTI-HUNDRED WATT HEAT SOURCE AND ITS COMPONENTS, THE EFFORT INCLUDES EXPERIMENTATION ON AERODYNAMIC STABILITY, PRESSURE, HEAT DISTRIBUTION, EATING RATE, INTERNAL TEMPERATURE DISTRIBUTION, ABLATION, AND THERMAL STRESS; AND EVALUATION OF TEST RESULTS. APPROACH IS EXPLORATORY TESTING AND ANALYSIS IN CONJUNCTION WITH ANALYTICAL PROGRAM BY PRIME CONTRACTOR (GENERAL ELECTRIC). TESTING OF SPECIFIC MODELS PREPARED BY THIS CENTER AND/OR PROVIDED BY G.E.

RTOP NO. 112-27-20 TITLE: THERMOELECTRIC SYSTEM TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: EPSTEIN, J. TEL. 301-982-4564
TECHNICAL SUMMARY

THE SUCCESS OF MISSIONS AIMED AT EXPLORING THE OUTER LIMITS OF THE SOLAR SYSTEM WILL DEPEND HEAVILY ON THE AVAILABILITY OF STABLE, LONG TERM RADIOISOTOPE THERMOELECTRIC GENERATORS (RTG). ACCURATE PREDICTIONS FOR LONG TERM PERFORMANCE GREATER THAN 5 YEARS) AND THE PRECISE DEFINITIONS OF THE RTG CREATED ENVIRONMENT ARE REQUIRED. LIVE TEST AND EVALUATION OF SEVERAL RTG CONCEPTS AND SPACECRAFT EXPERIMENTS FOR RADIATION AND MAGNETIC ENVIRONMENTAL COMPATIBILITY ARE THE TASKS REQUIRED TO ENHANCE THE SUCCESS PROBABILITY OF THESE MISSIONS. THE PROCESSES INVOLVED IN THE INTERACTIONS WITHIN THE RTG MUST BE DETERMINED AND CONTROLLED. THE DEVELOPMENT OF METHODS FOR MINIMIZING THE ENVIRONMENTAL INTERFERENCE AND THE VERIFICATION OF THESE METHODS BY EMPIRICAL MEANS ARE REQUIRED.

RTOP NO. 112-27-40 TITLE: NUCLEAR REACTOR THERMIONIC SYSTEM TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ACHIEVE THERMIONIC REACTOR POWER SUBSYSTEM TECHNOLOGY READINESS. THE POWER SUBSYSTEM (50 TO 300 KWE) WOULD BE USEFUL FOR ELECTRIC PROPULSION AND ELECTRIC POWER MISSIONS. THE POWER SUBSYSTEM INCLUDES A THERMIONIC REACTOR, A RADIATOR, A NUCLEAR SHIELD, AN ELECTROMAGNETIC PUMP, CONTROLS, AND STRUCTURE. THE THERMIONIC REACTOR IS THE ONLY COMPONENT THAT REQUIRES MAJOR TECHNOLOGY DEVELOPMENT. REACTOR TECHNOLOGY SUPPORT IS PROVIDED IN SELECTED KEY AREAS TO HELP DEVELOP THE TECHNOLOGY AND TO DETERMINE REACTOR CAPABILITIES. THE PRIMARY THERMIONIC REACTOR CONCEPT USES THERMIONIC CONVERTERS WITH INTERNALLY FUELED EMITTERS. SEVERAL CONVERTERS ARE CONNECTED IN SERIES TO FORM A "FLASHLIGHT" THERMIONIC FUEL ELEMENT. A CORE-LENGTH THERMIONIC CONVERTER WITH AN EXTERNALLY FUELED EMITTER IS ALSO BEING INVESTIGATED AS A BACKUP THERMIONIC FUEL ELEMENT. THE MAJOR MILESTONES REQUIRED TO ACHIEVE "TECHNOLOGY READINESS" ARE SEVERAL THOUSAND HOURS OPERATION OF BOTH A FLIGHT

PROTOTYPE THERMIONIC REACTOR AND A FLIGHT PROTOTYPE NON-NUCLEAR POWER SUBSYSTEM WITH THE THERMIONIC REACTOR SIMULATED. EXTRAPOLATION OF SYSTEM PERFORMANCE TO FULL MISSION LIFETIME REQUIREMENTS SHOULD HAVE RELATIVELY HIGH CONFIDENCE LEVELS WHEN "TECHNOLOGY READINESS" IS ACHIEVED. THE HIGH CONFIDENCE LEVEL WOULD BE PROVIDED BY OPERATING FLIGHT PROTOTYPE THERMIONIC FUEL ELEMENTS TO FULL MISSION LIFETIMES OR GREATER. A "FOCUS TECHNOLOGY" APPLICATION FOR AN UNMANNED NUCLEAR ELECTRIC PROPULSION SYSTEM TO ACHIEVE A HALLEY'S COMET RENDEZVOUS IN MID FY'86 IS RECOMMENDED FOR CONSIDERATION. THE SAME SYSTEM WOULD BE USEFUL FOR OTHER UNMANNED MISSIONS. THE SAME POWERSAME POWER SUBSYSTEM WOULD ALSO BE USEFUL AS----

RTOP NO. 112-27-41 TITLE: RTG SUPPORT FOR DEEP SPACE ADVANCED SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THIS TASK IS TO DEVELOP THE RTG TECHNOLOGY, AND TO PERFORM THE DESIGN TRADEOFFS, PERFORMANCE EVALUATIONS, AND ANALYSES, NECESSARY TO INTEGRATE HIGH PERFORMANCE RTG'S WITH ADVANCED SPACECRAFT. SUPPORTING RESEARCH AND TECHNOLOGY WILL ALSO BE PROVIDED TO OTHER NASA CENTERS AND TO THE ATOMIC ENERGY COMMISSION IN SUPPORT OF BOTH NEAR-TERM AND LONGTERM MISSIONS. THE WORK WILL BE CONDUCTED IN FOUR PARALLEL PROGRAMS INVOLVING BOTH IN-HOUSE AND CONTRACTED EFFORTS. ESSENTIAL TASKS IN THE PROGRAM INCLUDE (1) THE DEVELOPMENT OF SIMULATED RTG POWER SOURCES FOR PERFORMING SUBSYSTEM INTERFERENCE AND INTEGRATION TESTS IN THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT, WHICH IS IN PREPARATION FOR SUBSEQUENT OUTER PLANETS MISSIONS. CONCURRENTLY, TO EVALUATE AND INFLUENCE THE DEVELOPMENT OF THE A.E.C.'S MHW-RTG TO CONFORM TO TOPS REQUIREMENTS AND, AT THE EARLIEST POSSIBLE DATE, OBTAIN A PROTOTYPE MHW-RTG AND OTHER RELATED HARDWARE NECESSARY FOR EVALUATION AND INTEGRATION TESTS ON THE OUTER PLANETS SPACECRAFT. THE MAJOR EMPHASIS IN THIS PHASE OF THE PROGRAM WILL BE IN SUPPORTING THE NECESSARY RTG/SPACECRAFT INTEGRATION, AND CONDUCTING RTG OPTIMIZATION AND TRADE STUDIES. THIS PHASE WILL ALSO ACT AS A FOCUS FOR THE OTHER TECHNOLOGY PROGRAMS, (2) A SILICON-GERMANIUM TECHNOLOGY PROGRAM FOR THE PURPOSE OF DETERMINING LONG-TERM HIGH TEMPERATURE SUBLIMATION MECHANISMS, MATERIAL COMPATIBILITY, VAPOR PRESSURES, AND REACTION RATES, (3) AN IN-DEPTH NUCLEAR RADIATION PROGRAM TO PROVIDE DATA FROM WHICH THE RADIATION SENSITIVITY OF SPACECRAFT SUBSYSTEMS CAN BE DETERMINED, AND (4) A THERMOELECTRIC GENERATOR EVALUATION AND IMPROVEMENT PROGRAM WHICH WILL PROVIDEEXPERIMENTAL DATA CONCERNING THE----

RTOP NO. 112-27-42 TITLE: LIQUID METAL MHD RESEARCH
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

LIQUID METAL MHD IS A PROSPECTIVE ELECTRIC PROPULSION POWER SYSTEM WITH NO MOVING PARTS, MODERATE SOURCE TEMPERATURE OF 1100DEGC

(1800DEGF), AND AC OUTPUT. LITHIUM FLOWING FROM A REACTOR HEAT SOURCE IS MIXED WITH CESIUM, CAUSING THE CESIUM TO VAPORIZE. THE MIXTURE FLOWS THROUGH A NOZZLE AND SEPARATOR AND THE LITHIUM FLOWS THROUGH A GENERATOR AND RETURNS TO THE HEAT SOURCE. THE CESIUM FLOWS THROUGH A CONDENSER AND IS PUMPED BACK TO THE NOZZLE. THE SYSTEM IS ATTRACTIVE FOR HIGH RELIABILITY AND LOW DEVELOPMENT COST. PROBLEM AREAS REQUIRING INVESTIGATION ARE EFFICIENCY AND LIFETIME. NOZZLES AND SEPARATORS ARE INVESTIGATED WITH WATER-NITROGEN MIXTURES, GENERATORS WITH COLD NAK, AND CONVERTER MATERIALS WITH HOT LITHIUM. THE APPROACH IS TO SOLVE THE PROBLEMS THAT CAN BE STUDIED WITH SUCH SIMULATIONS AND THEN PROCEED TO CESIUMLITHIUM CONVERTER EXPERIMENTS. THE FY'72 OBJECTIVES ARE: (1) POWER GENERATION TO 30 KW WITH CLOSED-LOOP NAK SIMULATING LITHIUM AND OPEN-LOOP NITROGEN SIMULATING CESIUM VAPOR, (2) A 500-HR TEST WITH CESIUM AND LITHIUM AT 1000DEGC AND 130 M/S, (3) WATER-NITROGEN FLOW TESTS AND GENERATOR AND CYCLE ANALYSIS TO SELECT THE DESIGN FOR AN EXPERIMENTAL CS-LI CONVERTER.

RTOP NO. 112-27-43 TITLE: ZRH REACTOR-POWER SYSTEMS TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SAARI, M. J. TEL. 206-433-6638
TECHNICAL SUMMARY

THE ZRH REACTOR-POWER SYSTEMS TECHNOLOGY PROGRAM AT LEWIS IS A JOINT AEC/NASA EFFORT DIRECTED TOWARD PROVIDING A BROAD TECHNOLOGY BASE TO PERMIT A MISSION USER TO SELECT A ZRH REACTOR POWER SYSTEM FOR USE IN FUTURE MANNED OR UNMANNED MISSIONS. A URANIUM-ZIRCONIUM HYDRIDE (ZRH) REACTOR, PROCURED JOINTLY WITH THE AEC, WILL BE UTILIZED TO DEVELOP A SHIELDED HEAT SOURCE SUBSYSTEM THAT COULD BE COUPLED TO BRAYTON OR THERMOELECTRIC POWER CONVERSION SYSTEMS. THE WORK CONDUCTED UNDER THIS RTOP PROVIDES FOR (1) THE PREPARATION OF THE LEWIS SPACE POWER FACILITY (SPF) TO PERMIT TESTING OF THE SHIELDED HEAT-SOURCE SUBSYSTEM, (2) THE DESIGN, PROCUREMENT, AND/OR FABRICATION OF THE SHIELD AND COMPONENTS, OTHER THAN THE ZRH REACTOR, THAT COMPRISE THE HEAT-SOURCE SUBSYSTEM, (3) TEST EVALUATIONS OF THE HEAT-SOURCE SUBSYSTEM IN THE SIMULATED SPACE ENVIRONMENT OF SPF, AND (4) BASED ON THE SUCCESSFUL DEVELOPMENT OF THE ZRH REACTOR, BRAYTON SYSTEM (RTOP 112-27-12), AND THERMOELECTRIC SYSTEM (AEC) TECHNOLOGIES, AN INTEGRATED TEST OF THE REACTOR HEAT SOURCE AND POWER CONVERSION SYSTEM (BRAYTON AND/OR THERMOELECTRIC) MAY BE CONDUCTED IN THE SPF TO OBTAIN ADDITIONAL TEST DATA TO EVALUATE THE PERFORMANCE AND ENDURANCE CAPABILITIES OF AN INTEGRATED POWER SYSTEM.

RTOP NO. 112-28-13 TITLE: APPLICATION OF CONTROLLED THERMONUCLEAR FUSION TO PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: RAYLE, W. TEL. 216-433-6203
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL WORK WILL BE CONDUCTED TO DETERMINE THE FEASIBILITY AND THE MAJOR PROBLEM AREAS IN THE APPLICATION OF CONTROLLED FUSION TO SPACE PROPULSION. EMPHASIS WILL BE PLACED ON THOSE PROBLEMS THAT SEEM MOST CRUCIAL TO THE ATTAINMENT OF USEFUL

SPECIFIC MASSES. THE ANALYTICAL WORK WILL BE CENTERED ON THE DEUTERIUM-HELIUM-3 REACTION WHICH HAS NO NEUTRONS AS DIRECT PRODUCTS. THE NECESSARY CONDITIONS FOR NET POWER PRODUCTION FROM THIS REACTION WILL BE SPECIFIED, AND THE IMPLIED FLUXES OF RADIATION AND PARTICLES ESCAPING WILL BE EXAMINED TO DETERMINE THE REQUIREMENTS FOR SHIELDING AND COOLING OF STRUCTURES AND COMPONENTS. PLASMA HEATING AND CONFINEMENT STUDIES WILL BE CARRIED OUT IN MAGNETIC CONFIGURATIONS APPROACHING THE SIZE AND STRENGTHS THAT WILL BE NEEDED IN THE SPACE APPLICATION. THIS INVOLVES SUPERCONDUCTING CONFIGURATIONS BOTH CLOSED AND OPEN WITH FIELD STRENGTHS OF UP TO ABOUT 7 TESLA. WHEN SUFFICIENTLY HOT AND DENSE PLASMAS ARE ATTAINED, THEY WILL BE USED TO STUDY THE TRANSFER OF ENERGY FROM HOT PLASMAS TO COLD PROPELLANT. EFFORT WILL BE MADE TO REDUCE THE MASS OF SUPERCONDUCTORS AND ASSOCIATED CRYOGENIC SYSTEMS.

RTOP NO. 112-28-20 TITLE: FEASIBILITY OF GAS-CORE REACTORS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ROM, F. E. TEL. 216-433-4000
TECHNICAL SUMMARY

DEMONSTRATE FEASIBILITY OF STABLE CONTROLLABLE GAS-CORE NUCLEAR PROPULSION REACTORS SHORT OF FULL-SCALE FULL-POWER FISSION HEATED TESTS. THE GAS-CORE WORK IS COMPRISED OF A CONTINUING SERIES OF COLD-FLOW, HOT-FLOW, OPACITY, AND NUCLEAR EXPERIMENTS. EACH SUCCESSIVE EXPERIMENT IS DESIGNED TO INCORPORATE AND EXTEND INFORMATION GAINED FROM PRECEEDING TESTS. EACH SUCCESSIVE TEST IS CONDUCTED AT CONDITIONS THAT ARE CLOSER TO EXPECTED ENGINE CONDITIONS. THE ULTIMATE GOAL OF THE TESTS IS TO PROVIDE THE TECHNOLOGY NECESSARY TO BUILD AND OPERATE A 1/3 SCALE MODEL OF A GAS-CORE REACTOR. IN THIS PROPOSED 1/3 SCALE MODEL, ELECTRICAL INDUCTION HEATING (50-100 MEGAWATTS) WOULD BE USED TO SIMULATE NUCLEAR FISSION HEATING. THIS MODEL, WHICH WOULD SIMULTANEOUSLY OPERATE WITH VERY LOW NUCLEAR FISSION POWER (100-1000 WATTS) WOULD DEMONSTRATE STABLE AND CONTROLLABLE OPERATION THAT SIMULTANEOUSLY TAKES INTO ACCOUNT ALL THE INTERACTIONS BETWEEN THE HIGH TEMPERATURE RADIATING FISSIONING PLASMA, HYDROGEN PROPELLANT, URANIUM INJECTION SYSTEM AND NUCLEAR CONTROL SYSTEMS.

RTOP NO. 112-29-20 TITLE: IMPROVED COMPONENTS AND MATERIALS FOR SOLID CORE NUCLEAR ROCKET ENGINES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: JONES, W. L. TEL. 216-433-6857
TECHNICAL SUMMARY

IN ORDER TO PROVIDE BASIC TECHNOLOGY FOR IMPROVED COMPONENTS FOR NUCLEAR ROCKET ENGINES, RESEARCH WILL BE CONDUCTED IN THE FOLLOWING AREAS: 1. ROCKET NOZZLE COATINGS AND HEAT TRANSFER. UTILIZING A PLASMA ARC FACILITY FOR CONCEPTUAL SCREENING AND A ROCKET ENGINE FOR FINAL EVALUATION, GRADED COATINGS THAT ARE CAPABLE OF OPERATING AT HIGH TEMPERATURES AND HEAT FLUXES WILL BE DEVELOPED. 2. IRRADIATION EFFECTS ON SOLID LUBRICANTS. FRICTION AND WEAR TESTS WILL BE CONDUCTED IN-PILE, OVER A RANGE OF RADIATION FLUX LEVELS AND

TEMPERATURES, WITH THE OBJECTIVE OF DEVELOPING SOLID LUBRICANTS THAT WILL FUNCTION EFFECTIVELY IN THE NUCLEAR REACTOR ENVIRONMENT. 3. IRRADIATION EFFECTS ON MATERIALS. THE EFFECT OF RADIATION ON TENSILE STRENGTH AND LOW-CYCLE FATIGUE LIFE OF VARIOUS MATERIALS THAT ARE OF INTEREST FOR NUCLEAR APPLICATIONS WILL BE INVESTIGATED.

RTOP NO. 112-30-13 TITLE: TERMINAL TOOLS FOR SPACE TELEOPERATORS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: THORNTON, W. G. TEL. 205-453-5530
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP ADVANCED TOOLS FOR MANIPULATORS ON SPACE TELEOPERATORS. A DETAILED FUNCTIONAL ANALYSIS WILL _BE MADE OF REPRESENTATIVE TASKS ASSOCIATED WITH MAINTAINABILITY AND MANUFACTURING IN SPACE TO DETERMINE FUNCTIONAL REQUIREMENTS OF TERMINAL TOOLS. ENGINEERING MODELS OF REPRESENTATIVE AND PROMISING CONCEPTS WILL BE DESIGNED, DEVELOPED AND EVALUATED UNDER LABORATORY SIMULATED SPACE CONDITIONS. IN ORDER TO MAINTAIN REALISTIC STAGE-TELEOPERATOR INTERFACE RELATIONSHIPS, FULL USE WILL BE MADE OF INFORMATION RESULTING FROM CURRENT RNS DEFINITION STUDIES, CODE 789-40; AND RNS TECHNOLOGY PROGRAM, CODE 121-30-19. GENERALLY, CONVENTIONAL MANIPULATOR GRIPPERS WILL BE CONSIDERED AS ONLY ONE TYPE OF TOOL, AND OTHER TYPES SUCH AS CUT-OFF TOOLS, ORBITAL WELDERS, AND VISE-GRIPS WILL ALSO BE CONSIDERED, WITH EMPHASIS PLACED ON INTEGRITY OF TOOLS OPERATING IN SPACE SO THAT VITAL COMPONENT PARTS CANNOT BECOME DETACHED AND DRIFT AWAY.

RTOP NO. 112-30-14 TITLE: "SENSE-OF-PRESENCE" VISUAL SYSTEMS FOR TELEOPERATORS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THIS PLAN PROPOSES RESEARCH LEADING TO THE DEVELOPMENT OF ADVANCED DESIGN CONCEPTS FOR TELEOPERATOR VISUAL SENSORY SUBSYSTEMS AND THE DEMONSTRATION AND EVALUATION OF A BREAD-BOARD SYSTEM BY 1974. SUBSYSTEM REQUIREMENTS WILL BE DERIVED FROM ANTICIPATED NASA MISSIONS BOTH IN THE NEAR TERM AND DURING THE 1975 TO 1980 PERIOD. SPECIFIC OBJECTIVES WILL INCLUDE THE ADVANCED DEVELOPMENT OF IMAGING SYSTEMS, COMMUNICATION AND DATA COMPRESSION METHODS AND CONTROL AND DISPLAY TECHNIQUES REQUIRED TO GIVE THE HUMAN OPERATOR A SENSE OF PRESENCE AT THE REMOTE SITE. THE IMAGING SYSTEM WILL ALSO PROVIDE ADEQUATE QUALITY INFORMATION TO ALLOW ENVIRONMENT ASSESSMENT AND ACTION PLANNING AS WELL AS PROVIDE VISUAL FEEDBACK INFORMATION FOR REAL TIME PERFORMANCE EVALUATION. THE INITIAL EMPHASIS DURING FY'72 WILL BE TO ESTABLISH MEANINGFUL MISSION REQUIREMENTS, TO DEVELOP SPECIFIC DESIGN CONCEPTS NECESSARY TO MEET MISSION GOALS, AND TO EVOLVE A SPECIFIC DESIGN APPROACH TO THE BREAD-BOARD SYSTEM. THE RESULTING BREAD-BOARD SYSTEM TO BE BUILT AND EVALUATED BY THE END OF FY'74 WILL INCLUDE HEAD CONTROL, ACCURATE DEPTH PERCEPTION, AND VARIABLE RESOLUTION CAPABILITY FOR PANORAMIC ASSESSMENT, NAVIGATION, AND MANIPULATOR CONTROL. THIS EFFORT WILL BE CLOSELY COORDINATED WITH

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ON-GOING RESEARCH IN ARTIFICIAL INTELLIGENCE AT JPL AND IN MULTI-MODED MANIPULATORS AT MIT AS WELL AS WITH OTHER TELEOPERATOR EFFORTS.

RTOP NO. 112-30-19 TITLE: REUSABLE NUCLEAR STAGE TECHNOLOGY (RNS)
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ATTAYA, H. E., JR. TEL. 205-453-1121
TECHNICAL SUMMARY

THE LONG RANGE OBJECTIVE OF THIS RTOP IS THE DEVELOPMENT OF TECHNOLOGY FOR THE SUPPORT OF CONCEPTUAL DESIGNS OF THE RNS IN THE AREAS OF LONG LIVED COMPONENTS AND SYSTEMS CAPABLE OF OPERATION IN A NUCLEAR ENVIRONMENT, WITH THE CAPABILITY OF BEING TRANSPORTED BY THE CHEMICAL SPACE SHUTTLE TO EARTH ORBIT WHERE IT WILL BE CAPABLE, DUE TO INHERENT DESIGN, OF ASSEMBLY, CHECKOUT, LAUNCH, MAINTENANCE AND REFURBISHMENT. THE FY 72 OBJECTIVES ARE FOLLOW-ON EFFORT IN AREAS OF IN-HOUSE INVESTIGATION OF RADIATION EFFECTS ON MATERIALS, ADVANCED ELECTRONIC STAGE INSTRUMENTATION COMPONENTS, NUCLEAR PROPELLANT HEATING AND STRATIFICATION EXPERIMENT DESIGN, SLUSH HYDROGEN PROPELLANT MEASURING INSTRUMENTATION AND OPERATIONAL TECHNIQUES, NUCLEAR EFFECTS MEASURING INSTRUMENTATION, SHIELDING DESIGN AND DOSE RATE CALCULATIONS, DEVELOPMENT OF PRIMARY STRUCTURES CONCEPTS, MAINTAINABILITY CRITERIA, MAINTENANCE/REPAIR TECHNIQUES, AND LONG-LIFE COMPONENTS FOR SUSTAINED OPERATIONS (2-5 YEARS). THE FY 72 EFFORT WILL BE IMPLEMENTED BY COMBINATION CONTRACTUAL AND IN-HOUSE EFFORT IN APPROXIMATE RATIO 75/25, RESPECTIVELY. THE EFFORT COVERED UNDER THIS RTOP IS A CONTINUATION OF FY 71 RTOP #121-30-19, REUSABLE NUCLEAR STAGE TECHNOLOGY.

RTOP NO. 118-06-01 TITLE: ADVANCED NUCLEAR-ELECTRIC PROPULSION CONCEPTS AND ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO INVESTIGATE ADVANCED PROPULSION CONCEPTS FOR USE IN PLANETARY AND INTERPLANETARY SPACECRAFT. STUDIES ARE TO EVALUATE SYSTEM CHARACTERISTICS OVER A RANGE OF MISSION PARAMETERS. PERFORMANCE DATA AND COST DATA WILL BE OBTAINED. WHERE POSSIBLE, COMPARISONS WILL BE MADE TO OTHER METHODS OF PROPULSION. NUCLEAR ELECTRIC POWER SYSTEMS WILL BE CONSIDERED FOR COMMONALITY BETWEEN UNMANNED PROPULSION AND MANNED AUXILIARY POWER MISSIONS. BOTH TITAN CLASS AND SHUTTLE LAUNCH VEHICLES WILL BE ASSUMED IN DETERMINING MULTIMISSION PAYLOAD CAPABILITY.

OFFICE OF TRACKING & DATA ACQUISITION

RTOP NO. 150-22-20 TITLE: TRACKING AND DATA RELAY SATELLITE TECHNOLOGY DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CLARK, G. Q. TEL. 301-982-6331
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR THE ORDERLY DEVELOPMENT OF THE TECHNOLOGY REQUIRED TO IMPLEMENT A FIRST GENERATION TDRSS IN THE MID TO LATE 1970'S. STUDIES WILL BE PERFORMED TO ESTABLISH CRITERIA FOR A TDRSS. OTHER STUDIES WILL LOOK FOR SOLUTIONS TO PROBLEMS INHERENT IN THE SYSTEM AND TECHNOLOGY WILL BE DEVELOPED WHERE REQUIRED FOR A FIRST GENERATION TDRSS.

RTOP NO. 150-22-21 TITLE: NETWORK INTEGRATION AND DEVELOPMENT PLANS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SHAUGHNESSY, J. P. TEL. 301-982-2357
TECHNICAL SUMMARY

THIS TASK ADDRESSES THE TOTAL SCOPE OF PROBLEMS WHICH ARE RELATED TO THE TECHNICAL INTEGRATION OF THE STADAN AND THE MSFN AND THE DEVELOPMENT OF PLANS, PROGRAMS, AND TECHNIQUES REQUIRED TO UPDATE THE NETWORK. THIS TASK WILL EMPHASIZE THOSE AREAS WHICH MAXIMIZE THE EFFECTIVENESS OF EXISTING EQUIPMENT AND INCREASE THE COST EFFECTIVENESS OF THE TOTAL NETWORK. ADVANCED AND STATE OF THE ART TECHNIQUES WILL BE IDENTIFIED AND THEIR POTENTIAL IMPACT UPON THE NETWORK WILL BE EVALUATED. SPECIFIC OBJECTIVES OF THIS TASK WHICH WILL AFFECT ALL ELEMENTS OF THE NETWORK INCLUDING REMOTE SITES, CONTROL CENTERS AND DATA PROCESSING/DATA HANDLING CENTERS ARE IDENTIFIED IN THE FOLLOWING BROAD AREAS: A. INTEGRATION OF MSFN AND STADAN NETWORKS B. NETWORK CONTROL C. TDRS IMPACT ON THE NETWORK

RTOP NO. 150-22-22 TITLE: GODDARD TRAJECTORY DETERMINATION SYSTEM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: KAHN, W. D. TEL. 301-982-4554
TECHNICAL SUMMARY

THE GODDARD SPACE FLIGHT CENTER (GSFC) OPERATIONAL TRAJECTORY DETERMINATION SYSTEM CURRENTLY IN USE FOR DEFINITIVE AND OPERATIONAL ORBIT DETERMINATION MUST BE IMPROVED IN ORDER THAT ACCURACIES ON THE ORDER OF ONE TO TEN METERS CAN BE ATTAINED. SUCH ORBITAL ACCURACIES ARE TO BE COMMENSURATE WITH ANTICIPATED TRACKING SYSTEM ACCURACIES RESULTING FROM IMPROVED RF SYSTEMS, OPERATIONAL LASER SYSTEMS, AND VERY LONG BASELINE INTERFEROMETER SYSTEMS WHICH WILL BE AVAILABLE IN THE MID 1970'S. FURTHERMORE, EXPERIMENTERS WILL REQUIRE ORBITAL ACCURACIES WITHIN THE 1- TO 10-METER RANGE FOR REDUCTION OF EXPERIMENTAL DATA SINCE SPACECRAFT BORNE EXPERIMENT INSTRUMENTATION WILL ALSO BE IMPROVED BY AT LEAST AN ORDER OF MAGNITUDE IN THE MID 1970'S. IN ORDER TO SUPPORT LUNAR AND PLANETARY MISSIONS AS EXEMPLIFIED BY THE UPCOMING RADIO ASTRONOMY EXPLORER (RAE-B) LUNAR MISSION, THE GODDARD TRAJECTORY DETERMINATION SYSTEM (GTDS) WILL BE MODIFIED AND AUGMENTED UNDER THE CONCEPT OF A SERIES OF MAJOR SUBSYSTEMS IN THE AREAS OF ORBIT DETERMINATION, TRAJECTORY CONTROL, ATTITUDE DETERMINATION AND ATTITUDE CONTROL. THE AFOREMENTIONED

TRAJECTORY DETERMINATION SYSTEM WILL HAVE THE CAPABILITY TO FUNCTION AS UNIQUE SUBSYSTEMS OR AS AN INTEGRATED COMPUTING SYSTEM IN BOTH A REAL-TIME AND NONREAL-TIME ENVIRONMENT. FLEXIBILITY IN THE OVERALL DESIGN OF THE GTDS WILL BE MAINTAINED TO ASSURE THAT APPLICATION OF THIS SYSTEM TO FUTURE SPACE MISSIONS (PRESENTLY UNDEFINED) OF VARYING COMPLEXITY WILL REQUIRE MINIMAL MODIFICATIONS AND/OR ADDITIONS.

RTOP NO. 150-22-23 TITLE: NETWORK SIGNAL QUALITY AND TIMING ACCURACY IMPROVEMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: GOLDEN, T. S. TEL. 301-982-4297
TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS SOFTWARE AND HARDWARE TECHNOLOGY TO IMPROVE SIGNAL QUALITY FOR SATELLITE-TO-GROUND TELEMETRY AND TRACKING. QUALITY ENHANCEMENT WILL BE ACHIEVED THROUGH: (1) ANALYSIS OF PHENOMENA AND DEVELOPMENT OF TECHNIQUES TO ALLEVIATE IONOSPHERIC PROPAGATION ANOMALIES; (2) INVESTIGATION OF TECHNIQUES TO IMPROVE NETWORK TIME SYNCHRONIZATION TO MEET THE PLUS TO MINUS ONE MICROSECOND REQUIREMENT IMPOSED BY APPROVED SATELLITE EXPERIMENTS, (3) INVESTIGATION OF SOFTWARE AND HARDWARE TECHNIQUES TO USE DIFFERENCES BETWEEN PREDICTED AND ACTUAL SIGNAL-TO-NOISE RATIO DATA TO SENSE RECEIVING SYSTEM DEGRADATION AND TO IDENTIFY PROPER CORRECTIVE MEASURES TO RESTORE PEAK OPERATING CONDITION. EMPHASIS IS PLACED ON SATISFYING KNOWN PRESENT AND FUTURE DEFICIENCIES IN THE OPERATING NETWORKS. SOFTWARE MODELS WILL BE DEVELOPED WHERE APPROPRIATE. EXPERIMENTAL OR ENGINEERING MODELS OF SOME HARDWARE WILL BE BUILT AND TESTED IN SEMIOPERATIONAL OR OPERATIONAL ENVIRONMENTS.

RTOP NO. 150-22-25 TITLE: STUDY OF METHODS FOR AUTOMATIC COMPUTER PROGRAM DOCUMENTATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: DAMON, E. P. TEL. 301-982-5478
TECHNICAL SUMMARY

THROUGH NUMEROUS CURSORY INVESTIGATIONS AND A SYMPOSIUM ON AUTOMATED METHODS OF COMPUTER PROGRAM DOCUMENTATION HELD AT GSFC ON NOVEMBER 2 AND 3, 1970, IT IS OBVIOUS THAT A PROGRAM CAN BE WRITTEN THAT WILL PROVIDE AN AID TO COMPUTER PROGRAMMERS IN THE DOCUMENTATION AND STANDARDIZATION OF THIS DOCUMENTATION. THIS WILL OPERATE FROM THE CARD DECK OR THE ASSEMBLY CODE LISTING AS PREPARED FOR COMPUTER OPERATIONS. IT WILL PRESENT PERTINENT MATERIAL IN VARIOUS FORMATS THAT WILL THEN BE USED WITHIN THE DOCUMENT. THE PROGRAMMER IS THEN ONLY REQUIRED TO DESCRIBE HIS PROBLEM, HIS APPROACH, AND REFERENCES TO THE COMPUTER PROGRAM DEVELOPMENT MATERIAL. IT IS PROPOSED THAT THIS INITIAL STUDY WILL IDENTIFY WITHIN THE VARIOUS COMPILERS, ASSEMBLERS, AND LOADERS PRESENTLY IN EXISTENCE WHERE THE DEFINED INFORMATION CAN BE OBTAINED. IT WILL FURTHER PROVIDE DESIGNS OF SPECIAL PROGRAMMING THAT WILL GENERATE INFORMATION NOT AVAILABLE AS NOTED ABOVE. IT WILL ALSO ATTEMPT TO PRESENT AN IMPROVED FORMAT FOR COMPUTER PROGRAM DOCUMENTATION THAT WILL BE MORE EASILY UNDERSTOOD BY

OTHER PROGRAMMERS AND MANAGEMENT PERSONNEL.

RTOP NO. 150-22-26 TITLE: METRIC EVALUATION AND TRAJECTORY ANALYSIS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: COOLEY, J. L. TEL. 301-982-5671
TECHNICAL SUMMARY

PROVIDE COMPUTATIONAL TECHNIQUES FOR TRAJECTORY AND GUIDANCE ANALYSIS AND METRIC TRACKING DATA FOR SPACE FLIGHT MISSIONS SCHEDULED FOR THE MID 1970'S ERA, SUCH AS PLANETARY EXPLORER, RADIO ASTRONOMY EXPLORER, EARTH RESOURCES TECHNOLOGY SATELLITE, SMALL METEOROLOGICAL SATELLITE AND GEODETIC AND GEO-DYNAMIC SATELLITES. DEVELOP COMPUTER PROGRAMS AND ANALYSIS PROCEDURES FOR IMPROVING THE QUALITY AND USAGE OF TRACKING DATA INCLUDING PRE-FLIGHT CALIBRATION, REALTIME ANALYSIS AND POST-FLIGHT EVALUATION. CONDUCT EVALUATION STUDIES TO ISOLATE AND IDENTIFY TRACKING DATA ERROR SOURCES. DEVELOP COMPUTATIONAL AND PROCEDURAL TECHNIQUES WHICH ENHANCE THE UTILIZATION OF TRACKING DATA. DEVELOP TECHNIQUES AND COMPUTER PROGRAMS TO STUDY THE INTERRELATIONSHIP BETWEEN THE TRACKING DATA, THE ON-BOARD GUIDANCE SYSTEM, AND THE MISSION TO DETERMINE TRAJECTORY AND NAVIGATION REQUIREMENTS. THIS RTOP COVERS FOUR TASKS: (A) TRAJECTORY AND DATA ANALYSIS (B) METRIC EVALUATION OF TRACKING DATA (C) MISSION ANALYSIS, AND (D) DEVELOPMENT OF WIDEBAND FILTER THE TECHNICAL APPROACH COVERS THE FOLLOWING AREAS:

RTOP NO. 150-22-31 TITLE: A GROUND ANTENNA SYSTEM FOR 1 GHZ DATA RATES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: DURHAM, A. F. TEL. 301-982-4973
TECHNICAL SUMMARY

FUTURE ADVANCED SPACECRAFT SYSTEM WILL TRANSMIT DATA TO THE GROUND AT RATES MUCH HIGHER THAN THAT OF CURRENT OPERATIONAL SYSTEMS. THE EARTH OBSERVATION SATELLITE (EOS) WILL TRANSMIT HIGH RESOLUTION COLOR TV REQUIRING A DATA BANDWIDTH OF ABOUT 100 MHZ EITHER DIRECTLY TO A GROUND STATION OR VIA A TRACKING AND DATA RELAY SATELLITE (TDRS). THE TDRS WILL TRANSMIT SIGNALS FROM EOSAND OTHER SATELLITES WHICH REQUIRED TOTAL TDRS BANDWIDTHS APPROACHING 2 GHZ. EXISTING NASA GROUND STATIONS ARE NOT EQUIPPED FOR SUCH DATA RATES. FUTURE WIDEBAND COMMUNICATION BY TDRS, EOS AND OTHER PROJECTS, REQUIRE USE OF FREQUENCIES AT WHICH THE NECESSARY BANDWIDTH CAN BE ALLOCATED. A 2 GHZ BANDWIDTH REQUIRES A HIGH PERFORMANCE GROUND ANTENNA SYSTEM. EMPHASIS ON OVERALL SYSTEM EFFICIENCY WILL BE ESSENTIAL TO AN ECONOMICALLY FEASIBLE GROUND STATION. IN PARTICULAR, TECHNIQUES AND COMPONENTS WILL BE DEVELOPED WHICH YIELD HIGH EFFICIENCY ANTENNA SYSTEMS, FEED SYSTEMS AND LOW NOISE PREAMPLIFIERS. IN ADDITION, DICHROIC SUBREFLECTOR TECHNIQUES PERMITTING SIMULTANEOUS AND EFFICIENT OPERATION OF AN ANTENNA AT DIFFERENT FREQUENCIES WITHOUT DEGRADATION OF OVERALL PERFORMANCE OR FLEXIBILITY WILL BE REFINED. ANALYTICAL PROCEDURES AND DESIGN TOOLS WILL BE FURTHER DEVELOPED TO SUPPORT THE SPECIFIC REQUIREMENTS OF THESE ADVANCED ANTENNA SYSTEMS AND THE GENERAL ANTENNA DEVELOPMENT PROGRAM. IN ADDITION, THE

PERFORMANCE OF THE USB SYSTEM WILL BE EVALUATED WHEN OPERATING IN A POLARIZATION SWITCHING MODE AS IS PLANNED WITH THE HEAO PROJECT. IF NECESSARY, HARDWARE AND OPERATING PROCEDURE MODIFICATIONS WILL BE INITIATED.

RTOP NO. 150-22-32 TITLE: HIGH RELIABILITY CONTROL SYSTEMS FOR ANTENNAS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: WINSTON, G. C. TEL. 301-982-5626
TECHNICAL SUMMARY

CONCENTRATION OF DATA ACQUISITION RESPONSIBILITIES AND INCREASING DATA BANDWIDTHS RESULTING FROM REDUCTION IN THE NUMBER OF NETWORK STATIONS AND DEVELOPMENTS SUCH AS THE TRACKING AND DATA RELAY SATELLITE (TDRS) SYSTEM ARE PLACING GREATER LOADS ON THE NETWORK LINKS. THUS, THE COST OF LINK DOWN TIME IS INCREASED, REQUIRING A CORRESPONDING INCREASE IN LINK RELIABILITY. BUT THE ANTENNA CONTROL SYSTEM IS ONE OF THE FEW COMPONENTS IN THE LINK TO WHICH REDUNDANCY CANNOT BE ECONOMICALLY APPLIED. THE ANTENNA ELECTRIC DRIVE (IN OPERATION AT THE NETWORK TEST AND TRAINING FACILITY (NTTF) FOR ONE YEAR) WILL BE RECOMMENDED FOR S-BAND COMMAND ANTENNAS SCHEDULED FOR JOHANNESBURG, QUITO AND ORRORAL. THE TDRS GROUND ANTENNA WILL ALSO USE AN ELECTRIC DRIVE SYSTEM AND THE DRIVE WILL BE A CANDIDATE FOR POSSIBLE MODIFICATION OF THE JOHANNESBURG DSN-85. THE COMPUTER CONTROLLED ANTENNA TASK HAS DEMONSTRATED A POTENTIAL FOR MARKED REDUCTION IN STATION MANPOWER. FOR EXAMPLE, TIME REQUIRED FOR A WEEKLY MAINTENANCE AND CHECKOUT PROCEDURE OF CONTROL SYSTEM COMPONENTS HAS BEEN REDUCED BY A FACTOR OF FOUR AND THE FUNCTIONS OF SEVERALBEEN SUCCESSFULLY INTEGRATED. THIS SYSTEM IS THIS SYSTEM S OPERATING EXPERIMENTALLY AT THE NTTF AND PROTOTYPE DESIGN HAS BEGUN FOR LATE FY-72 OPERATION. IT WILL SUPPORT THE STADAC AT NTTF AND WILL LATER BE INSTALLED IN THE NETWORK STATIONS. THE ACOUSTICAL ANALYSIS METHOD FOR DETECTING AND IDENTIFYING INCIPIENT FAILURES IN HYDRAULIC AND MECHANICAL SYSTEMS IS BEING INSTALLED IN FIVE MSFN STATIONS (NTTF, CORPUS CHRISTI, GOLDSTONE, MADRID, CANBERRA) UNDER A COORDINATED NETWORK EQUIPMENT EFFORT. IN ADDITION TO DIRECT SUPPORT TO THE NETWORK THESE----

RTOP NO. 150-22-35 TITLE: AUTOMATION AND UTILIZATION OF COMBINED NETWORKS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SHAUGHNESSY, J. P. TEL. 301-982-2357
TECHNICAL SUMMARY

THIS RTOP CARRIES FORWARD CERTAIN LINES OF DEVELOPMENT FOR AUTOMATING STATION EQUIPMENT. RECENT PROGRESS IN THIS AREA HAS CULMINATED IN THE STADAC SYSTEM FOR AUTOMATICALLY CONTROLLING STATION FUNCTIONS USING NEW SAMPLING AND PROCESSING EQUIPMENT, AND IN REAL-TIME COMPRESSION OF HIGH SPEED DATA USING EXISTING EQUIPMENT. THIS RTOP WILL WORK TOWARD AUTOMATION OF OTHER PHASES OF STATION OPERATION, SPECIFICALLY (1) A CONTROL AND DIAGNOSTIC PROGRAM FOR THE AUTOMATED MULTI-FUNCTIONAL RECEIVER, (2) AN ADVANCED SWITCHING

SYSTEM, AND (3) ANALYSIS OF FUTURE NETWORK TESTING REQUIREMENTS. THE BENEFITS ASSOCIATED WITH AUTOMATING THESE FUNCTIONS INCLUDE LIGHTENING THE ON-SITE WORKLOAD, REDUCING TURNAROUND TIME, LOWERING OPERATING COSTS, AND IMPROVING STATION RELIABILITY. THE OBJECTIVE OF THE AMFR CONTROL AND DIAGNOSTIC PROGRAM IS TO ACHIEVE ON-LINE FREQUENCY TUNING OF THE RECEIVER THEREBY ELIMINATING THE PROBLEMS OF FREQUENCY SWEEPING AND SIDELOBE LOCK, AND TO ACHIEVE ON-LINE EVALUATION OF COMPONENT AND SUBSYSTEM STATUS FOR MAINTENANCE PURPOSES. THE OBJECTIVE OF THE ADVANCED SWITCHING SYSTEM IS TO PERMIT REPLACEMENT OF MANUAL PATCHING AND SWITCHING FUNCTIONS WITH PROGRAMMED CONTROL BASED ON A MINIMUM NUMBER OF INPUT PARAMETERS.

RTOP NO. 150-22-36 TITLE: AUTOMATIC DATA HANDLING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: RODGERS, J. C. TEL. 301-982-4123
TECHNICAL SUMMARY

NETWORK IMPROVEMENTS TO MEET THE LARGE INCREASES IN SUPPORT REQUIREMENTS DEMANDED BY NASA'S FUTURE SPACE PROGRAMS SPECIFICALLY INCLUDE THE LINKING OF THE REMOTE GROUND STATIONS BY WIDEBAND (BIT RATES IN EXCESS OF 7.2 KILOBITS/SECOND) DATA COMMUNICATIONS TO GSFC FACILITIES SUCH AS SPACECRAFT CONTROL CENTERS, COMPUTATION FACILITIES, AND CENTRALIZED DATA PROCESSING SYSTEMS. THIS RTOP SHALL STUDY METHODS OF HANDLING THE WIDEBAND DATA ONCE IT ARRIVES AT GSFC AND SHALL RESULT IN TWO END PRODUCTS: (1) A VARIABLE EXERCISABLE COMPUTER SIMULATION OF THE FUTURE DATA HANDLING AND PROCESSING CAPABILITY AT GSFC, AND (2) THE DESIGN OF AN AUTOMATIC DATA DISTRIBUTION SYSTEM LOCATED AT GSFC WITH THE NECESSARY WIDEBAND DATA HANDLING CAPABILITY TO MEET THE INCREASED DATA VOLUME/DATA RATE TRAFFIC OF NASA'S INCREASINGLY COMPLEX SPACECRAFT. THE COMPUTER SIMULATION WILL AID IN DETERMINING THE REQUIREMENTS AND THE DESIGN OF SYSTEMS TO HANDLE AND PROCESS THE DATA AT GSFC. THE SIMULATION WILL ALSO BE AN EVALUATION TOOL TO DETERMINE WHERE BOTTLENECKS OCCUR AND WHAT EFFECT ALTERNATE CHANGES HAVE ON THE OVERALL DATA HANDLING SYSTEM. THE SIMULATION CAN ALSO BE USED IN THE EVALUATION OF EQUIPMENT PROPOSALS. THE AUTOMATIC DATA DISTRIBUTION SYSTEM SHALL INTERFACE WITH THE NASCOM NETWORK, CONCENTRATING ON THE PARTICULAR PROBLEMS INHERENT IN INTERFACING, SWITCHING AND DISTRIBUTING DATA RECEIVED ON CHANNELS OR GROUPS OF CHANNELS EXTENDING BEYOND 7.2 KBS NARROW-BAND. STUDIES SHALL SPECIFY EQUIPMENT REQUIREMENTS AND EQUIPMENT CONFIGURATIONS NEEDED TO INTERFACE THE DISTRIBUTION SYSTEM WITH THE WIDEBAND (WB) CHANNELS SWITCHED BY NASCOM AND WITH OTHER PRESENT AND PLANNED GSFC FACILITIES FOR PROCESSING DATA.

RTOP NO. 150-22-38 TITLE: DATA PROCESSING SYSTEM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: POLAND, W. B., JR. TEL. 301-982-4592
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PROVIDE MEANS FOR IMPROVING THE SPEED, RELIABILITY, OR EFFICIENCY OF DATA PROCESSING OPERATIONS IN GSFC. THE WORK PROPOSED FALLS INTO SIX CATEGORIES: (1) STORAGE

SYSTEM EVALUATION (2) DATA PROCESSING SYSTEM DESIGN STUDIES (3) PROCESSING SYSTEM DISPLAYS (4) ANALYSIS OF DATA PROCESSING SYSTEMS (5) APPLICATIONS PROGRAMMING STUDIES (6) DIGITAL TAPE EVALUATION IN EACH TASK AREA, THE INITIAL PHASE CONSISTS OF IN-HOUSE PROBLEM FORMULATION BY GSFC PERSONNEL. THIS MAY BE FOLLOWED BY IN-HOUSE IMPLEMENTATION OR A PROBLEM-ORIENTED STUDY CONTRACT OR GRANT. IMPLEMENTATION OF SOLUTIONS FOR A PARTICULAR APPLICATION ARE SUPPORTED DIRECTLY BY THE APPROPRIATE PROJECT.

RTOP NO. 150-22-39 TITLE: IMAGE PROCESSING FACILITY PERFORMANCE EVALUATION AND IMPROVEMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SOS, J. Y. TEL. 301-982-4419
TECHNICAL SUMMARY

THE ERTS NASA DATA PROCESSING FACILITY (NDPF) IS CHARACTERIZED BY TWO SIGNIFICANT REQUIREMENTS: (1) HIGH DATA VOLUME (300,000 IMAGES PER WEEK) AND (2) EXTREMELY DEMANDING PERFORMANCE OF THE EQUIPMENT WITHIN NDPF. PROBLEMS RESULTING FROM THE ABOVE REQUIREMENTS THAT NEED ATTENTION ARE: (1) LACK OF EFFICIENT NDPF EQUIPMENT AND IMAGE PRODUCT PERFORMANCE MONITORING TECHNIQUES (2) LACK OF RELATIVELY SIMPLE FILM PROCESSING METHODS AND (3) LACK OF A RESEARCH COMPUTER FOR DEVELOPMENT OF IMAGE PROCESSING TECHNIQUES AND EQUIPMENTS. IT IS PROPOSED TO DEVELOP EFFICIENT PERFORMANCE AND QUALITY MONITORING TECHNIQUES FOR ERTS IMAGE DATA, IMPROVE AND SIMPLIFY PHOTOGRAPHIC PROCESSING TECHNIQUES TO ACHIEVE A BETTER FILM PRODUCT (IN TERMS OF GAMMA LINEARITY, DENSITY UNIFORMITY ACROSS THE FILM SURFACE, ETC.), AND TO OBTAIN A RESEARCH COMPUTER FOR DEVELOPMENT OF IMAGE PROCESSING TECHNIQUES AND EQUIPMENTS.

RTOP NO. 150-22-41 TITLE: SOLID STATE MINITRACK DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SIMAS, V. R. TEL. 301-982-4936
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO DEVELOP A SOLID STATE MINITRACK ELECTRONICS SYSTEM FOR THE PURPOSE OF REPLACING THE EXISTING VACUUM TUBE SYSTEMS WHICH HAVE BEEN IN SERVICE FOR ABOUT TEN YEARS. GOALS ARE THE REDUCTION OF LOGISTIC PROBLEMS, MAINTENANCE COSTS, AND DOWN TIME AS WELL AS IMPROVED ACCURACY AND SENSITIVITY, AUTOMATED OPERATION, REDUCTION IN SIZE AND POWER CONSUMPTION AND LOW OPERATING COSTS. MODERNTECHNIQUES SUCH AS INTEGRATED CIRCUITS, I.F. AND CIRCUITS, IF AND DIGITAL BUILDING BLOCKS, ETC., WILL ENABLE THE 9 RACKS OF VACUUM TUBE ELECTRONICS IN THE EXISTING SYSTEM TO BE REPLACED WITH LESS THAN TWO RACKS OF SOLID STATE CIRCUITRY. IN ADDITION, THE FOLLOWING FUNCTIONAL IMPROVEMENTS WILL BE MADE: 1) THE TIME REQUIRED TO MAKE PHASE MEASUREMENTS WILL BE REDUCED BY A FACTOR OF 25, ELIMINATING A SOURCE OF ERROR THAT CAN AMOUNT TO 25 COUNTS; 2) THE AGC WILL CONTROL EACH COMBINED I.F. CHANNEL INDEPENDENTLY; 3) TUNING ACCURACY WILL BE IMPROVED TO ONE PART IN 10 TO THE 10TH POWER BY AN IMPROVED SYNTHESIZER; 4) CROSSTALK BETWEEN CHANNELS WILL BE REDUCED TO AN INSIGNIFICANT LEVEL; 5) THE RECEIVER

WILL BE SET UP, CALIBRATED AND OPERATED COMPLETELY AUTOMATICALLY; 6) THE POST DETECTION PASSIVE FILTER WILL BE REPLACED BY AN ACTIVE FILTER WHICH WILL ELIMINATE ERRORS AND PROBLEMS ASSOCIATED WITH COMPENSATING THE DATA FOR THE PASSIVE FILTER TIME DELAY.

RTOP NO. 150-22-42 TITLE: FREQUENCY STANDARD SOURCES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: PETERS, H. E. TEL. 301-982-4948
TECHNICAL SUMMARY

THE GOAL OF THIS TASK IS TO PROVIDE FIELD OPERABLE STANDARD SIGNAL SOURCES WHICH ARE RELATIVELY SIMPLE, ECONOMICAL, RUGGED, RELIABLE, AND LONG LIVED, WHILE IMPROVING THE SIGNAL QUALITY TO THE EXTENT THAT SIGNAL SOURCE STABILITY WILL NO LONGER BE A SIGNIFICANT LIMITING FACTOR IN USE. FOR RADIO INTERFEROMETRY, DEEP SPACE TRACKING, AND GEODESY, THE GOAL IS FRACTIONAL STABILITIES OF TEN TO THE MINUS 13TH POWER, TEN TO THE MINUS 15TH POWER, AND TEN TO THE MINUS 14TH POWER FOR MEASURING TIMES OF ONE SECOND, 10,000 SECONDS RESPECTIVELY. FOR TIMING AND NAVIGATION, THE GOAL IS A FREQUENCY REPRODUCIBILITY OF TEN TO THE MINUS 14TH POWER, WHICH WILL MAINTAIN WORLD WIDE TIME SYNCHRONIZATICN TO BETTER THAN ONE MICROSECOND FOR SEVERAL YEARS. FOR GREATER INTERNATIONAL UNIFORMITY OF TIME SCALES, THE GOAL OF ACCURACY TO TEN TO THE MINUS 14TH POWER BASED ON A NEW HYDROGEN STANDARD WILL PROVIDE A FACTOR OF 50 IMPROVEMENT OVER THE BEST PRESENT LABORATORY STANDARDS, WITH A CORRESPONDING REDUCTION IN PRESENTLY REQUIRED INTERCONTINENTAL COMPARISONS AND SYNCHRONIZATIONS. TYPICAL OF THE NEW PROPOSED TYPE OF FIELD OPERABLE STANDARDS IS THE NASA/GSFC NP PROTOTYPE HYDROGEN MASER STANDARDS WHICH HAVE SUCCESSFULLY COMPLETED SEVERAL YEARS OF FIELD TRIALS. TO ATTAIN THE PRESENT GOALS, WORK WILL BE DIRECTED TO IMPROVEMENTS IN THE NP STANDARDS, AND TO REALIZATION OF A NEW HYDROGEN BEAM STANDARD OF EXCEPTIONAL ACCURACY. IN HYDROGEN MASERS, IMPROVEMENTS IN MAGNETIC SHIELDING, SOURCES, BEAM OPTICS, AND CAVITY STABILIZATION IS PLANNED TO PROVIDE IMPROVED MASER BASED STANDARDS FOR FIELD EVALUATION IN 1973. IN HYDROGEN BEAM TUBES, LOW VELOCITY SOURCES & EFFICIENT DETECTOR DEVELOPMENT----

RTOP NO. 150-22-45 TITLE: UNIFIED INFORMATION SUBSYSTEM DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: TREVATHAN, C. E. TEL. 301-982-5376
TECHNICAL SUMMARY

THE GOAL IS TO IMPROVE THE OVERALL SPACECRAFT-GROUND CAPABILITY IN THE HANDLING OF DATA (INFORMATION) ORIGINATING FROM SENSORS & EXPERIMENTS ON THE SPACECRAFT WITH THE FURTHER OBJECTIVE OF ACHIEVING HIGHER RELIABILITY & EFFICIENCY LEADING TO A SIGNIFICANTLY LOWER OVERALL COST OF THE DATA ACQUISITION & PROCESSING FOR A WIDE VARIETY OF MISSIONS. THE SPECIFIC TECHNICAL OBJECTIVE IS TO DEVELOP A UNIFIED, SEMI-AUTOMATED, COMPUTER CONTROLLED, TELEMETRY DATA-HANDLING SUBSYSTEM TO BE FLOWN ON SPACECRAFT, WHICH WILL MAKE USE OF DATA-ENCODING, REDUNDANCE REDUCTION, CENTRAL PROCESSING, DATA STORAGE, & ASYNCHRONOUS OPERATION, TO MAXIMIZE THE TRANSFER OF

"INFORMATION". ESSENTIAL TO THIS GOAL IS OPTIMIZATION OF THE STORAGE MEDIA AND ON-BOARD PROCESSING SYSTEMS TO PROVIDE AN EFFICIENT MATCH WITH THE DATA VOLUME TO BE PROCESSED, STORED AND TRANSMITTED & THE DELINEATION AND DESIGN OF THE ASSOCIATED GROUND SUPPORT EQUIPMENT.

RTOP NO. 150-22-46 TITLE: UNIFIED SPACECRAFT RADIO FREQUENCY SUBSYSTEM DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BLOCK, A. F. TEL. 301-982-4158
TECHNICAL SUMMARY

THIS PROGRAM PROVIDES IMPROVED TRACKING, TELEMETRY, AND COMMAND EQUIPMENT FOR SPACE FLIGHT PROGRAMS. IT DEVELOPS DESIGNS WHICH DUE TO VERSATILITY ARE APPLICABLE TO LARGE SPACECRAFT REQUIRING HIGH POWER, WIDE BAND TRANSMITTERS AS WELL AS SMALLER PAYLOADS HAVING MODEST SIZE, WEIGHT, AND POWER BUDGETS. THIS IS ACHIEVED BY: 1. DEVELOPING NEW COMPONENTS TO PROVIDE EXTENDED COMMUNICATION ABILITIES. ONE EXAMPLE OF THIS IS THE PROGRAM TO DEVELOP NEW TRANSISTORS WITH IMPROVED POWER AND FREQUENCY CAPABILITY. 2. IMPROVING CIRCUIT DESIGN OR CIRCUIT EFFECTIVENESS THROUGH FABRICATION TECHNIQUE AND COMPONENT APPLICATION. LOW NOISE PREAMPLIFIERS AND STABILIZED OSCILLATORS ARE TYPICAL OF THIS TYPE EFFORT. 3. DESIGNING COMPLETE SYSTEMS. THIS IS EXEMPLIFIED BY THE PRESENT EFFORT WHICH WILL PRODUCE A TRANSPONDER WITH COMMAND, TELEMETRY, AND TRACKING CAPABILITY INTO ANY OF THE SEVERAL NASA NETWORKS (DSN, MSFN, AND STADAN). THIS WORK IS DONE BOTH IN-HOUSE AND ON CONTRACT. IT PROVIDES ASSEMBLY DESIGN AND PROTOTYPE FABRICATION. WITH THE MODULAR CONCEPT, POWER AMPLIFIERS CAN BE ADDED TO THE BASIC ONE-HALF WATT OUTPUT TRANSPONDER TO PRODUCE OUTPUTS OF TEN WATTS AT S-BAND. THE INCREASED DESIRE BY LARGE----

OFFICE OF SPACE SCIENCE & APPLICATIONS

RTOP NO. 160-20-51 TITLE: SPACECRAFT SYSTEMS AND TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: FLAHERTY, J. B. TEL. 301-982-6862
TECHNICAL SUMMARY

STUDIES OF COMPLETE SPACECRAFT AND THE DEVELOPMENT OF SELECTED SPACECRAFT SUBSYSTEMS WILL BE UNDERTAKEN IN SUPPORT OF FUTURE NASA EARTH OBSERVATION PROGRAMS. BOTH SYNCHRONOUS AND LOW-ORBITING SPACECRAFT REQUIREMENTS WILL BE CONSIDERED AS APPLICABLE DURING THE COURSE OF THE STUDIES. SPECIFIC SPACECRAFT SUBSYSTEM ELEMENTS, SUCH AS CONTROLS, COMMAND AND TELEMETRY ANTENNAS, AND CRYO COOLERS WILL BE INVESTIGATED AS PART OF THIS EFFORT FOR THE PURPOSE OF SUPPLYING THE REQUISITE ADVANCED TECHNOLOGY TO MESH WITH FOLLOW-ON SPACECRAFT AND SUBSYSTEMS. THE THRUST OF THESE STUDIES AND DEVELOPMENTS WILL BE TO IMPROVE THE SPACECRAFT CAPABILITY TO HANDLE HIGHER RESOLUTION SENSORS. IN ADDITION, CRYOGENIC COOLERS FOR USE WITH ADVANCED SPACECRAFT SENSORS WILL BE DEVELOPED. THESE ADVANCED EFFORTS WILL BE POINTED TO DEVELOPING THE REQUISITE TECHNOLOGY FOR SUCH ADVANCED PROGRAMS AS EOS AND ADVANCED SMS, AS WELL AS THE TECHNOLOGY REQUIRED FOR ADVANCED EARTH OBSERVATION SENSORS TO BE FLOWN ON FOLLOW-ON ATS SPACECRAFT. METHODS OF CONTROL WILL BE STUDIED TO DECREASE THE JITTER ON THE SPACECRAFT AND TO DECREASE THE SPACECRAFT RATES IN BOTH LOW AND SYNCHRONOUS ORBIT. THE HIGH ALTITUDE CAUSES LARGE GROUND MOTIONS TO OCCUR FOR SMALL SPACECRAFT MOTIONS. SCANNING STEP MIRRORS INTERACT WITH THE SPACECRAFT CAUSING DECREASED RESOLUTION. SCANNER DYNAMICS WILL ALSO BE STUDIED. A CRYOGENIC COOLER WILL BE DEVELOPED TO ENABLE SPACECRAFT FLEXIBILITY IN THE PLACEMENT OF RADIOMETERS. PASSIVE COOLING REQUIRES AN ANTI-SUN POSITION FOR THE SPACECRAFT.

RTOP NO. 160-20-52 TITLE: ON-BOARD DATA MANAGEMENT, STORAGE AND PROCESSING INSTRUMENTATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MAXWELL, M. TEL. 301-982-4036
TECHNICAL SUMMARY

THE NEXT GENERATION OF EARTH OBSERVATION SPACECRAFT WILL GENERATE LARGE QUANTITIES OF DATA. THIS RTOP WILL INVESTIGATE AND DEVELOP SYSTEMS THAT WILL PROVIDE THE NEEDED SPACECRAFT AND GROUND DATA SYSTEMS TO ACQUIRE, PROCESS, STORE AND DISPLAY THIS VERY HIGH RESOLUTION DATA. TECHNIQUES WILL BE DEVELOPED TO OPTIMIZE THE DATA ACQUISITION AND THEN REDUCE THE AMOUNT OF DATA THAT MUST BE STORED IN THE SPACECRAFT. THIS WILL BE DONE USING HIGH SPEED MULTIPLEXERS AND MULTISPECTRAL REDUNDANCY REDUCTION TECHNIQUES. APPROPRIATE STORAGE AND BUFFERING SYSTEMS ARE BEING DEVELOPED USING BOTH MAGNETIC TAPE RECORDERS AND OTHER MASS DATA STORAGE TECHNIQUES. ON-BOARD PROCESSING SYSTEMS TO IMPROVE DATA ACQUISITION ARE ALSO BEING INVESTIGATED. GROUND SYSTEMS TO BE DEVELOPED INCLUDE SMALL RECEIVING SITE SYSTEMS FOR ERS DATA, WITH THEIR ASSOCIATED STORAGE AND DISPLAY SYSTEMS. HIGH RESOLUTION DISPLAYS COMPATIBLE WITH THE ADVANCED SENSORS WILL BE DEVELOPED. THE IMPLICATIONS OF USER DIGITAL GROUND DATA PROCESSING OF DATA FROM A MULTISPECTRAL CONIC SCANNER WHICH ACQUIRES DATA ALONG A CURVED ARC WILL BE STUDIED. CLOSE LIAISON WILL BE MAINTAINED WITH RTOP 160-20-53 TO ASSURE COMPATIBILITY WITH ADVANCED SENSOR DEVELOPMENT, AND WITH RTOP 160-75-53 TO ASSURE

COMPATIBILITY WITH THE ERTS GROUND DATA PROCESSING DEVELOPMENTS. THERE WILL ALSO BE COORDINATION WITH THE EOS ADVANCED STUDIES RTOP'S.

RTOP NO. 160-20-52 TITLE: DATA MANAGEMENT AND STORAGE
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

ADVANCED DATA MANAGEMENT AND PROCESSING SYSTEM TECHNOLOGY WILL BE DEVELOPED TO SATISFY FUTURE EARTH SATELLITE REQUIREMENTS. THE FOCUS OF THE ACTIVITY WILL BE TO DEVELOP PRELIMINARY DESIGN OF A COMPUTER AIDED TELEMETRY SYSTEM, AN ADAPTIVE, HIGH-PERFORMANCE TELEVISION DATA COMPRESSOR, AND A RELIABLE, FLEXIBLE MASS DATA STORAGE DEVICE. IT IS PLANNED TO DEMONSTRATE THE FEASIBILITY AND UTILITY OF THESE DESIGNS BY THE END OF FISCAL YEAR '73. THESE ADVANCED DEVELOPMENT ACTIVITIES WILL BE PERFORMED IN-HOUSE BY PERSONNEL WHO HAVE DEVELOPED INNOVATIVE SOLUTIONS TO SIMILAR PROBLEMS RELATED TO ADVANCED PLANETARY MISSIONS.

RTOP NO. 160-20-53 TITLE: EARTH OBSERVATION SENSOR TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: OSTROW, H. TEL. 301-982-4107
TECHNICAL SUMMARY

IMAGING SYSTEMS WITH ADVANCED PERFORMANCE CAPABILITY ARE REQUIRED FOR FUTURE EARTH OBSERVATION MISSIONS. SYSTEMS WITH INCREASED SPATIAL AND SPECTRAL RESOLUTION, RESPONSE INTO THE EMISSIVE IR ALONG WITH INHERENT REGISTRATION BETWEEN SPECTRAL CHANNEL ARE REQUIRED. THE DESIRED CHARACTERISTICS CAN BE ACHIEVED BY DEVELOPMENT OF SUITABLE NEW SENSORS, SUCH AS LARGE PHOTOSENSOR LINE ARRAYS. SOLID STATE LINEAR ARRAYS CAN BE FABRICATED WITH NOMINALLY 10,000 ELEMENTS. WITH MULTIPLE ARRAYS REGISTERED HIGH SPATIAL RESOLUTION IMAGES CAN BE OBTAINED WITHOUT USING MECHANICAL SCANNING TECHNIQUES. LINE SCAN SENSORS USING ELECTRON BEAM READOUT TECHNIQUES CAN ALSO BE PRODUCED, ELIMINATING THE NEED TO MAKE ELECTRICAL CONTACT WITH EACH DETECTOR ELEMENT. SCANNING SPECTRORADIOMETERS CAN PROVIDE RADIOMETRICALLY ACCURATE DATA FROM THE VISIBLE THROUGH THE EMISSIVE IR REGION, BUT ADDITIONAL DEVELOPMENT IS REQUIRED IN THE AREA OF DETECTOR TECHNOLOGY AND COOLERS TO ACHIEVE HIGH RESOLUTION AT HIGH SIGNAL-TO-NOISE RATIO. OTHER ADVANCED IMAGE SENSOR TECHNIQUES APPEAR APPLICABLE. ONE TECHNIQUE USES AN OPTICAL FILTER WHICH ENCODES EACH SPECTRAL BAND INTO A DISCRETER AND SEPARABLE CHANNEL IN THE FREQUENCY DOMAIN. THIS TECHNIQUE IS NOW BEING USED IN SOME GROUND BASED APPLICATIONS AND PROVIDES INHERENTLY PERFECT REGISTRATION.THE EXTENSION OF THE TECHNIQUE TO EARTH OBSERVATION SYSTEMS WILL BE PURSUED.

RTOP NO. 160-20-54 TITLE: MICROWAVE RADIOMETRY FOR REMOTE SENSING
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO IMPROVE THE REMOTE SENSING CAPABILITY OF MICROWAVE DEVICES. THE GENERAL APPROACH IS TO INVESTIGATE THE APPLICATION OF PASSIVE RADIOMETRY FOR OBTAINING EARTH RESOURCE MEASUREMENT WITH EMPHASIS IN THE AREA OF OCEANOGRAPHY. RESEARCH IS FOCUSED ON IMPROVING THE ANALYSIS AND INTERPRETATION OF DATA AS WELL AS IMPROVEMENTS IN HARDWARE CAPABILITY. THIS WILL REQUIRE THE VALIDATION OF ANALYTICAL MODELS FOR INFERRING PHYSICAL PROPERTIES FROM THE MEASUREMENT OF SCATTERING AND EMISSIONS FROM ROUGH SURFACES SUCH AS THE OCEAN, AND THE IMPROVEMENT OF THE STATE-OF-THE-ART OF KEY COMPONENTS IN THE MICROWAVE AND MILLIMETER WAVE RADIOMETERS FOR SPECIFIC FLIGHT APPLICATIONS. THE SCOPE OF THE WORK INCLUDES THE COMPUTER MODELING, CONSTRUCTION, AND MEASUREMENT OF SIMULATED ROUGH OCEAN SURFACES, AND EXPERIMENTAL WORK USING WAVE TANKS AND REMOTE STATIONS SUCH AS THE BUZZARD'S BAY BRIDGE AND AIRBORNE PLATFORMS. ALSO INCLUDED ARE THE DEVELOPMENT OF SOLID STATE OSCILLATORS, IMAGE LINE INTEGRATED CIRCUITS, AND LOW NOISE ANTENNAS TO IMPROVE RADIOMETER INSTRUMENT PERFORMANCE IN SUPPORT OF BOTH EXPERIMENTAL MEASUREMENT AND FLIGHT APPLICATION PROGRAMS.

RTOP NO. 160-20-54 TITLE: MICROWAVE TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ADVANCE THE STATE OF THE ART IN MICROWAVE AND MILLIMETER WAVE RADIOMETERS, RADIOMETER COMPONENTS, AND RADIOMETER AND RADIOMETER ANTENNAS, FOR SPACECRAFT APPLICATIONS. RADIOMETER COMPONENTS, SUCH AS RF SWITCHES, LOW NOISE MIXERS AND SOLID STATE LOCAL OSCILLATORS WILL BE INVESTIGATED FOR SPACECRAFT APPLICABILITY AND IMPROVED AS NECESSARY. ENVIRONMENTAL AND LIFE TEST METHODOLOGY WILL BE DEVELOPED AND ACTUAL TESTS ON TYPICAL OR SPECIFIC COMPONENTS AND SUBSYSTEMS WILL BE PERFORMED. HIGH PERFORMANCE ANTENNAS OF VARIOUS CONFIGURATIONS AND ESPECIALLY OF THE SCANNING PHASED ARRAY VARIETY, WILL BE INVESTIGATED AND SELECTED BREADBOARDS DEVELOPED AND EVALUATED, BOTH FROM THE ELECTRICAL AND THE ENVIRONMENTAL POINTS OF VIEW. SPECIFIC HIGH PERFORMANCE, HIGH RESOLUTION AND HIGH STABILITY RADIOMETER DESIGNS WILL BE INVESTIGATED AND BREADBOARDS DEVELOPED AND EVALUATED. THE MAJOR PART OF THIS EFFORT WILL BE PERFORMED BY INDUSTRY UNDER R & D CONTRACTS.

RTOP NO. 160-20-56 TITLE: ATMOSPHERIC POLLUTION SENSING:
HETERODYNE RADIOMETRY AND SPECTROSCOPY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THIS RTOP DEVELOPS SENSING SYSTEMS WHICH USE INFRARED LASERS FOR THE REMOTE MONITORING OF ATMOSPHERIC POLLUTANTS FROM AIRCRAFT AND

SPACECRAFT ALTITUDES. THESE SYSTEMS ARE TO BE CAPABLE OF A VARIETY OF ATMOSPHERIC MEASUREMENTS, SOME OF WHICH ARE NOT POSSIBLE USING PASSIVE RADIOMETERS OR SOLAR ABSORPTION SPECTROMETERS. IN ADDITION, LABORATORY MEASUREMENTS WILL BE UNDERTAKEN TO DETERMINE SPECTROSCOPIC LINE STRENGTHS AND LINE WIDTHS OF VARIOUS POLLUTANT MOLECULES. THE INITIAL INSTRUMENT WILL BE A HETERODYNE RADIOMETER USING A CARBON DIOXIDE LASER AS THE LOCAL OSCILLATOR. THE HETERODYNE RADIOMETER RESPONDS VERY SENSITIVELY TO A SMALL WAVELENGTH INTERVAL AROUND THE LOCAL OSCILLATOR WAVELENGTH. THIS INTERVAL IS NEARLY EQUAL TO AN ATMOSPHERIC PRESSURE-BROADENED MOLECULAR LINEWIDTH. THUS, IF THE LOCAL OSCILLATOR WAVELENGTH OVERLAPS AN EMISSION LINE OF A PARTICULAR MOLECULE, THE RADIOMETER WILL RESPOND SELECTIVELY TO THE PRESENCE OF THIS CONSTITUENT. SUCH SPECTRAL OVERLAPS BETWEEN CO2 LASER LINES AND THERMAL EMISSION LINES OF SUCH POLLUTANTS AS NH3, SO2, O3, C2H4, CO AND NO HAVE ALREADY BEEN IDENTIFIED. THESE OVERLAPS MAKE THE HETERODYNE RADIOMETER ATTRACTIVE AS A VERY SELECTIVE DETECTOR OF VARIOUS ATMOSPHERIC CONSTITUENTS. THE GOALS FOR FY'72 ARE TO DEMONSTRATE THE EFFECTIVENESS OF THIS INSTRUMENT WITH GROUND BASED OBSERVATIONS; TO STUDY THE FEASIBILITY OF USING OTHER LASER LOCAL OSCILLATOR SOURCES IN HETERODYNE RECEIVERS, SUCH AS THE CO LASER AND THE PBSNTE DIODE LASER; AND TO BEGIN DEVELOPMENT OF AN INSTRUMENT SUITABLE FOR USE IN AIRCRAFT OR SPACECRAFT. THE HETERODYNE RADIOMETER WILL ALSO BE USEFUL IN GROUND-BASED REMOTE----

RTOP NO. 160-20-60 TITLE: SURFACE MOTION MONITOR
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE IS TO MEASURE THE MOTION OF A SURFACE WITH RESPECT TO BENCHMARKS BY USING COHERENT RADAR TECHNIQUES. TWO AREAS THAT ARE OF PARTICULAR INTEREST ARE THE ICE AREAS IN GREENLAND AND THE REGION COVERED BY THE ALASKAN PIPE LINES, AND THESE AREAS CAN BE USED TO ESTABLISH THE DEGREE OF PRACTICALITY OF THE SYSTEM. THE AREAS OF INTEREST WILL BE IMAGED BY THE JPL 25 CM RADAR AND THE IMAGERY WILL SHOW THE LARGE SCATTERERS BURIED BENEATH THE SURFACE OF SNOW. THE POSITION OF THESE SCATTERERS WILL BE CHECKED FOUR TIMES DURING THE COURSE OF A YEAR. THIS MEASUREMENT USES THE IMAGING PROPERTIES OF THE COHERENT RADAR. SEVERAL LUNEBERG LENS REFLECTORS WILL BE PLACED ON THE SURFACE, SOME LOCATED ON MOUNTAINS OR REGIONS NOT EXPECTED TO MOVE TO SERVE AS REFERENCE POSITIONS. THE OTHERS WILL BE PLACED ON ICE FIELDS, PERMAFROST AREAS, GLACIAL AREAS OR SLIDE AREAS. THE RELATIVE LOCATION OF THESE REFLECTORS WILL THEN BE MEASURED TO WITHIN A FRACTION OF A WAVELENGTH DURING THE FOUR OVER-FLIGHTS DURING THE YEAR. THESE MEASUREMENTS WILL NOT BE AFFECTED BY SNOW COVER, CLOUD COVER OR WEATHER.

RTOP NO. 160-20-61 TITLE: MICROWAVE STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

JPL SHALL PROVIDE TECHNICAL ADVICE AND CONSULTATION SERVICES TO NASA HEADQUARTERS AND MSC IN THE FIELD OF MICROWAVE RADIOMETRY RELATING TO THE REMOTE SENSING OF EARTH RESOURCES. JPL SHALL CONDUCT SCIENTIFIC AND TECHNICAL RESEARCH, AND PERFORM EXPERIMENTAL PROGRAMS FOR FURTHERING THE APPLICATIONS OF PASSIVE MICROWAVE TECHNIQUES TO THE REMOTE SENSING OF EARTH RESOURCES. SPECIFICALLY, JPL WILL STUDY MICROWAVE PROPERTIES OF GEOLOGIC MATERIALS AT WAVELENGTHS OF 0.95, 2.8 AND 21 CM. THIS STUDY WILL INCLUDE ANALYTIC MODELING AND QUANTITATIVE DETERMINATION OF PHYSICAL PARAMETERS THROUGH CONTROLLED EXPERIMENTS. THESE STUDIES WILL BE PERFORMED IN CONJUNCTION WITH THE UNIVERSITY OF NEVADA. JPL WILL SUPPLY CONSULTING AND TECHNICAL ASSISTANCE TO SEVERAL SELECT UNIVERSITY GROUPS CURRENTLY FUNDED BY NASA TO PERFORM RESEARCH IN REMOTE SENSING. TECHNICAL SERVICES ARE PROVIDED THROUGH MEMBERSHIP IN APPROPRIATE COMMITTEES, AND PARTICIPATION IN MEETINGS AND SEMINARS CALLED BY NASA AND ITS AGENCIES. GROUND BASED MICROWAVE RADIOMETRIC STUDIES OF GEOLOGIC MATERIALS WILL BE PERFORMED USING EXISTING EQUIPMENT, INCLUDING VAN DUAL POLARIZED RADIOMETERS AND REAL TIME DATA REDUCTION SYSTEM. FREQUENCY SCAN APPROACHS MAY BE PURSUED AT L-BAND (1-2 GHZ). SEVERAL UNIVERSITIES WILL BE SUPPORTED BY LENDING THEM RADIOMETERS ON AN AS-AVAILABLE BASIS AND PROVIDING LIMITED SUPPORT WITH THE MICROWAVE RADIOMETER GROUND-BASED EQUIPMENT.

RTOP NO. 160-44-51 TITLE: TECHNIQUES FOR UTILIZING SATELLITE OBSERVATIONS IN METEOROLOGICAL APPLICATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: WEXLER, R. TEL. 301-982-2188
TECHNICAL SUMMARY

THE OBJECTIVE IS TO APPLY SATELLITE OBSERVATIONS TO THE QUANTITATIVE MEASUREMENTS OF METEOROLOGICAL PHENOMENA. SPECIFICALLY, THE SATELLITE DATA ARE APPLIED TO DETERMINE SEA SURFACE TEMPERATURE, VERTICAL DISTRIBUTION OF ATMOSPHERIC TEMPERATURE, HUMIDITY, AND OZONE, AND CLOUD MOTIONS (WINDS) FROM GEOSTATIONARY SATELLITES. APPLICATIONS OF THESE DERIVED PARAMETERS MAY THEN BE MADE TO STUDIES OF MESOSCALE SYSTEMS, PLANETARY SCALE PHENOMENA STRATOSPHERIC CIRCULATION, THE RADIATION HEAT BUDGET AND CLIMATIC CHANGE. SPECIAL FOCAL POINTS OF THIS RESEARCH ARE THE ESTABLISHMENT OF A BASIS FOR THE SPECIFICATION OF THE REMOTE SENSING PART OF THE GLOBAL METEOROLOGICAL OBSERVING SYSTEM OF THE 1970'S REQUIRED FOR LARGE-SCALE, LONG-TERM WEATHER FORECASTS (VIZ. THE GLOBAL ATMOSPHERIC RESEARCH PROGRAM - GARP), AND, SIMILARLY, THE ESTABLISHMENT OF A BASIS FOR THE SPECIFICATION OF A SYSTEM FOR CONTINUOUS OBSERVATIONS OF WEATHER FEATURES SO THAT THESE OBSERVATIONS CAN BE APPLIED TO SHORT-TERM WEATHER FORECASTS.

RTOP NO. 160-44-52 TITLE: STUDIES IN THE APPLICATION OF METEOROLOGICAL SATELLITE DATA TO FORECASTING THE GENERAL CIRCULATION

ORGANIZATION: GODDARD INSTITUTE FOR SPACE STUDIES

MONITOR: JASTROW, R. TEL. 212-866-3200

TECHNICAL SUMMARY

THIS PROGRAM USES NUMERICAL MODELING EXPERIMENTS FOR THE OPTIMIZATION OF SATELLITE OBSERVING SYSTEMS WITH THE AIM OF EXTRACTING MAXIMUM METEOROLOGICAL INFORMATION FROM SPACE-BORNE SENSORS. THE PROGRAM INCLUDES: (1) LONG-RANGE FORECASTS AND CLIMATOLOGY: STUDIES ON THE UTILIZATION OF SATELLITE DATA INCLUDING HEAT BUDGET DATA FOR LONG-RANGE, SEASONAL AND CLIMATOLOGICAL PREDICTIONS; (2) MODELING RESEARCH: STUDIES OF BASIC ATMOSPHERIC PROCESSES ENTERING INTO NUMERICAL MODELS OF THE ATMOSPHERE, INCLUDING PROCESSES OF MOIST CONVECTION LATERAL EDDY TRANSPORT, BOUNDARY LAYER PHENOMENA AND RADIATIVE TRANSFER; (3) COMPUTATIONAL RESEARCH: INCLUDING RESEARCH ON NUMERICAL METHODS FOR SOLVING ATMOSPHERIC EQUATIONS, AND ON DEVELOPMENTS IN COMPUTING SOFTWARE AND HARDWARE DESIGNED FOR SPECIALIZED APPLICATION TO THE EQUATIONS OF ATMOSPHERIC DYNAMICS.

RTOP NO. 160-44-53 TITLE: REMOTE SENSING TECHNIQUES FOR ATMOSPHERE STRUCTURE AND SURFACE CONDITION RELEVANT TO METEOROLOGY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HOVIS, W. A. TEL. 301-982-6465

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP AND TEST TECHNIQUES FOR REMOTE SENSING OF THE ATMOSPHERE, INCLUDING SUSPENDED PARTICULATE MATTER AND SURFACE INTERFACE CONDITIONS SUCH AS SEA SURFACE TEMPERATURE AND SOIL MOISTURE CONTENT PERTINENT TO METEOROLOGY. STUDIES OF CLOUD PHYSICAL PARAMETERS SUCH AS PHASE; I.E. ICE OR WATER, PARTICLE SIZE, PARTICLE SIZE DISTRIBUTION AND POSSIBLY PARTICLE SHAPE ARE BEING CARRIED OUT USING RADIOMETRIC AND POLARIMETRIC STUDIES OF SOLAR ENERGY REFLECTED OFF CLOUD TOPS. IN CONJUNCTION WITH THE REMOTE SENSING OF CLOUDS, IN SITU MEASUREMENTS ARE CARRIED OUT WITH A LASER NEPHELOMETER TO MAKE PARTICLE SIZE AND SIZE DISTRIBUTION MEASUREMENTS TO VERIFY AND CALIBRATE THE RESULTS OBTAINED WITH THE REMOTE SENSING INSTRUMENTS. INTERFACE MEASUREMENTS, OF SURFACE CONDITIONS PERTINENT TO METEOROLOGY, ARE CARRIED OUT IN THE MICROWAVE AND INFRARED REGION OF THE SPECTRUM. MEASUREMENT OF SOIL MOISTURE CONTENT WITH MICROWAVE RADIOMETERS AND OPTICAL POLARIMETERS AND MEASUREMENTS OF SEA SURFACE TEMPERATURES WITH INFRARED AND MICROWAVE INSTRUMENTS ARE DEVELOPED AND TESTED AS A PRELUDE TO FLIGHT OF SIMILAR EXPERIMENTS ON APPLICATIONS SPACECRAFT.

RTOP NO. 160-44-54 TITLE: RADIATIVE TRANSFER MODELS RELATING TO ATMOSPHERE AND SURFACE CHARACTERISTICS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: FRASER, R. TEL. 301-982-4235
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE RADIATIVE CHARACTERISTICS OF GASEOUS AND PARTICULATE CONSTITUENTS OF THE ATMOSPHERE AND OF NATURAL SURFACES. LABORATORY MEASUREMENTS, INVOLVING ABSORPTION TUBES, WILL BE MADE TO STUDY THE RADIATIVE PROPERTIES OF THE OPTICALLY ACTIVE GASES. THEORETICAL ANALYSES OF SPECTRAL LINE INTENSITIES, POSITIONS, AND SHAPES WILL BE MADE IN CONJUNCTION WITH THE EXPERIMENTAL MEASUREMENTS. AN INFRARED INTERFEROMETER SPECTROMETER (IRIS) WILL BE FLOWN ALOFT BY MEANS OF A HIGH ALTITUDE BALLOON AND INFRARED SPECTRA WILL BE OBTAINED WITH A RESOLUTION OF 0.2 WAVENUMBERS IN THE SPECTRAL REGION 4-50 MICROMETERS. THESE MEASUREMENTS WILL BE USED TO INVESTIGATE RADIATIVE PROPERTIES OF THE SURFACE OF THE EARTH AND OF OPTICALLY ACTIVE GASES AND PARTICULATES IN THE ATMOSPHERE. A MICROWAVE RADIOMETER MOUNTED ON AIRCRAFT OR HIGH ALTITUDE BALLOON WILL MEASURE RADIANCES AT SELECTED WAVELENGTHS NEAR 5 MM OVER DIFFERENT KINDS OF TERRAIN AND THROUGH A VARIETY OF CLOUDS. THESE STUDIES WILL PROVIDE THE PHYSICAL BASIS FOR REMOTELY SOUNDING THE ATMOSPHERE AND FOR SENSING CHARACTERISTICS OF THE SURFACE BOUNDARY SUCH AS LAND AND SEA SURFACE TEMPERATURES, SOIL MOISTURE, ETC.

RTOP NO. 160-44-55 TITLE: ANALYSIS OF ENERGY INTERACTIONS BETWEEN DIFFERENT LEVELS OF THE ATMOSPHERE AND SOLAR-TERRESTRIAL RELATIONSHIPS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HEATH, D. F. TEL. 301-982-6421
TECHNICAL SUMMARY

THE OBJECTIVES ARE THE STUDY OF THE INTERACTIONS OF MECHANICAL, RADIATIONAL AND CHEMICAL ENERGIES BETWEEN THE LOWER AND UPPER REGION OF THE ATMOSPHERE, AND THE MEASUREMENT OF SOLAR ENERGY WHICH IS SUBSEQUENTLY ABSORBED AND SCATTERED BY THE OZONOSPHERE, MESOSPHERE, AND LOWER THERMOSPHERE. THE AREAS OF INVESTIGATION INCLUDE: GRAVITY WAVES, TIDES, AND TURBULENCE ORIGINATING IN THE LOWER ATMOSPHERE; THE MEASUREMENT WITH HIGH ABSOLUTE ACCURACY OF THE ULTRAVIOLET SOLAR FLUX, ATMOSPHERIC SCATTERING, ABSORPTION AND EMISSION RESULTING FROM CHEMICAL AND PHOTOCHEMICAL REACTION IN THE UPPER ATMOSPHERE; AND THE HORIZONTAL AND VERTICAL TRANSPORT PROCESSES. EXISTING SOUNDING ROCKET SATELLITE, AND GROUND BASED OBSERVATION TECHNIQUES WILL BE EMPLOYED, AND NEW TECHNIQUES WILL BE DEVELOPED TO OBSERVE THE THERMODYNAMIC STRUCTURE, CIRCULATION, AND COMPOSITION OF THE STRATOSPHERE-MESOSPHERE-LOWER THERMOSPHERE REGIONS.

RTOP NO. 160-44-56 TITLE: EARTH OBSERVATIONS LABORATORY, FIELD EXPERIMENTS AND CALIBRATION OF RADIATION SENSORS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HOVIS, W. A. TEL. 301-982-6465
TECHNICAL SUMMARY

THE OBJECT OF THIS EFFORT IS TO CARRY OUT LABORATORY AND FIELD TESTS OF METEOROLOGICAL SENSORS TO TEST PERFORMANCE, DETERMINE CALIBRATION ACCURACY AND TO VERIFY THE SYSTEM CONCEPT IN TESTS CLOSELY SIMULATING THE CONDITIONS TO BE ENCOUNTERED IN SPACECRAFT SENSING. IN THE MICROWAVE REGION OF THE SPECTRUM THE EMISSIVITIES OF NATURAL SURFACES WILL BE DETERMINED TOGETHER WITH DEVELOPMENT OF NEW COMPONENTS AND NEW CALIBRATION TECHNIQUES. MICROWAVE RADIOMETERS AT SEVERAL FREQUENCIES WILL BE USED TO STUDY THE DISTINGUISHABLE FEATURES OF MATERIALS SUCH AS WATER, ICE, DRY SOIL, SWAMPS, DENSE VEGETATION, CLOUDS AND RAINFALL. DEVELOPMENT OF NEW TECHNIQUES IN THE AREA OF SENSOR COMPONENTS SUCH AS IMPROVED DETECTORS ARE CARRIED OUT IN THIS AREA AND TESTED IN BREADBOARD UNITS TO VERIFY APPLICABILITY TO FUTURE SPACEFLIGHT MISSIONS. A SPACE SIMULATING CALIBRATION FACILITY IS MAINTAINED FOR VERIFICATION OF CALIBRATION OF FLIGHT UNITS AND LIFE TESTS OF COMPONENTS AND INSTRUMENTS IN SUPPORT OF SENSOR DESIGN. THE NASA CV 990 AIRCRAFT IS MODIFIED AND EQUIPPED TO PROVIDE A FACILITY TO TEST A WIDE VARIETY OF SENSORS FOR METEOROLOGICAL REMOTE SENSING IN

RTOP NO. 160-44-57 TITLE: AIRBORNE METEOROLOGY PROGRAM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RTOP IS TO PROVIDE AN AIRBORNE PLATFORM, CARRYING INSTRUMENTATION FOR METEOROLOGICAL MEASUREMENTS. EXPERIMENTS WILL BE MOUNTED AND FLOWN ABOARD THE CONVAIR 990 (NASA 711) AND A LEASED LEAR JET TO CONDUCT BASIC METEOROLOGICAL STUDIES AND TO SUPPORT SATELLITE INSTRUMENTATION DEVELOPMENT AND DATA ANALYSIS. A NECESSARY FIRST STEP IN THE DEVELOPMENT OF SATELLITE INSTRUMENTATION FOR REMOTE SENSING OF THE EARTH AND ATMOSPHERE IS TO OBTAIN INFORMATION BASIC TO THE UNDERSTANDING OF FACTORS INFLUENCING THE SPECTRAL SIGNALS TO BE OBSERVED FROM SPACE. THIS INFORMATION MUST BE OBTAINED ABOARD AIRCRAFT BECAUSE MEASUREMENTS MUST BE MADE FROM THE GROUND TO THE STRATOSPHERE WITH SPEED AND FLEXIBILITY IN GEOGRAPHICAL LOCATION TO OBTAIN DATA UNDER THE MANY DESIRED METEOROLOGICAL CONDITIONS. SCALES RANGING FROM LOCAL TO GLOBAL ARE AMENABLE TO STUDY BY AN AIRCRAFT SUCH AS THE CV-990. THE LEAR JET WILL BE USED PRIMARILY TO FLY ONE OR TWO SMALL EXPERIMENTS ON A LOCAL SCALE.

RTOP NO. 160-44-58 TITLE: CLIMATOLOGICAL-STATISTICAL ATMOSPHERIC AND CLOUD COVER MODELS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CAREY, W. T. TEL. 205-453-3424
TECHNICAL SUMMARY

TASK #1. WORLD-WIDE CLOUD COVER MODEL - THE CONSEQUENCE OF CLOUD COVER ON EARTH-VIEWING SPACE MISSIONS IS EVALUATED BY A MONTE-CARLO COMPUTER SIMULATION PROCEDURE USING THE WORLD-WIDE CLOUD COVER STATISTICS. THESE CLOUD AND SEVERE WEATHER (THUNDERSTORM, ELECTRICAL ACTIVITY, HURRICANES, ETC.) DATA CONTAIN PROBABILITY DISTRIBUTIONS FOR VARIOUS CATEGORIES ARRANGED BY MONTHLY AND THREE HOURLY REFERENCE PERIODS. TO ACCOUNT FOR CLOUD PERSISTENCE, SPATIAL AND TEMPORAL PROBABILITY VALUES ARE INCLUDED. SIMULATION RESULTS ARE GIVEN FOR A SPECIFIED SATELLITE PASS NUMBER. THESE ANALYSES ARE DIRECTLY APPLICABLE TO SKYLAB AND OTHER EARTH RESOURCES MISSION ANALYSIS STUDIES. TASK #2. FOUR-DIMENSIONAL ATMOSPHERIC MODELS (WORLD-WIDE) - ATMOSPHERIC DATA COMPRISED OF MONTHLY MEANS AND DAILY VALUES ARE BEING COLLECTED AND ANALYZED FOR THE PURPOSE OF MAKING ELECTROMAGNETIC ENERGY ATTENUATION PREDICTIONS. WHILE ATMOSPHERIC MOISTURE IS THE MOST IMPORTANT PARAMETER OTHER THERMODYNAMIC QUANTITIES (PRESSURE, TEMPERATURE, AND DENSITY) ARE INCLUDED IN THE STUDY. THESE DATA ARE BEING EXTENDED TO A UNIFORM ALTITUDE ON A GLOBAL BASIS. AFTER ANALYSIS, ANALYTICAL FUNCTIONS WILL BE FITTED TO THESE EMPIRICAL DATA SO THAT PROFILES REQUIRED IN ATTENUATION COMPUTATIONS CAN BE INTERNALLY GENERATED BY THE COMPUTER. NEXT, A MONTE-CARLO PROCEDURE WILL PERMIT SELECTION OF A PROFILE FOR MISSION SIMULATION (MISSION ANALYSIS) STUDIES. THESE DATA AND THE MISSION SIMULATION PROCEDURES WILL HAVE A DIRECT IMPACT ON EARTH SENSOR DESIGN AND SELECTION.

RTOP NO. 160-44-60 TITLE: ATMOSPHERIC EFFECTS UPON REMOTE SENSING FROM AIRCRAFT AND SATELLITES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE PURPOSE IS TO DETERMINE THE EFFECTS OF SPECTRAL TRANSMITTANCE AND VARIABILITY UPON THE QUANTITATIVE INTERPRETATION OF RADIOMETRIC DATA OBTAINED FROM AIRCRAFT AND SPACECRAFT; AND TO DEVELOP ANALYTICAL MODELS FOR SUBSEQUENT CORRECTION AND INTERPRETATION. THE RESEARCH WILL DIRECTLY SUPPORT THE PRESENT NASA EARTH RESOURCES PROGRAM IN THAT THE MEASUREMENTS AND ANALYSES WILL AID THE INTERPRETATION OF MULTISPECTRAL DATA FROM EARTH RESOURCES TECHNOLOGY SATELLITES (ERTS) AND WILL DELINEATE OPTIMUM SPECTRAL REGIONS FOR DETECTION AND IDENTIFICATION OF SELECTED RESOURCE TARGETS. ANALYTICAL STUDIES WILL BE MADE OF THE SOLAR AND INFRARED REGIONS TO DETERMINE THE CHARACTERISTICS AND INFLUENCE OF THE ATMOSPHERE, INCLUDING CLOUDS, ON THE SENSING OF SURFACE TEMPERATURES AND SELECTED SPECTRAL REFLECTANCE AND EMITTANCE SIGNATURES. PARAMETRIC STUDIES WILL BE MADE OF ATMOSPHERIC TRANSMISSION EFFECTS AND SPECTRAL SIGNATURES OF SELECTED EARTH RESOURCES TARGETS TO DETERMINE OPTIMUM SPECTRAL REGIONS FOR DETECTION AND IDENTIFICATION. AIRBORNE SPECTRORADIOMETRIC MEASUREMENTS OF DIRECT AND

SCATTERED SOLAR RADIATION AND EMITTED INFRARED RADIATION FROM THE EARTH AND ATMOSPHERE WILL BE MADE.

RTOP NO. 160-75-51 TITLE: SIGNATURE STUDIES AND SIMULATIONS FOR ADVANCED EARTH OBSERVATIONS MISSIONS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HOVIS, W. A. TEL. 301-982-6465
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DETERMINE SIGNATURES FOR SELECTION OF SPECTRAL PARAMETERS OF ADVANCED EARTH OBSERVATION SENSORS, TO ACCURATELY SIMULATE PRESENTLY PLANNED SENSORS AND TO DEVISE MEANS TO ACCURATELY CALIBRATE SENSORS PLANNED FOR THE FUTURE. THE DETERMINATION OF SPECTRAL INTERVALS FOR FUTURE SENSORS WILL BE USED TO OPTIMIZE THEIR USEFULNESS BY SELECTING THOSE SPECTRAL INTERVALS THAT WILL PROVIDE MAXIMUM INFORMATION CONSIDERING BOTH SURFACE AND ATMOSPHERIC EFFECTS ON SENSING. SPECTROMETERS WILL PROVIDE A CONTINUOUS SPECTRUM OF SURFACES OF INTEREST THAT WILL ALLOW COMPUTER SELECTION OF OPTIMUM SPECTRAL INTERVALS AND BAND SHAPES. SIMULATORS WILL BE CONSTRUCTED THAT SIMULATE THE SPECTRAL RESPONSE FUNCTIONS OF SENSORS PLANNED FOR FLIGHT ON ERTS AND EOS. THESE SIMULATORS WILL BE USED TO PRODUCE DATA AND SIGNATURES THAT CAN BE USED TO SUPPORT THE INTERPRETATION OF ERTS AND EOS DATA. THE RESPONSE FUNCTIONS OF SENSORSSUCH AS THE ERTS, MSS AND RBV ARE SO UNIQUE THAT NO DATA EXISTS ON WHICH TO BASE SIGNATURE STUDIES. SUCH DATA MUST BE COLLECTED WITH SIMULATING SENSORS. SENSORS PLANNED FOR FUTURE EARTH OBSERVATION MISSIONS, PARTICULARLY IN AREAS SUCH AS OCEANOGRAPHY, PRESENT PROBLEMS IN CALIBRATION NEVER

RTOP NO. 160-75-53 TITLE: PRESENTATION, MANIPULATION, VALIDATION, AND RECORDING OF IMAGE DATA
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SOS, J. Y. TEL. 301-982-4419
TECHNICAL SUMMARY

THE ERTS GROUND DATA HANDLING SYSTEM (GDHS) IS BEING ESTABLISHED WITH LITTLE FLEXIBILITY AND ESSENTIALLY NO R&D CAPABILITY. THIS APPROACH IS SATISFACTORY TO MEET INITIAL USER REQUIREMENTS FOR ERTS-A AND -B. BUT AS USER APPLICATIONS OF SATELLITE IMAGERY EVOLVE INTO ARTICULATE REQUIREMENTS AND AS FUTURE SYSTEMS DEVELOP THE GDHS MUST ALSO EVOLVE TO INSURE EFFECTIVE UTILIZATION OF IMAGERY DATA. TECHNIQUES WILL BE INVESTIGATED THAT WILL LEAD UP TO THE GENERATION OF MORE USEFUL IMAGE DATA PRODUCTS SUCH AS IMAGE MOS ENHANCED IMAGES, AND FALSE COLOR PRESENTATIONS. EMPHASIS WILL ALSO BE PLACED ON THE DEVELOPMENT OF EFFICIENT DIGITAL IMAGE PROCESSING ALGORITHMS AND SYSTEM CONCEPTS THAT DO NOT REQUIRE VERY LARGE DIGITAL COMPUTERS TO KEEP UP WITH THE ANTICIPATED ANALYSIS.

RTOP NO. 160-75-54 TITLE: EARTH RESOURCES STUDIES WITH SATELLITE IMAGERY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SHORT, N. M. TEL. 301-982-6603
TECHNICAL SUMMARY

IT IS PROPOSED TO DEVELOP AND IMPLEMENT ANALYTICAL PROCEDURES FOR INTERPRETATION OF EARTH RESOURCES DATA FROM SATELLITE OBSERVATIONS, SUPPLEMENTED BY AIRCRAFT IMAGERY AND GROUND MEASUREMENTS. SPECIFIC OBJECTIVES ARE TO 1) EXAMINE THE EARTH'S SURFACE AS A UNIFIED CONTINUUM OF OBJECTS WITH DIFFERING SPECTRAL PROPERTIES, AND 2) DEVELOP PROVEN TECHNIQUES FOR PROCESSING AND INTERPRETATION OF SATELLITE-OBTAINED DATA APPLICABLE TO RESOURCES EXPLORATION AND MANAGEMENT. TO DATE, ACTIVITIES ORIENTED TOWARDS THESE OBJECTIVES INCLUDE STUDIES OF NIMBUS DATA RELATING TO PHENOLOGICAL CHANGES IN AFRICA AND TO GEOLOGICAL FEATURES IN WYOMING AND COLORADO, INVESTIGATION OF AUTOMATIC PATTERN RECOGNITION TECHNIQUES FOR SPACE-ACQUIRED IMAGERY, AND ACQUISITION OF SETS OF REFLECTANCE SPECTRA AND MULTIBAND PHOTOS OF SOILS, ROCKS, AND PLANTS MEASURED IN THE LABORATORY AND THE FIELD.

RTOP NO. 160-75-55 TITLE: IRIS-D BREADBOARD MODIFICATION TO 0.03 CM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HANEL, R. A. TEL. 301-982-4528
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEMONSTRATE IN THE LABORATORY THE FEASIBILITY OF CONSTRUCTING A SMALL LIGHTWEIGHT, INFRARED INTERFEROMETER CAPABLE OF RESOLVING THE ROTATIONAL STRUCTURE OF GASES IN THE EARTH'S ATMOSPHERE. TO THIS END THE PRESENTLY AVAILABLE NIMBUS-D BREADBOARD WILL BE MODIFIED TO ACHIEVE 0.03 CM RESOLUTION. THE MODIFICATION WILL CONCENTRATE ON A NEW MICHELSON MOTOR DESIGN, BUT WILL ALSO INCLUDE A COOLED DETECTOR, AND A LASER AS A WAVELENGTH REFERENCE.

RTOP NO. 160-75-55 TITLE: MSC REGIONAL CENTER FOR EARTH RESOURCE SURVEY APPLICATIONS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: ERB, R. B. TEL. 713-483-4623
TECHNICAL SUMMARY

THE MSC REGIONAL CENTER FOR EARTH RESOURCE SURVEY APPLICATIONS IS ESTABLISHED FOR THE PURPOSE OF STUDYING AND APPLYING EARTH RESOURCES REMOTE SENSING TECHNOLOGY TO AN 18-COUNTY AREA SURROUNDING THE CITY OF HOUSTON, THIS WILL INCLUDE A SURVEY OF THE AREA AND DETAILED STUDY OF SPECIFIC PROBLEMS WITHIN THIS TEST SITE. THE APPROACH WILL BE TO SELECT A SPECIFIC "USER" OR "OPERATING" AGENCY PROBLEM OR TASK, TO EXAMINE AND ANALYZE THE INPUT PARAMETERS TO THIS TASK AND THE OUTPUT PRODUCT OF THE SELECTED AGENCY, AND ATTEMPT TO IMPROVE OR OPTIMIZE THE JOB OR PRODUCT BY INTEGRATING INTO THE TASK THE PRINCIPLES OF REMOTE SENSING AND INFORMATION SYSTEMS TECHNOLOGY. THE "PILOT PLANT" WILL OPERATE THE EXISTING INFORMATION SYSTEMS OF THE "OPERATING AGENCIES" INTERNAL TO THE "PILOT PLANT" AND WILL

MEASURE AND DEMONSTRATE THE IMPROVEMENTS ATTAINED WITH THE INTEGRATION OF REMOTE SENSING AND INFORMATION SYSTEMS TECHNOLOGY. THE GOAL IS THE DEVELOPMENT AND DEMONSTRATION OF IMPROVED SYSTEMS FOR MONITORING AND PRODUCING MANAGEMENT DECISIONS CONCERNING THE TERRESTRIAL ENVIRONMENT. THESE SYSTEMS WILL BE DESIGNED, IMPLEMENTED, AND OPERATED IN THE PERFORMANCE OF PRACTICAL APPLICATIONS TASKS, USING BOTH CONVENTIONAL AND NEWER TECHNIQUES FOR OBTAINING DATA, PROCESSING DATA, AND MAKING DECISIONS. INITIALLY DATA WILL BE DERIVED FROM THE EARTH RESOURCES AND AIRCRAFT PROGRAM BUT ERTS AND SKYLAB/EREP DATA WILL BE UTILIZED AS SOON AS POSSIBLE. THE INFORMATION GAINED WILL BE USED TO GUIDE TECHNIQUE RESEARCH AND DEVELOPMENT; AND TO PRODUCE A SEQUENCE OF DOCUMENTED APPLICATIONS TASKS FOR USE IN TRANSMITTING THE RESULTS TO LOCAL, STATE, AND FEDERAL AGENCIES, TO INDUSTRY AND COMMERCIAL INTERESTS, AND TO THE PUBLIC AT LARGE.

RTOP NO. 160-75-56 TITLE: HARDWARE FOR HANDLING AIRCRAFT AND SPACECRAFT ACQUIRED DATA
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HOLTER, M. R. TEL. 713-483-4776
TECHNICAL SUMMARY

THE REQUIREMENT TO ACQUIRE AIRCRAFT AND SPACECRAFT DATA AT EXTREMELY HIGH PACKING DENSITIES HAS NECESSITATED THE DEVELOPMENT OF MANY DIVERSIFIED AND SOPHISTICATED DATA ACQUISITION SYSTEMS EMPLOYING A BROAD SPECTRUM OF ENCODING AND FORMATING TECHNIQUES. THE TECHNIQUE EMPLOYED BY THESE SYSTEMS HAS, IN MANY CASES, SURPASSED THE CAPABILITY OF EXISTING DATA CORRELATION AND PROCESSING HARDWARE TO HANDLE THESE DATA IN AN ACCURATE AND TIMELY MANNER. IT IS THEREFORE REQUIRED THAT COMPLEMENTARY TECHNIQUES BE DEVELOPED THAT CAN BE IMPLEMENTED IN EXISTING AND FUTURE AUTOMATIC DATA CORRELATION AND PROCESSING SYSTEMS THAT WILL PERMIT EFFICIENT PROCESSING AND ANALYSIS OF THESE DATA. SPECIFIC AREAS THAT REQUIRE TECHNIQUE DEVELOPMENT INCLUDE: AUTOMATIC DATA REGISTRATION; SIGNATURE DATA ANALYSIS; AND MICROWAVE SENSORS DATA ANALYSIS. HARDWARE WILL BE DEVELOPED TO IMPLEMENT THE TECHNIQUES REQUIRED TO PROCESS THESE DATA. STUDIES WILL BE UNDERTAKEN TO DEFINE THE DETAILED SPECIFICATIONS REQUIRED TO DEVELOP, TEST, IMPROVE, AND IMPLEMENT TECHNIQUES, HARDWARE, AND SYSTEMS THAT WILL MEET DATA EXTRACTION AND MANAGEMENT REQUIREMENTS.

RTOP NO. 160-75-57 TITLE: INSTRUMENTS FOR SENSING EARTH RESOURCES FROM A/C AND MANNED S/C
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EVANS, D. E. TEL. 713-483-4776
TECHNICAL SUMMARY

THE INTENT OF THIS PORTION OF THE EARTH RESOURCES PROGRAM IS TO INVESTIGATE THE VARIOUS TYPES OF SENSORS AND SYSTEMS FROM AIRCRAFT AND SPACECRAFT AND EVALUATE THEIR UTILITY FOR PROVIDING PERIODIC DATA WHICH WILL ENABLE THE VARIOUS USERS TO CONDUCT THEIR EARTH RESOURCES TASKS MORE EFFICIENTLY. STUDY, DEVELOP, TEST, AND IMPROVE SENSORS AND SYSTEMS TO DETECT, IDENTIFY, LOCATE AND MEASURE EARTH RESOURCES

PHENOMENA FROM AERIAL AND ORBITAL ALTITUDE. MEASUREMENTS ARE TO BE MADE IN THE MICROWAVE, INFRARED, VISIBLE, AND ULTRAVIOLET PORTION OF THE ELECTROMAGNETIC SPECTRUM. THIS TASK IS BEING PERFORMED TO PROVIDE DATA IN DISCIPLINES SUCH AS AGRICULTURE/FORESTRY, GEOGRAPHY, HYDROLOGY,OCEANOGRAPHY, AND GEOLOGY TO PROVIDE THE INVESTIGATOR IN THE AREAS WITH DATA FROM WHICH THEY MAY ESTABLISH COMPREHENSIVE MODELS OF ATMOSPHERE DYNAMIC EARTH, OCEANS, AND LAND.

RTOP NO. 160-75-58 TITLE: UNIVERSITY OF MICHIGAN SPECIAL COMPETENCE GROUP, DATA PROCESSING, AND INFORMATION EXTRACTION FOR MULTICHANNEL AND RADAR SENSORS (UV, VISIBLE, IR, AND MW)

ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EVANS, D. E. TEL. 713-483-4776
TECHNICAL SUMMARY

MANY VARIABLE PHYSICAL FACTORS AFFECT THE DATA COLLECTED BY REMOTE SENSORS AND LIMIT THE EFFECTIVENESS OF PRESENT INFORMATION EXTRACTION TECHNIQUES USED IN ANALYZING SUCH DATA. ALSO, THE PRESENT PROCESSING TECHNIQUES ARE LIMITED TO THE AREAS NEAR "GROUND TRUTH" SITES USED AS "TRAINING SETS". SPACEBORNE SENSORS AND AIRCRAFT UNDERFLIGHTS MAKE WIDE AREA SURVEYS FOR EARTH RESOURCES POSSIBLE, IN TURN CREATING LARGE VOLUMES OF DATA FROM WHICH INFORMATION MUST BE EXTRACTED. TO SURMOUNT THE LIMITED POWER OF PRESENT INFORMATION EXTRACTION TECHNIQUES RESEARCH STUDY IS UNDERWAY (1) TO UNDERSTAND THE PHYSICAL PHENOMENA CAUSING THE VARIABILITY AND IMPOSING THE LIMITATIONS, (2) TO DEVELOP MORE POWERFUL TECHNIQUES FOR OVERCOMING THOSE LIMITATIONS, AND (3) TO APPLY THEM TO ACTUAL SURVEY APPLICATIONS. TO AID IN REMOVING THE REQUIREMENT FOR LOCAL "GROUND TRUTH," (1) SPECTRAL SIGNATURES OF VARIOUS MATERIALS ARE BEING MEASURED AND COLLECTED IN THE EARTH RESOURCES SPECTRAL INFORMATION SYSTEM AT THE MANNED SPACECRAFT CENTER, AND (2) STUDIES ARE PLANNED TO DEVELOP MATHEMATICAL MODELS TO APPLY THE EFFECTS OF ENVIRONMENTAL, INSTRUMENTAL, AND TEMPORAL DIFFERENCES TO THE STORED LABORATORY AND FIELD SIGNATURES TO CONSTRUCT SIGNATURES WHICH WILL BE USEFUL IN INFORMATION EXTRACTION METHODS IN OPERATIONAL SURVEY APPLICATIONS. TO ENABLE MORE ECONOMIC PROCESSING OF THE LARGE VOLUME OF DATA, HIGHLY EFFICIENT SYSTEMS ARE BEING DEVELOPED TO PERMIT "NEAR REAL TIME" DATA PROCESSING. THIS CAPABILITY WILL BE MADE AVAILABLE TO THE USER AGENCIES.

RTOP NO. 160-75-59 TITLE: UNIVERSITY OF KANSAS SPECIAL COMPETENCE GROUP RADAR DATA APPLICATIONS AND SYSTEMS STUDIES

ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EVANS, D. E. TEL. 713-483-4776
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT SIGNATURE STUDIES AND DETERMINE RADAR SYSTEMS TO BE USED IN AIRCRAFT AND EARTH ORBITING SPACECRAFT FOR THE PURPOSE OF MAPPING THE GROSS FEATURES OF THE EARTH. TO PROVIDE EVALUATION OF THE USEFULNESS OF THE SPACEBORNE RADAR AS A

GEOSCIENCE EXPERIMENT AND MAPPING TOOL FOR STUDY OF EARTH RESOURCES IN THE FIELDS OF GEOLOGY, FORESTRY, GEOGRAPHY, AND OCEANOGRAPHY. SYSTEM STUDIES WILL BE CONDUCTED OF MULTIPLE-POLARIZED RADAR IMAGING SYSTEMS. FEASIBILITY STUDIES OF THE RADAR SYSTEMS ARE PROCEEDING. MANY OF THE PARAMETERS TO BE MEASURED HAVE BEEN IDENTIFIED. DATA ANALYSIS TECHNIQUES ARE BEING CONTINUOUSLY IMPROVED. RADAR DATA IS BEING COLLECTED AND EVALUATED FROM SEVERAL SOURCES: EXISTING RADAR DATA WHERE SOME KNOWLEDGE OF THE TERRAIN STATE AT THE TIME OF IMAGING IS AVAILABLE CURRENTLY OBTAINED DATA FROM AIRCRAFT-BORNE RADARS WHERE ON SITE TERRAIN STATE IS OBTAINED CURRENTLY WITH OVERFLIGHT; ACOUSTIC MODELING DATA AND RADAR DATA OBTAINED FROM GROUND STATION LABORATORY INSTRUMENTATION.

RTOP NO. 160-75-60 TITLE: MIDWEST/GREAT LAKES APPLICATIONS OF EARTH OBSERVATION SATELLITES
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: MARK, H. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO ENCOURAGE AND PROMOTE USEFUL LOCAL AND REGIONAL APPLICATIONS OF THE CAPABILITIES OF EARTH OBSERVATION SATELLITES AND AIRCRAFT. TO ACHIEVE THIS OBJECTIVE, A BASIC IN-HOUSE CAPABILITY IS BEING DEVELOPED AT LEWIS TO RECEIVE, PROCESS, INTERPRET, AND DISTRIBUTE SATELLITE AND AIRCRAFT IMAGES AND DATA, SO THAT LEWIS CAN EFFECTIVELY SERVE AS NASA'S REGIONAL CENTER FOR INITIATING, COORDINATING AND IMPLEMENTING APPLICATION PROGRAMS. TO ACHIEVE MAXIMUM EFFICIENCY IN USE OF AVAILABLE FUNDS, LEWIS WILL INCORPORATE REGIONAL DATA ACQUISITION AND PROCESSING CAPABILITIES AND THE CAPABILITIES AND INTERESTS OF REGIONAL USER ORGANIZATIONS INTO A SERIES OF COOPERATIVE PROGRAMS DIRECTED TOWARD THOSE APPLICATIONS THAT SEEM TECHNICALLY MOST FEASIBLE AND ECONOMICALLY MOST SIGNIFICANT IN THIS REGION. CURRENTLY, PROGRAMS IN VARIOUS STAGES OF PLANNING ARE DIRECTED TOWARD (1) GREAT LAKES REGIONAL WATER QUALITY EVALUATION AND MONITORING, (2) GREAT LAKES ICE EVALUATION AND MONITORING. SEVERAL OTHER APPLICATIONS OF MORE LIMITED SCOPE ARE ALSO BEING CONSIDERED.

RTOP NO. 160-75-61 TITLE: STATISTICAL DATA MANAGEMENT METHODS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CAREY, W. T. TEL. 205-453-3424
TECHNICAL SUMMARY

LARGE VOLUMES OF COMPLEX AND DIVERSE DATA SETS ARE BEING GENERATED VIA AIRCRAFT FLIGHT SURVEYS AND THE ERTS PROGRAM. IN ORDER TO REALIZE THE BENEFITS FROM THIS MAGNITUDE OF EARTH SURVEY DATA, A GENERALIZED SET OF STATISTICAL DATA MANAGEMENT ALGORITHMS NEED TO BE DEVELOPED FOR THE DATA ANALYSIS, WHICH REQUIRES ONLY MINOR MODIFICATIONS FOR SPECIFIC USER APPLICATIONS. SUCH ALGORITHMS ARE ALREADY IN THE DEVELOPMENT STAGE AND AT PRESENT SOME ARE NEAR COMPLETION. THE APPROACH IS TO CONTINUE THE DEVELOPMENT OF THESE ALGORITHMS ON ALREADY AVAILABLE AIRCRAFT AND FLIGHT SURVEYS OF HYDROLOGICAL TARGETS. AFTER COMPLETION OF THE DEVELOPMENT STAGE,

PLANS WILL BE MADE FOR ADAPTING THESE ALGORITHMS TO ON-LINE ANALYSIS IN THE FLIGHT SURVEY INSTRUMENT PACKAGE.

RTOP NO. 160-75-62 TITLE: EARTH ECOLOGY - WILDLIFE RESEARCH
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: COTE, C. E. TEL. 301-982-4215
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE APPLICATIONS OF SPACE TECHNOLOGY IN THE STUDY OF EARTH'S WILDLIFE AND TO DEVELOP INSTRUMENTATION COMPATIBLE WITH THE ANIMAL ENVIRONMENT FOR SATELLITE TRACKING AND DATA COLLECTION APPLICATIONS. A STUDY PROGRAM IS UNDERWAY TO DEFINE ANIMAL TRACKING REQUIREMENTS THROUGH A SURVEY OF BIOLOGISTS AND MANAGERS OF WILDLIFE. THE SURVEY WILL ENDEAVOR TO CLARIFY THE TYPES AND CLASSES OF ANIMALS WHICH SHOULD BE TRACKED. ON THE BASIS OF THE USER REQUIREMENTS, CONCEPTS WILL BE DEVELOPED FOR INSTRUMENTATING THE VARIOUS ANIMALS WITH EQUIPMENT SUITABLE FOR SATELLITE TRACKING THROUGH DOPPLER TECHNIQUES. CONCEPTS WILL BE EVALUATED THROUGH TEST PROGRAMS UNDER SIMULATED ANIMAL ENVIRONMENT CONDITIONS. VIABLE TECHNIQUES PROVEN THROUGH TESTING WILL BE MADE AVAILABLE TO THE SCIENTIFIC USER COMMUNITY.

RTOP NO. 160-75-64 TITLE: THE USE OF RAMAN SPECTROSCOPY FOR REMOTE SIGNATURE RECOGNITION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HUDSON, R. D. TEL. 713-483-6234
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO EXPLORE THE FEASIBILITY OF USING RAMAN SPECTROSCOPY FOR THE REMOTE SIGNATURE RECOGNITION OF VEGETATION, MINERALS, AND WATER PRODUCTIVITY. THE OBJECTIVE WILL BE ACHIEVED BY (1) LABORATORY MEASUREMENTS OF THE LASER RAMAN SIGNATURES OF SELECTED TARGETS, (2) USING THESE MEASUREMENTS TO CALCULATE EXPECTED RETURNS FROM A REMOTE RAMAN SYSTEM, (3) CONSTRUCTING A BREADBOARD REMOTE SENSING SYSTEM, WHICH CAN BE TESTED BOTH IN THE LABORATORY AND IN THE FIELD (IF THE RESULTS OF (2) ARE FAVORABLE).

RTOP NO. 160-75-66 TITLE: REMOTE SENSING OCEANOGRAPHY PLAN
ORGANIZATION: DEPARTMENT OF THE NAVY
MONITOR: SHERMAN, J. W. III TEL. 202-767-2837
TECHNICAL SUMMARY

IN OCTOBER 1965, A FORMAL WORKING AGREEMENT WAS SIGNED BY DR. ROBERT SEAMANS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) AND DR. ROBERT MORSE, ASSISTANT SECRETARY OF THE NAVY (R&D) TO COOPERATE IN CONDUCTING A RESEARCH PROGRAM TO DEFINE FEASIBLE OCEAN MEASUREMENTS FROM SPACE PLATFORMS. THE PROGRAM WAS ASSIGNED BY THE NAVY TO THE NAVAL OCEANOGRAPHIC OFFICE WHICH ESTABLISHED THE SPACECRAFT OCEANOGRAPHY (SPOC) PROJECT. THE AREAS OF RESEARCH TO SPECIFY SENSOR SYSTEMS, OBSERVATIONAL REQUIREMENTS, AND DATA HANDLING TECHNIQUES WERE PREVIOUSLY DIVIDED INTO SEVEN AREAS OF FEASIBILITY AS

INDICATED IN TABLE "A". THIS RESEARCH AND TECHNOLOGY OBJECTIVE AND PLAN (RTOP) FOR FY72 WILL CONTINUE THIS RESEARCH EXCEPT THAT THE PROGRAM IS NOW DIVIDED INTO FOUR PRIME RESEARCH AREAS AS RELATED TO THE FEASIBILITY AREAS IN TABLE "A". IT SHOULD BE NOTED THAT ACTION IS IN PROGRESS TO MAKE THE FOLLOWING CHANGES WITH REGARD TO THE SPOC PROJECT FOR FISCAL YEAR 1972: (1) THE PERSONNEL AND MISSION OF THE SPOC PROJECT WILL BE TRANSFERRED FROM THE NAVAL OCEANOGRAPHIC OFFICE TO THE NAVAL RESEARCH LABORATORY. (2) THE NAME OF THE PROJECT WILL BE CHANGED TO THE REMOTE SENSING OCEANOGRAPHY (RSOC) PROJECT. (3) THE ANNUAL DIRECT NAVY SUPPORT FOR THIS PROJECT WILL BE INCREASED FROM $70K TO ABOUT $300K IN FY72. INDIRECT SUPPORT IS NOTED IN 18.B WHICH FOLLOWS.

RTOP NO. 160-75-69 TITLE: GEOLOGY USDI
ORGANIZATION: NASA HEADQUARTERS
MONITOR: PARK, A. B. TEL. 202-963-6523
TECHNICAL SUMMARY

TO APPLY AN INTERDISCIPLINARY APPROACH OF PHYSICS AND GEOLOGY IN THE DEVELOPMENT OF REMOTE SENSING AS A TOOL IN DISCRIMINATING ROCK AND SOIL TYPES AND THE IDENTIFICATION OF STRUCTURAL FEATURES AND MINERALIZED ZONES. B) TO USE SATELLITE AND AERIAL PHOTOGRAPHY AND OTHER IMAGING REMOTE SENSORS TO OBSERVE LARGE SCALE GEOLOGIC FEATURES THAT REVEAL GEOTECTONIC AND GEOMORPHIC RELATIONSHIPS OF REGIONAL OR CONTINENTAL SIGNIFICANCE. C) TO IDENTIFY AND REPEATEDLY OBSERVE ACTIVE TIME-VARIANT PHENOMENA SUCH AS NEAR-SHORE CURRENTS, THERMAL SPRING ACTIVITY, AND THERMAL ANOMALIES ASSOCIATED WITH ACTIVE VOLCANOES IN A STATE OF REPOSE, SEASONAL VARIATIONS IN VEGETATION AND SNOW COVER THAT MAY BE DIRECTLY RELATED TO GEOLOGIC PROCESSES OR THAT MAY ENHANCE SOME GEOLOGIC FEATURES. D) TO DEFINE WHICH INSTRUMENTS FOR GROUND-MONITORING OF ACTIVE VOLCANOES AND EARTHQUAKE REGIONS ARE SUITABLE FOR USE IN A SATELLITE TELEMETRY NETWORK. INFRARED IMAGES OF THE MILL CREEK, OKLA. TEST AREA PERMIT DISTINCTION OF RELATIVELY PURE LIMESTONE AND DOLOMITE SUITABLY FOR REMOTE GEOLOGIC MAPPING; BEDDING DETAIL IS SUFFICIENT FOR DETERMINATION OF FOLDS AND FAULTS, AND SOME FAULTS NOT OTHERWISE EXPOSED ARE SHOWN BY INFRARED IMAGES. B) A DETAILED ANALYSIS HAS BEEN PERFORMED TO PROVE THE FEASIBILITY OF USING A TUNABLE CARBON DIOXIDE LASER SYSTEM (9.1 TOEXPLORATION. C) A SOILS ASSOCIATION MAP OF A ASSOCIATION MAP OF 117,000 SQUARE MILE AREA IN THE SOUTHWESTERN U.S. AND NORTHERN MEXICO COMPILED FROM GEMINI PHOTOGRAPHS, SHOWS CONSISTENCY BETWEEN MAPPED UNITS NOT NORMALLY AVAILABLE ON MAPS COMPILED BY CONVENTIONAL MEANS WHERE SEVERAL SOURCES OF DATA MUST BE USED. D)----

RTOP NO. 160-75-70 TITLE: HYDROLOGY, USDI
ORGANIZATION: NASA HDQTRS.
MONITOR: DEUTSCH, M. TEL. 202-382-4423
TECHNICAL SUMMARY

THE HYDROLOGIC PROBLEMS HAVE BEEN DIVIDED INTO 3 STUDY CLASSES: (1) HYDROLOGIC FEATURES, (2) HYDROLOGIC APPLICATIONS OF MICROWAVE SENSORS, AND (3) HYDROLOGIC STUDIES IN THE CENTRAL ATLANTIC

REGIONAL ECOLOGICAL TEST SITE. THE PURPOSE OF THE HYDROLOGY PROGRAM IS TO DEVELOP APPLICATIONS OF REMOTE SENSOR TECHNOLOGY IN THE SOLUTION OF WATER RESOUCES PROBLEMS AND TO DEVELOP AN AUTOMATED DATA COLLECTION, PROCESSING, ANALYSIS AND DISTRIBUTION NETWORK UTILIZING BOTH REMOTE SENSOR (AIR AND SPACE) AND GROUND CONTROL DATA. A REAL-TIME NETWORK OF GROUND MONITOR STATIONS WILL BE SELECTED FROM ABOUT 50,000 DATA COLLECTION STATIONS PRESENTLY MAINTAINED BY THE USGS WATER RESOURCES DIVISION IN COOPERATION WITH ALL 50 STATES, AND NUMEROUS FEDERAL, INTERSTATE AND LOCAL AGENCIES. REMOTE SENSING ADDS 3 DIMENTIONS TO CONVENTIONAL HYDROLOGIC STUDIES THAT CANNOT BE READILY OBTAINED BY ANY OTHER MEANS. THESE ARE: (1) SPATIAL--A RECORD AT A GIVEN TIME CAN BE OBTAINED ACCORDING TO AREA COVERAGE-RESOLUTION REQUIREMENTS, (2) SPECTRAL--INFORMATION CAN BE ACQUIRED BEYOND THE SPECTRAL RANGE OF COMPREHENSION, AND (3) TEMPORAL--RECORDS CAN BE ACQUIRED FOR STUDY OF CHANGE (TIDE, DIURNAL, SEASONAL AND LONG TERM). THIS REMOTE SENSING DATA PROVIDES AN OVERVIEW FOR HYDROLOGIC INTERPRETATION OF DATA ACQUIRED BY GROUND SENSORS AND PROVIDES INFORMATION BETWEEN DATA COLLECTION STATIONS. THERE IS A STRONG TIE BETWEEN THE AIRCRAFT PROGRAM AND THE COMING ERTS AND SKYLAB PROGRAMS. THE HYDROLOGY PROGRAM STRIVES TO BRING TOGETHER COMPLEMENTARY GROUND, SKY, AND SPACE DATA THAT CAN BE USED FOR IMPROVED DECISIONS WITHIN WATER RESOURCES MANAGEMENT.

RTOP NO. 160-75-71 TITLE: PURDUE APPLICATION ANALYSIS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EVANS, D. E. TEL. 713-483-4776
TECHNICAL SUMMARY

RESEARCH ACTIVITIES BEGAN AT PURDUE UNIVERSITY IN 1966 AT THE LABORATORY FOR AGRICULTURAL REMOTE SENSING (LARS) UNDER THE SPONSORSHIP OF NASA IN COOPERATION WITH THE USDA. THE PRINCIPAL OBJECTIVE OF THE ACTIVITY WAS, AND CONTINUES TO BE, THE DEVELOPMENT OF DATA ACQUISITION, PROCESSING, AND DISTRIBUTION TECHNIQUES FOR INCORPORATION INTO EARTH RESOURCES INFORMATION SYSTEMS OF THE FUTURE. TIMELY, ACCURATE, AND COMPREHENSIVE DATA ARE ESSENTIAL TO PRUDENT RESOURCE DEVELOPMENT PLANNING AND RESOURCE USE MANAGEMENT. FUTURE INFORMATION SYSTEMS WILL DEPEND ON OBSERVATIONS AND MEASUREMENTS COLLECTED FROM THE GROUND, AIR, AND SPACE. THE OBSERVATIONS COLLECTED BY FUTURE EARTH-ORIENTED SATELLITES WILL BE SUPPLEMENTED BY MEASUREMENTS AND OBSERVATIONS BY AIRCRAFT SYSTEMS. GROUND OBSERVATIONS WILL CONTINUE TO BE OF VALUE. REGARDLESS OF HOW DATA ARE REQUIRED, THERE IS A TREMENDOUS NEED TO BE ABLE TO PROCESS THE DATA AUTOMATICALLY FOR THEIR INFORMATION CONTENT. THE MAJOR THRUST OF THE RESEARCH PROGRAMS AT PURDUE UNIVERSITY IS ORIENTED TOWARD MEETING THIS REQUIREMENT.

RTOP NO. 160-75-71 TITLE: URBAN AND REGIONAL CHANGE DETECTION & PREDICTION: ECOLOGICAL TEST SITE
ORGANIZATION: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MONITOR: PARK, A. B. TEL. 202-963-6523
TECHNICAL SUMMARY

THE USGS GEOGRAPHIC APPLICATIONS PROGRAM ACTIVITIES FOR FY 1972 WILL INCLUDE THE DEVELOPMENT OF PROCEDURES TO DETECT, IDENTIFY, AND MEASURE REGIONAL LAND USE CHANGES AND USE THE RESULTS OF THE RESEARCH IN ASSESSING THE CONSEQUENCES OF THOSE CHANGES IN TERMS OF ENVIRONMENTAL IMPACTS IN MULTI-DISCIPLINARY STUDY SITES (CENTRAL ATLANTIC, SO. ARIZONA, AND CALIFORNIA). REMOTE SENSOR DATA FROM HIGH ALTITUDE AIRCRAFT AND ERTS SIMULATED DATA WILL BE UTILIZED IN THE PREPARATION OF ADEQUATE MAPS AND DEVELOPMENT OF COMPUTERIZED DATA BANKS FROM WHICH TO MEASURE CHANGES, IDENTIFY TRENDS, AND FORECAST ENVIRONMENTAL INTERACTIONS IN THE SAMPLE GROUP OF "CENSUS CITIES" WHICH WERE OVERFLOWN AT THE SAME TIME AS THE 1970 CENSUS OF POPULATION. A SYSTEM WILL BE DEVELOPED TO INCORPORATE PERIODICALLY GATHERED REMOTE SENSOR DATA FROM SATELLITES FOR URBAN PLANNING AND MANAGEMENT, AND TO SIMPLIFY PREDICTIVE MODELS OF INTER- AND INTRA-URBAN CHANGE. IN ADDITION, THE GEOGRAPHIC APPLICATIONS PROGRAM PROPOSES TO DEVELOP AN INTEGRATED ENVIRONMENTAL PROJECT, THE CENTRAL ATLANTIC REGIONAL ECOLOGICAL TEST SITE (CARETS) THAT WILL PROVIDE AN OPERATIONAL TEST OF THE UTILITY OF MONITORING ENVIRONMENTAL CHANGE BY MEANS OF REMOTE SENSORS; DEVELOP A MULTI-DISCIPLINARY INFORMATION SERVICE FOR FEDERAL, STATE, REGIONAL, AND LOCAL INSTITUTIONS WITH DECISION MAKING RESPONSIBILITIES IN THE AREA ENVIRONS; INCORPORATE EXISTING DATA WITH HIGH ALTITUDE AND ERTS DATA; AND BRING TOGETHER POTENTIAL USERS AND EDUCATE THEM AS TO THE PROCEDURES AND METHODOLOGY FOR PRACTICAL AND OPERATIONAL APPLICATION OF REMOTE SENSOR DATA. STUDIES WILL ALSO BE CONDUCTED TO DETERMINE IF REMOTE SENSING DATA CAN----

RTOP NO. 160-75-72 TITLE: CARTOGRAPHIC APPLICATIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: PARK, A. TEL. 202-963-7101
TECHNICAL SUMMARY

THE SPECIFIC OBJECTIVES ARE TO: 1. APPLY REMOTE SENSING OF THE EARTH (BASICALLY FROM SPACE) TO THE FOLLOWING: A. TOPOGRAPHIC AND PLANIMETRIC BASE MAPPING. B. RAPID THEMATIC MAPPING OF SIGNIFICANT TEMPORAL PHENOMENA SUCH AS WATER, SNOW, VEGETATION AND THE MASSED WORKS OF MAN. C. PROCESSED IMAGES FROM WHICH USEFUL INFORMATION CAN BE MORE READILY DERIVED FOR A VARIETY OF APPLICATIONS ASSOCIATED WITH EARTH OBSERVATIONS. D. RAPID DETERMINATION OF PRECISE POINT LOCATION OF UNPREDICTABLE PHENOMENA. 2. PROVIDE A USER ORIENTED RESEARCH FACILITY IN WHICH ANALOG DATA PROCESSING TECHNIQUES CAN BE DEVELOPED AND TESTED IN CONJUNCTION WITH VARIOUS USER GROUPS ASSOCIATED WITH EARTH OBSERVATIONS FROM SPACE.

RTOP NO. 160-75-73 TITLE: NATURAL AND CULTURAL RESOURCES MANAGEMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: PARK, A. TEL. 202-963-7101
TECHNICAL SUMMARY

THE THIRTEEN TASKS COVERED BY THIS PLAN HAVE INTERRELATED AND SHARED OBJECTIVES. THESE OBJECTIVES ARE: 1. TO ENHANCE THE ABILITY OF VARIOUS BUREAUS INCLUDING RECLAMATION, LAND MANAGEMENT, INDIAN AFFAIRS, MINES, OUTDOOR RECREATION, SPORT FISHERIES AND WILDLIFE, AND THE NATIONAL PARK SERVICE, TO PERFORM THEIR MISSIONS OF THE EFFECTIVE, TIMELY, ECONOMICAL, AND EFFICIENT MANAGEMENT OF THE VARIOUS RESOURCES FOR WHICH THEY ARE RESPONSIBLE. 2. INVESTIGATE REMOTELY SENSED DATA AVAILABLE FROM AIRCRAFT, ERTS AND SKYLAB TO DETERMINE THE FEASIBILITY OF AND HOW BEST TO UTILIZE THE INFORMATION THUS OBTAINED TO STUDY, INVENTORY, ANALYZE, CLASSIFY AND IDENTIFY LAND USE, WATER, POLLUTION, VEGETATION, MINERALS, ARCHAEOLOGICAL SITES AND OTHER RESOURCES TO BETTER UNDERSTAND, MONITOR, CONSERVE AND MANAGE THE LIMITED NATURAL RESOURCES AVAILABLE FOR MINING, GRAZING, RECREATION, SPORTS, WILDLIFE AND OTHER BENEFICIAL USES. 3. DEFINE METHODS AND DEVELOP TECHNIQUES AND PROVIDE FACILITIES TO ACQUIRE, PROCESS, STORE, INTERPRET, AND DISSEMINATE RELEVANT INFORMATION OBTAINED BY REMOTE SENSING TO THE RESPONSIBLE USERS. 4. PERFORM ONE OF MORE OF THE ABOVE FUNCTIONS RELATED TO VARIOUS LOCATIONS INCLUDING THE ARIZONA AND ROCKY MOUNTAIN TEST SITES, THE COLORADO RIVER, THE PACIFIC NORTHWEST, DESERT LANDS, PUBLIC LAND, NORTH AND SOUTH CAROLINA, TVA AND APPALACHIA.

RTOP NO. 160-75-75 TITLE: PUBLIC HEALTH ECOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: FULLER, C. E. TEL. 713-483-3108
TECHNICAL SUMMARY

THE PUBLIC HEALTH ECOLOGY GROUP OF THE MEDICAL RESEARCH AND OPERATIONS DIRECTORATE IS ENCOURAGED THAT IT WILL FIND SIGNIFICANT SCIENTIFIC CORRELATIONS BETWEEN DISEASE, WATER, AIR AND URBAN DEGRADATION, AND NATURAL DISASTERS AS THEY SHOW RELATIONSHIPS TO OTHER OBSERVED PHENOMENA SUCH AS INDICATOR SPECIES, CROWN SIGNATURES OF TREES, EVIDENCE OF OTHER RELIABLE SYMBIOTIC RELATIONSHIPS, AND OTHER DIRECT AND INDIRECT INDICES. A FEW EARLY EXAMPLES OF THIS ENCOURAGEMENT ARE THE RECOGNITION OF POORLY DEFINED RELATIONSHIPS SUCH AS THAT OUTBREAK OF SCREWWORMS (COCHLIOMYIA HOMINIVOREX) ON THE UNITED STATES-MEXICAN BORDER ARE ASSOCIATED WITH THE ADVENT OF LUSH VEGETATION ADVANCES; AND IN CASES WHERE CERTAIN INSECT VECTORS ARE KNOWN TO BE ASSOCIATED WITH SPECIFIC SPECIES OF PLANTS IN A SYMBIOTIC RELATIONSHIP, THE HABITAT OF THAT VECTOR MIGHT BE DEFINED BY DETERMINING THE LOCATION AND AREAS COVERED BY THE PLANT USING REMOTE SENSING TECHNIQUES. EXAMPLES OF THIS INCLUDE THE YELLOW FEVER MOSQUITO (AEDES SIMPSONI) RELATIONSHIPS WITH THE FALSE BANANA PLANT, AND ALSO WITH THE COCOA YAM (COLOCASIA) IN AFRICA; THE ST. LOUIS ENCEPHALITIS CARRIER MOSQUITO (CULEX QUINQUEFASCIATUS) SYMBIOSIS WITH CERTAIN CLASSES OF WATER AND PLANTS OF THE TEXAS GULF COAST REGION. THIS EFFORT WILL REQUIRE A THOROUGH KNOWLEDGE OF DATA IN THE EARTH RESOURCES RESEARCH DATA FACILITY AT THE MANNED SPACECRAFT CENTER, ONGOING PROGRAMS, MULTISPECTRAL SENSING DEVICES, AND THEIR AIR AND

SPACE PLATFORMS IN AN EFFORT TO DEFINE SIGNIFICANT SCIENTIFIC CORRELATIONS BETWEEN DISEASE, WATER, AIR, AND URBAN DEGRADATION, NATURAL DISASTERS, AND OTHER OBSERVED SIGNATURE PHENOMENA.

RTOP NO. 160-75-76 TITLE: LASER RADAR MEASUREMENTS OF THE MARINE ATMOSPHERE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THIS RESEARCH DEALS WITH EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF LASER RADAR AS A MEANS OF REMOTELY SENSING THE MARINE ATMOSPHERE. IT INVOLVES THE DEVELOPMENT OF EXPERIMENTAL APPARATUS, PERFORMANCE OF EXPERIMENTAL MEASUREMENTS IN THE MARINE ATMOSPHERE, AND DEVELOPMENT OF THEORETICAL MODELS AND ANALYSES. EMPHASIS WILL BE PLACED ON THE FOLLOWING MEASUREMENTS: MONOCHROMATIC TRANSMISSIVITY OF MARINE ATMOSPHERE, SPATIAL DISTRIBUTION OF SEAL SALTS, AEROSOLS AND MOLECULAR DENSITIES; CONSTITUENT DENSITY DISTRIBUTIONS, ESPECIALLY WATER VAPOR AND CLOUD FORMATION AND DISTRIBUTIONS OVER THE OCEAN. THIS RESEARCH IS EXPECTED TO PROVIDE NEW MEASUREMENT TECHNIQUES FOR STUDYING THE MARINE ATMOSPHERE AND WILL THEREBY CONTRIBUTE TO THE BASIC UNDERSTANDING OF THE AIR-SEA INTERACTION AND OF THE MARINE ENVIRONMENT IN GENERAL. IN ADDITION, IT SHOULD PROVIDE INFORMATION ON ATMOSPHERIC TRANSMISSIVITY WHICH IS NEEDED TO FURTHER RESEARCH ON REMOTE SENSING OF SEA-SURFACE TEMPERATURE BY SATELLITES.

RTOP NO. 160-75-77 TITLE: DEVELOPMENT OF CHESAPEAKE BAY ECOLOGICAL TEST SITE FOR REMOTE SENSING APPLICATIONS
ORGANIZATION: WALLOPS STATION
MONITOR: BETTLE, J. F. TEL. 703-824-3411
TECHNICAL SUMMARY

A BROAD, LONG-RANGE PROGRAM HAS BEEN INITIATED TO ESTABLISH AND DEVELOP THE CHESAPEAKE BAY AS AN AREA IN WHICH MANY POTENTIAL APPLICATIONS OF REMOTE SENSING FROM AIRCRAFT AND SPACECRAFT CAN BE EVALUATED AND CALIBRATED, IN PARTICULAR THOSE INVOLVING LANDSEA INTERFACES. EFFORTS AND PLANS ARE BEING DIRECTED AT MAKING THE BAY AREA A MULTIDISCIPLINARY TEST SITE ABOUT WHICH A SUBSTANTIAL INFORMATION CENTER CAN BE DEVELOPED. THIS INFORMATION WILL BE ACQUIRED FROM SUBSURFACE, SURFACE, AIRCRAFT, AND EARTH RESOURCES SATELLITE OBSERVATIONS. INFORMATION RESULTING FROM WORK WITHIN, AND THE EXCHANGE AND INTERACTION BETWEEN, THESE PROGRAM OBJECTIVES WILL STRONGLY AID IN THE DEVELOPMENT OF TECHNIQUES FOR UNDERSTANDING AND MANAGING ENVIRONMENTAL AND NATURAL RESOURCE PROBLEMS IN THE CHESAPEAKE BAY REGION. THE DEVELOPMENT OF THE SITE WILL PROVIDE A TEST-BED FOR EARTH RESOURCE EXPERIMENTS AND A CALIBRATION AND GROUND TRUTH AREA FOR EARTH SURVEY SPACE SYSTEMS. THE DEVELOPED TECHNOLOGY CAN BE EXTENDED TO OTHER GEOGRAPHICAL AREAS ON AN OPERATIONAL BASIS. IN ORDER TO CONFORM WITH CURRENT FUNDING GUIDELINES, THE PROGRAM CAN PROVIDE FOR ONLY RESTRICTED DEVELOPMENT ACTIVITY IN LIMITED PORTIONS OF THE CHESAPEAKE BAY REGION. FURTHERMORE, THE SCHEDULE FOR

DEVELOPMENT OF A FULL RANGE OF REGIONAL TEST SITE ACTIVITIES MUST BE DEFERRED UNTIL ADEQUATE FUNDS ARE MADE AVAILABLE.

RTOP NO. 160-75-79 TITLE: AMES RESEARCH CENTER AIRBORNE EARTH RESOURCES PROGRAM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

AN AIRBORNE EARTH RESOURCES PROGRAM WILL BE INSTITUTED AT AMES RESEARCH CENTER. THE PROGRAM WILL INCLUDE IN-HOUSE RESEARCH PROGRAMS PERTINENT TO EARTH RESOURCES; COORDINATION AND COOPERATION WITH THE USER COMMUNITY AND OTHER PARTICIPATING AGENCIES TO DEFINE THE PROBLEMS WHICH THE PROGRAM WILL BE DIRECTED TOWARD, AND THE APPROACHES TO BE TAKEN IN RESOLVING THESE PROBLEMS; AND THE DEVELOPMENT OF THE FACILITIES NECESSARY TO CONDUCT THE PROGRAM. LABORATORY AND AERIAL STUDIES DEALING WITH WATER AND AIR POLLUTION WILL BE CONDUCTED. FLIGHT MISSIONS ON THE AMES CV 990 WILL BE CONDUCTED. AMES AND UNIVERSITY OF CALIFORNIA WILL INTERACT AND ASSESS USER COMMUNITY REQUIREMENTS.

RTOP NO. 160-75-81 TITLE: AMES RESEARCH CENTER LIFE SCIENCES EARTH RESOURCES PROGRAM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

RESEARCH PROGRAMS TO DEFINE SPECIFIC ASPECTS OF TERRESTRIAL BIOLOGY ARE PRESENTED. TASKS THAT CAN ENHANCE OR DELINEATE POSSIBLE PROBLEM AREAS IN THE ERTS PROGRAM AT THE UNIV. OF CALIF. ARE INCLUDED. SPECIAL EMPHASIS IS BEING PLACED ON IDENTIFYING THE APPROPRIATE ASPECTS OF SPACE TECHNOLOGY THAT WOULD LEAD TO MORE RELIABLE AND EFFECTIVE METHODS FOR CONDUCTING ECOLOGICAL RESEARCH. THE ROLE OF AIRCRAFT AND SPACECRAFT AS PLATFORMS FOR REMOTE SENSING OF LIFE FORMS IS BEING STUDIED. ACKNOWLEDGED SPECIALISTS AND EXPERTS ARE PARTICIPATING IN DEFINITION AND FULFILLMENT OF RESEARCH GOALS, E.G., THE NATIONAL MARINE FISHERIES SERVICE, SEATTLE (NOAA) AND THE NAVAL UNDERSEA LAB, MARINE BIOSCIENCE DIVISION, SAN DIEGO. FIELD INVESTIGATIONS TO VERIFY THE FEASIBILITY OF VARIOUS SENSORS AND DATA COLLECTING SYSTEMS ARE BEING CONDUCTED. THE RELATIONSHIP BETWEEN WILDLIFE BEHAVIOR AND THE MANY ELEMENTS OF THE EARTH'S BIOSPHERE ARE TO BE DETERMINED FOR USE IN FOOD RESOURCE MANAGEMENT. POOLING OF DATA FOR CORRELATION INCLUDES INTERAGENCY AGREEMENTS WITH CALIFORNIAN AND ALASKAN FISH AND GAME COMMISSIONS, NMFS, NUL, WASHINGTON DEPARTMENT OF FISHERIES, INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION AND BRITISH COLUMBIA DEPARTMENT OF FISHERIES. THE RELATIONSHIP OF THE ORGANIC, HEAVY METAL VAPOR, AND MICROORGANISM CONTENT OF THE ATMOSPHERE TO THE BIOLOGY ON THE SURFACE OF THE EARTH WILL BE DEFINED. A FEASIBILITY STUDY WILL TEST THE CAPABILITY OF THE NIMBUS IRLS CAPABILITY TO RETURN TELEMETERED PHYSIOLOGICAL FUNCTION DATA, E.G., EKG, VENOUS PRESSURE, ARTERIAL PRESSURE, VENTRICULAR AND AURICULAR PRESSURE, BLOOD FLOW, AND DEEP BODY TEMPERATURE, TOGETHER

WITH FURTHER----

RTOP NO. 160-75-82 TITLE: APPLICATIONS OF REMOTE SENSING DATA TO COASTAL ZONE PROBLEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

TO INVESTIGATE THE USE OF EXISTING AND PLANNED REMOTE SENSING DATA TO PROBLEMS PERTINENT TO COASTAL REGIONS, PARTICULARLY THE COASTAL AND ESTUARY PORTIONS OF MIDEASTERN U.S. DATA SOURCES INCLUDE THE ERTS A AND B, SKYLAB-EREP, THE SUPPORTING AIRCRAFT UNDERFLIGHTS, AND ADDITIONAL SUPPLEMENTARY AIRCRAFT- OR HELICOPTER- BORNE SENSORS. SUPPORTING SURFACE OBSERVATIONS WILL BE OBTAINED AS REQUIRED BY CONTRACTUAL AND IN-HOUSE EFFORTS. PROBLEM AREAS OF INITIAL INTEREST INCLUDE WATER MIXING AND CIRCULATION AND THE ASSOCIATED SEDIMENTATION LOADS AND THERMAL CHARACTERISTICS, CORRELATIONS OF MIXING ZONE VARIATIONS WITH PERTINENT PHYSICAL PARAMETERS, MATH MODELING, AND ALTERNATIVE TECHNIQUES FOR DATA PROCESSING AND INFORMATION DISPLAY.

RTOP NO. 160-75-90 TITLE: APPLICATION OF VECTOR MAGNETOMETRY TO EARTH RESOURCES AND GEOLOGICAL STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

THE ARC VECTOR MAGNETOMETER ALONG WITH TECHNIQUES DEVELOPED AS A RESULT OF DEEP SPACE, LOW-FIELD MAGNETOMETRY, WILL BE UTILIZED TO DETERMINE THE CAPABILITIES OF SUCH A SYSTEM FOR REMOTE SENSING AND IDENTIFICATION OF NATURAL GEOMAGNETIC FEATURES FROM AIRCRAFT AND SATELLITES. AIRBORNE VECTOR MAGNETOMETER PROFILES WILL BE MADE TO OBSERVE HIGH FREQUENCY FLUCTUATIONS IN THE POLARITY OF THE EARTH'S MAGNETIC FIELD AS RECORDED IN OCEANIC CRUST FROM WHICH PALEOMAGNETIC DATING CAN BE INFERRED. THE EQUIPMENT WILL ALSO BE USED TO ACQUIRE DATA FROM WHICH GAPS IN THE KNOWLEDGE OF THE GEOMAGNETIC FIELD AT VARIOUS ALTITUDES AND OVER INACCESSIBLE SURFACE AREAS CAN BE FILLED AND FROM WHICH STUDIES RELATING TO THE EARTH'S CRUST AND MANTLE CAN BE UNDERTAKEN TO IDENTIFY FEATURES OF GEOLOGICAL AND EARTH RESOURCE SIGNIFICANCE. THE DATA WILL ALSO BE USED TO ASSIST IN THE FURTHER IDENTIFICATION OF THE ENERGY SOURCE AND MECHANISM OF INTERACTION IN THE CORE OF THE EARTH AND, HENCE, TO ACCOUNT FOR THE PATTERNS OF THE INTERNAL MAGNETIC FIELD AND VARIATIONS IN THE CORE-MANTLE COUPLING. CLOSE WORKING RELATIONSHIPS WITH OTHER AGENCIES WILL BE MAINTAINED TO FACILITATE THE ESTABLISHMENT OF DATA STANDARDS AND EFFECTIVE DATA UTILIZATION. STUDIES WILL BE PERFORMED TO DEFINE THE MISSION AND PERFORMANCE DETAILS FOR A LOW-COST, LOW-ALTITUDE VECTOR MAGNETIC FIELDS SATELLITE.

RTOP NO. 160-79-51 TITLE: SHORT AND LONG TERM DYNAMICS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SMITH, D. E. TEL. 301-982-4555
TECHNICAL SUMMARY

THE PROGRAM PLANS TO INVESTIGATE THE ESTABLISHMENT OF A REFERENCE COORDINATE SYSTEM BY VERY LONG BASELINE INTERFEROMETRY. THIS REFERENCE SYSTEM IS REQUIRED IN THE STUDY OF BOTH THE SHORT AND LONG TERM DYNAMICS OF THE EARTH WHICH IT IS INTENDED TO INVESTIGATE. THE HARDWARE REQUIREMENTS FOR PRECISION SATELLITE TRACKING WILL BE DETERMINED AND THE DEVELOPMENT OF PRECISE TRAJECTORY DETERMINATION SYSTEMS WILL CONTINUE. HARMONIC COEFFICIENTS OF THE EARTH'S GRAVITATIONAL FIELD ARE BEING DETERMINED FROM SATELLITE ORBIT DATA AND GROUND BASED GRAVITY MEASUREMENTS ARE BEING INCLUDED. THE ANALYSIS OF THE TIDAL PARAMETERS FOR THE SOLID EARTH AND THE MEASUREMENT OF THE MOTION OF THE POLE OF ROTATION ARE CONTINUING. EXPERIMENTS FOR THE MEASUREMENT OF THE ROTATION RATE OF THE EARTH AND CONTINENTAL DRIFTS ARE PLANNED TOGETHER WITH INVESTIGATIONS OF THE RELATIONSHIPS BETWEEN POLAR MOTION AND OTHER GEOPHYSICAL PHENOMENA.

RTOP NO. 160-79-55 TITLE: OCEAN DYNAMICS
ORGANIZATION: WALLOPS STATION
MONITOR: STANLEY, H. R. TEL. 703-824-3411
TECHNICAL SUMMARY

THIS PLAN DETAILS THE REQUIRED RESEARCH, STUDIES AND TECHNOLOGY DEVELOPMENT NECESSARY TO ADVANCE THE UNDERSTANDING OF THE DYNAMICS OF THE WORLD'S OCEANS THROUGH THE USE OF AN ORBITING ALTIMETER CAPABLE OF DETERMINING THE TOPOGRAPHICAL RELIEF OF THE PHYSICAL SEA SURFACE WITH 10 CENTIMETER ACCURACY. THE PLAN DEFINES METHODS FOR: 1) THE DEVELOPMENT OF INSTRUMENTATION SUFFICIENT TO MEET THE REQUIRED ACCURACY; 2) THE DEVELOPMENT OF A CALIBRATION AND VERIFICATION PLAN, INCLUDING APPROPRIATE GROUND TRUTH, TO DEMONSTRATE ACHIEVEMENT OF THE REQUIRED ACCURACY; 3) RESEARCH INTO THE EFFECTS OF SEA STATE, WAVE HEIGHT, AND ELECTROMAGNETIC WAVE SCATTERING FROM A NON-LINEAR SEA SURFACE ON THE ALTIMETER SYSTEM ACCURACY; AND 4) THE TESTING OF THE HYPOTHESIS THAT THE REFLECTED ALTIMETER PULSE DOES CONTAIN SEA STATE SIGNATURE, AND THAT UNDERSTANDING OF THISSIGNATURE IS A PREREQUISITE TO ACHIEVING THE REQUIRED SYSTEM ACCURACY. THE EXPERIMENTS AND ANALYSES PROPOSED RELY HEAVILY ON INFORMATION DEVELOPED FROM ON-GOING ASSOCIATED PROJECTS AT WALLOPS STATION. FOR EXAMPLE, CURRENT INSTRUMENTATION DEVELOPMENT FOR THE GEOS-C AND SKYLAB PROJECTS INDICATE THAT THE 10 CENTIMETER INSTRUMENTATION ACCURACY IS FEASIBLE AND THAT AN ORBITING ALTIMETER OF THIS ACCURACY COULD BE FLOWN IN THE 1976-1977 TIME PERIOD. THIS PLAN PROVIDES FOR EXPERIMENTATION AND ANALYSIS IN EACH OF THE FOUR AREAS DESCRIBED ABOVE AND DEMONSTRATES THAT THERE IS A STRONG PROBABILITY THAT THE SYSTEM WILL PROVIDE SIGNIFICANT INFORMATION CONCERNING THE PATTERNS AND TRANSPORTS OF PRIMARY OCEAN CURRENTS, GLOBAL SEA STATE, AND THE GRAVITY FIELD AND GEOIDAL FIGURE OF THE EARTH.

RTOP NO. 160-79-57 TITLE: COHERENT RADAR ALTIMETRY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THIS TASK WILL PROVIDE A MEANS WHEREBY THE RANGE TO AN OCEAN SURFACE FROM AN ELEVATED PLATFORM (TOWER, AIRCRAFT OR SPACECRAFT) CAN BE MEASURED TO AN ACCURACY OF A FEW CENTIMETERS. THE MEASUREMENT IS MADE BY USING THE AMPLITUDE AND PHASE INFORMATION IN THE ECHO GENERATED BY A COHERENT RADAR AND RECORDED BY AN OPTICAL RECORDER. THE COHERENT RADAR SYSTEMS HAVE AN EXTREMELY HIGH DEGREE OF STABILITY THAT ENABLES ACCURATE RECORDING OF THE ECHO PHASE INFORMATION. THESE MEASUREMENTS CAN BE USED TO ESTABLISH THE OCEAN LEVEL ACROSS TRENCHES, AND THE EFFECTS OF TIDES AND CURRENTS UPON OCEAN LEVELS ON A LOCAL OR A WORLD WIDE BASIS.

RTOP NO. 160-79-61 TITLE: LASER INSTRUMENTATION FOR EARTH PHYSICS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: JOHNSON, T. S. TEL. 301-982-4287
TECHNICAL SUMMARY

OBJECTIVE IS DEVELOPMENT, TEST, DEPLOYMENT, AND EVALUATION OF ADVANCED LASER INSTRUMENTS AND SYSTEMS FOR EARTH PHYSICS AND GEODESY PROGRAMS. IN PARTICULAR, IN RESPONSE TO SPECIFIC REQUIREMENTS OF THE EARTH PHYSICS AND GEODESY PROGRAMS, (A) THIS RTOP WILL IMPROVE THE ACCURACY AND PRECISION OF LASER SATELLITE TRACKING OVER THAT PRESENTLY ACHIEVED, INCREASE THE DATA RATE, EXTEND THE TRACKING RANGE, AND SIMPLIFY THE GROUND STATION FOR ECONOMY AND RELIABILITY; (B) IT WILL APPLY LASER RANGING TECHNIQUES TO DEVELOPMENT OF SPACEBORNE LASER ALTIMETERS CAPABLE OF 5 CM PRECISION ABOVE THE OCEAN AND STUDY OF THE SEA SURFACE STATE. LASERS BASED UPON NEODYMIUM DOPING IN YAG (YTTRIUM-ALUMIUM GARNET) AND YALO (YTTRIUM-ALUMINATE) OR IN GLASS WILL BE INCORPORATED INTO SATELLITE TRACKING SYSTEMS AND WILL BE TESTED IN FY72. THIS CAN POTENTIALLY INCREASE PRECISION AND DATA RATE OVER RUBY LASERS BY AN ORDER OF MAGNITUDE. TRACKING OF LUNAR REFLECTORS USING SMALLER TRANSMITTING TELESCOPES WILL BE DEVELOPED. APPLICATION OF SPACEBORNE ND:YAG LASER TO ALTIMETRY AND SEA-STATE OBSERVATIONS WILL BE STUDIED.

RTOP NO. 160-79-64 TITLE: VERY LONG BASELINE INTERFEROMETRY (VLBI)
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: RAMASASTRY, J. TEL. 301-982-5462
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP AND UTILIZE THE TECHNIQUES OF VERY LONG BASELINE INTERFEROMETRY (VLBI) FOR PRECISE GEODETIC AND ASTROMETRIC MEASUREMENTS, UNIVERSAL TIME-SYNCHRONIZATION, PRECISION SATELLITE TRACKING AND EARTH PHYSICS INVESTIGATIONS WITH AN OPERATIONAL NETWORK. THIS NETWORK SHOULD CONSIST OF A NUMBER OF INDEPENDENT STATIONS EQUIPPED WITH RECEIVING ANTENNAS CAPABLE OF OBSERVING BOTH NATURAL RADIO SOURCES (QUASARS, PULSARS, RADIO GALAXIES) AND SATELLITE BORNE RADIO SOURCES IN THE FREQUENCY RANGE 1-10 GHZ, PLUS A CENTRAL PROCESSING FACILITY WHERE

THE DATA TAKEN AT THE STATIONS IS CROSS CORRELATED. MAIN EFFORT WILL BE CONCENTRATED ON UTILIZING NASA TRACKING NETWORKS (MSFN, STADAN, ATSR), WITH SIMPLE MODIFICATICNS WHERE AND WHEN NECESSARY FOR CONDUCTING VLBI OBSERVATIONS ON A ROUTINE BASIS. RADIO ASTRONOMY SITES (OWENS VALLEY, CALIFORNIA; HAYSTACK, MASSACHUSETTS; GREENBANK, WEST VIRGINIA; AGASSIZ, MASSACHUSETTS; GOLDSTONE, CALIFORNIA AND MANY OTHERS) WILL ALSO BE UTILIZED WHERE AND WHEN NECESSARY. A PRIME BENEFIT OF VLBI FOR THE EARTH AND OCEAN DYNAMICS PROGRAM IS THE CAPABILITY FOR UTILIZING A QUASAR-DEFINED INERTIAL REFERENCE-FRAME IN GEOPHYSICAL INVESTIGATIONS. THIS RTOP ALSO SEEKS IMPROVEMENTS IN THE HARDWARE TO ENHANCE THE PRECISION OF THE VLBI TECHNIQUE, AND REFINEMENTS IN ASSOCIATED SOFTWARE TO PROCESS LARGE VOLUMES OF DATA. AN INTENSIVE, CONTINUING, OBSERVATIONAL PROGRAM HAS BEEN UNDERTAKEN

RTOP NO. 160-79-64 TITLE: VERY LONG BASELINE INTERFEROMETRY (VLBI) EARTH PHYSICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

TO DEMONSTRATE THE FEASIBILITY OF USING THE DEEP SPACE NETWORK (DSN) FOR MAKING VERY LONG BASELINE INTERFEROMETRY (VLBI) OBSERVATIONS OF GEOPHYSICALLY SIGNIFICANT PHENOMENA AND ESTABLISHMENT OF A HIGH ACCURACY CELESTIAL RADIO SOURCE COORDINATE FRAME WHICH IS REFERABLE TO THE SOLAR SYSTEM. A. USING DSN TRACKING STATIONS, DEMONSTRATE THE FEASIBILITY OF USING THE VLBI TECHNIQUE FOR MEASURING VARIATIONS IN UNIVERSAL TIME (UT) AND POLAR MOTION (PM) WITH THE ACCURACY OF THE OPTICAL STATE-OF-THE-ART (OUT = 3 MILLISECONDS, OPM = 1 METER). B. INTERCOMPARE VLBI GEOPHYSICAL RESULTS WITH: 1. CURRENTLY AVAILABLE OPTICALLY DETERMINED UT AND PM. 2. DSN STATION LOCATIONS, UT AND PM AS DERIVED FROM DOPPLER AND RANGE TRACKING OF THE MM'71 MARS ORBITING SPACECRAFT. 3. CONVENTIONAL ANDSATELLITE GEODESY. C. ESTABLISHMENT OF A RIGHT ASCENSION ORIGIN FOR THE CELESTIAL RADIO REFERENCE FRAME (TO WITHIN 0.005" WITH RESPECT TO MARS) BY VLBI PHASE-COHERENT COMPARISONS OF THE MM'71 RADIO TRANSMISSION WITH EXTRA-GALACTIC RADIO SOURCES. D. ASSESS THE RELATIVE MERITS OF VLBI SPACECRAFT TRACKING AND CONVENTIONAL TWO-WAY AND TWO-WAY MINUS THREE-WAY DOPPLER TRACKING OF SPACECRAFT.

RTOP NO. 160-79-68 TITLE: GEODETIC & EARTH PHYSICS EXPERIMENT SYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: SIRY, J. W. TEL. 301-982-4905
TECHNICAL SUMMARY

INVESTIGATIONS WILL BE MADE OF THE VALUE OF LOW-ALTITUDE OBSERVATORY SYSTEMS, INCLUDING EARTH HARMONIC SPACECRAFT, AND SATELLITES AT OTHER ALTITUDES, SUCH AS GEODYNAMIC, GEOPAUSE AND EARTH PHYSICS OBSERVATORY SPACECRAFT, IN CONNECTION WITH MEETING A VARIETY OF APPLICATIONS AND SCIENTIFIC OBJECTIVES. AMONG THE SCIENTIFIC DISCIPLINES INVOLVED ARE GEODESY, OCEAN PHYSICS, GEOMAGNETISM, IONOSPHYSICS, SEISMOLOGY, ATMOSPHERIC PHYSICS, AND IONOSPHERIC

PHYSICS. THE ASSOCIATED TECHNOLOGICAL PROGRAMS INCLUDE THE DEVELOPMENT AND USE OF SATELLITE-TO-SATELLITE TRACKING SYSTEMS, SATELLITE ALTIMETER SYSTEMS, DRAG-FREE SATELLITE SYSTEMS AND LASER AND VLBI SYSTEMS. IN THE FIELD OF GEODESY, FOR EXAMPLE, THE GRAVITATIONAL FIELD OF THE EARTH WILL BE STUDIED IN TWO WAYS, BY SATELLITE-TO-SATELLITE TRACKING OF LOW-ALTITUDE EARTH HARMONIC GRAVMAG SPACECRAFT ORBITING IN THE 250 TO 300 KILOMETER ALTITUDE RANGE, AND BY MEANS OF SATELLITE-BORNE ALTIMETERS OPERATING IN THESE SPACECRAFT AND IN EARTH PHYSICS OBSERVATORIES AT ABOUT 700 KM ALTITUDE. THESE SAME ALTIMETERS WILL ALSO BE USED FOR OCEAN PHYSICS INVESTIGATIONS INCLUDING SEA STATE STUDIES AND SURVEYS OF THE OCEAN SURFACE TOPOGRAPHY. ULTIMATELY, THE GEODESY AND OCEAN PHYSICS PROGRAMS TOGETHER MAY YIELD INFORMATION ABOUT THE RELATIONSHIP BETWEEN THE GEOID AND THE OCEAN SURFACE. SUCH KNOWLEDGE WILL BE VALUABLE IN CONNECTION WITH STUDIES OF THE GENERAL CIRCULATION OF THE OCEANS, CURRENTS, TSUNAMIS, STORM SURGES, ETC.

RTOP NO. 160-79-69 TITLE: GEODESY AND GEODETIC SYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BERBERT, J. H. TEL. 301-982-5055
TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS TECHNOLOGY FOR UTILIZING AVAILABLE SPACECRAFT TRACKING AND SURFACE GRAVITY DATA FOR GEODESY AND FOR AN INITIAL EARTH PHYSICS REFERENCE SYSTEM. EXPECTED RESULTS INCLUDE THE DEVELOPMENT OF A STANDARD GEOMETRIC AND GRAVIMETRIC EARTH REFERENCE SYSTEM BY 1973. THIS REFERENCE SYSTEM IS REQUIRED AS A BASIS FOR REFERENCING THE DYNAMIC EARTH MEASUREMENTS OF THE NEW EARTH PHYSICS PROGRAM. THIS WILL ALSO PROVIDE A DETERMINATION OF THE MOST SUITABLE GRAVITY MODELS FOR GODDARD TRAJECTORIES NEAR THE EARTH, AND A MORE ACCURATE DETERMINATION OF THE COORDINATES OF THE NASA TRACKING STATIONS ON A UNIFIED WORLD DATUM. THESE RESULTS SHOULD IMPROVE NASA'S ORBIT PREDICTION AND MISSION ANALYSIS CAPABILITIES LEADING TO AN EVENTUAL REDUCTION IN TRACKING DATA COLLECTION AND ANALYSIS REQUIREMENTS.NEW GRAVITY FIELDS AND STATION COORDINATES ARE DEVELOPED FROM AVAILABLE DATA (NGSP, ISAGEX, SURFACE GRAVITY) AND EVALUATED BY COMPARISONS WITH PREVIOUS SOLUTIONS AND WITH INDEPENDENT DATA.

RTOP NO. 164-06-50 TITLE: COMMUNICATIONS SYSTEMS ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE CONTINUING DEVELOPMENT OF COMMUNICATION SATELLITES, INFORMATION NETWORKS, AND SYSTEM MONITORS IS PLACING A PREMIUM ON COMMUNICATIONS FREQUENCIES AND CHANNEL BANDWIDTH. AS A RESULT, THERE IS AN OVERWHELMING NEED TO INVESTIGATE ALL POSSIBLE METHODS OF BANDWIDTH CONSERVATION, AND RECOMMEND THE USE OF THOSE BANDWIDTH SAVING TECHNIQUES WHICH DO NOT IN OTHER WAYS DEGRADE OR

OVERCOMPLICATE THE DESIGN OF THE SYSTEM. SECONDLY, A GOOD UNDERSTANDING OF THE CHANNELS KNOWN, AND UNKNOWN, AND TIME-VARYING PARAMETERS IS ESSENTIAL IF THE PERFORMANCE OF THE PROPOSED DESIGNS IS TO BE OPTIMIZED. MULTIPATH AND MANMADE INTERFERENCE MUST BE ACCOMMODATED FOR IN THE SYSTEMS. ANALYSIS AND EXPERIMENTAL DEMONSTRATION OF A SUPPRESSED-CARRIER, COHERENT SINGLE-SIDEBAND DIGITAL DATA TRANSMISSION SYSTEM EMPLOYING TWO INDEPENDENT DATA CHANNELS IS AN IMMEDIATE GOAL OF THIS EFFORT. EACH DATA CHANNEL, WHICH MAY BE AT DIFFERENT DATA RATES, FORMS RESPECTIVELY THE UPPER AND LOWER SIDEBANDS OF THE SUPPRESSED CARRIER. A DATA-AIDED TYPE CARRIER REGENERATING LOOP IS USED TO DERIVE CARRIER COHERENCE. TRANSMITTER EFFICIENCY, LINEARITY AND INTER-CHANNEL INTERFERENCE ARE IMPORTANT MEASURES OF SYSTEM PERFORMANCE, AS IS THE OVERALL EFFICIENCY MEASURED BY THE REQUIRED ENERGY-TO-NOISE SPECTRAL-DENSITY RATIO. THE WORTH OF MULTI-LEVEL SIGNAL SETS IS ALSO BEING GIVEN CONSIDERATION AS A POTENTIAL BANDWIDTH SAVING TECHNIQUE. ADDITIONAL STUDIES WILL INCLUDE IDENTIFYING THE TIME-VARYING PARAMETERS OF LINKS IN TANDEM, AND SEEKING A BETTER ANALYTICAL UNDERSTANDING OF THE LINEAR AND NON-LINEAR DEVICES THAT MAKE UP A SATELLITE RELAY SYSTEM. THE EXPERIMENTAL EVALUATION WORK WILL BEACCOMPLISHED VIA FUNCTIONAL SIMULATION----

RTOP NO. 164-06-53 TITLE: ADVANCED DOMESTIC COMMUNICATION SATELLITE SYSTEMS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: LYNCH, T. J. TEL. 301-982-2265

TECHNICAL SUMMARY

TO ASSESS THE TECHNICAL AND ECONOMIC FEASIBILITY OF USING COMMUNICATIONS SATELLITES TO FULFILL THE INFORMATION TRANSFER REQUIREMENTS OF PROFESSIONAL, INDUSTRIAL, GOVERNMENTAL USER COMMUNITIES. TO DEVELOP SYSTEM AND SATELLITE CONFIGURATION OPTIONS WHICH FUTURE TECHNOLOGY REQUIREMENTS CAN BE DETERMINED. THE RTOP TASKS WILL FORM THREE GENERAL CATEGORIES: A) DOMESTIC INFORMATION NETWORKS. INCLUDED IN THIS CATEGORY WILL BE BIOMEDICAL COMMUNICATION NETWORKS STUDIES AND LAW ENFORCEMENT NETWORK STUDIES AS WELL AS STATISTICAL COST MODELING FOR COMMUNICATIONS SATELLITE SYSTEMS. B) COMMUNICATIONS SYSTEMS FOR RURAL/REMOTE REGIONS. IN THIS CATEGORY WILL BE INCLUDED STUDIES FOR EXPERIMENTAL SATELLITE SYSTEMS FOR THE STATE OF ALASKA, AS WELL AS FOR OTHER RURAL REGIONS SUCH AS THE ROCKY MOUNTAIN REGION, THE NORTHWEST AND SOUTHWEST STATES, APPALACHIA, THE PACIFIC BASIN AND TRUST TERRITORIES. C) SUBSYSTEM TECHNIQUES ANALYSES. WITHIN THIS CATEGORY WILL BE INCLUDED STUDIES ON REPEATER TECHNOLOGY, MULTI-FUNCTIONAL COMMUNICATIONS SATELLITES, BANDWIDTH COMPRESSION TECHNIQUES, AND ERROR CONTROL CODING TECHNIQUES.

RTOP NO. 164-06-56 TITLE: INFORMATION TRANSFER VIA COMMUNICATION SATELLITES

ORGANIZATION:

MONITOR: FOSTER, J. V. TEL. 415-961-2267

TECHNICAL SUMMARY

DETERMINE THE REQUIREMENTS FOR EFFECTIVE TELECONFERENCING AND INTERACTIVE COMPUTER DATA TRANSFER VIA COMMUNICATION SATELLITES. FULLY EXPLOIT THE TECHNICAL POTENTIAL OF SATELLITE LINKS FOR THIS APPLICATION, WHICH CANNOT BE PROVIDED BY EXISTING LAND-LINE FACILITIES. MAXIMIZE THE COMMUNICATION LINK EFFICIENCY FROM POWER AND BANDWIDTH ASPECTS BY APPLICATION OF SOURCE AND CHANNEL CODING TECHNIQUES. ANALYZE THE TRADE-OFF BETWEEN SYSTEM PARAMETERS TO DEVELOP A COST-EFFECTIVE GROUND TERMINAL. DEVELOP AN ALL-DIGITAL TELECONFERENCING SYSTEM FOR VOICE, VIDEO, HARD-COPY, AND COMPUTER DATA TRANSFER TO SET A STANDARD OF PERFORMANCE; DETERMINE BY COMPARISON TESTING WITH AND WITHOUT SATELLITE LINK, THE DEGREE TO WHICH EACH ELEMENT OF THE TOTAL SYSTEM CONTRIBUTES TO THE OVERALL FIDELITY. DESIGN AND DEVELOP AN ADVANCED GROUND TERMINAL FOR CONDUCTING EXPERIMENTS WITH EXISTING AND PLANNED COMMUNICATION SATELLITES. EXTEND THE GROUND TERMINAL CAPABILITIES TO EXPLORE AND CHARACTERIZE THE HIGH FREQUENCY CHANNELS TO THE 100 GHZ REGION. USE THE ABOVE DATA BASE TO DETERMINE THE EFFECTIVENESS OF SATELLITE LINKS FOR OTHER USER REQUIREMENTS.

RTOP NO. 164-18-51 TITLE: SATELLITE APPLICATIONS FOR AERONAUTICAL SYSTEMS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: MALINOWSKI, A. B. TEL. 301-982-6462

TECHNICAL SUMMARY

THE WORK IN THIS RTOP IS DIRECTED TOWARDS THE DEVELOPMENT AND APPLICATION OF SATELLITE NAVIGATION, SURVEILLANCE AND COMMUNICATION SYSTEMS TO (1) IMPROVE OR AUGMENT THE PRESENT DOMESTIC AND OCEANIC AIR TRAFFIC CONTROL SYSTEMS. THE MAJOR SERVICES WHICH CAN BE PROVIDED BY THE NAVIGATION, SURVEILLANCE AND COMMUNICATION FUNCTIONS ARE: GROUND DERIVED COLLISION AVOIDANCE FOR AIRCRAFT, ASSISTANCE TO SEARCH AND REDJCE OPERATIONS, ASSISTANCE TO FLOW CONTROL OF AIRCRAFT FROM TERMINAL TO TERMINAL. BECAUSE OF THE UNIQUE ABILITY OF SATELLITES TO KEEP IN VIEW ALL MOBILE TRAFFIC AT ALL TIMES OVER LARGE GEOGRAPHIC REGIONS (E.G., UNITED STATES), SATELLITE SYSTEMS WHICH PROVIDE NAVIGATION, SURVEILLANCE AND COMMUNICATION FUNCTIONS BECOME HIGHLY ATTRACTIVE CANDIDATES FOR AIR TRAFFIC CONTROL SERVICES. HOWEVER, THERE ARE MANY QUESTIONS THAT NEED TO BE ANSWERED IF SATELLITE SYSTEMS ARE TO BE IMPLEMENTED TO OPERATE IN PLACE OF OR IN ADDITION TO THE PRESENT OR FUTURE GROUND SYSTEMS. SOME OF THE MAJOR QUESTIONS ARE CONCERNED WITH SYSTEM PERFORMANCE (E.G., POSITION LOCATION ACCURACY), CAPACITY (NUMBER OF USERS), COST FACTORS (USER AND GOVERNMENT COSTS TO ESTABLISH AND OPERATE) AND SYSTEM RELIABILITY. THE STUDY EFFORTS OF THIS RTOP WILL ATTEMPT TO DEFINE ALL SUCH QUESTIONS AND PROVIDE THE ANSWERS. THE WORK TOWARDS THE SOLUTION OF THESE PROBLEMS CONSISTS OF MOSTLY STUDY EFFORTS TO (1) DEFINE THE COMMUNITY OF USERS AND THEIR NEEDS, (2) DEVELOP SATELLITE NAVIGATION SURVEILLANCE, NAVIGATION AND COMMUNICATION TECHNIQUES, (3)

DEVELOP NEW AND IMPROVED SATELLITE COMPONENTS, AND (4) DEFINE NAVIGATION, SURVEILLANCE AND COMMUNICATION EXPERIMENT FOR SATELLITES.

RTOP NO. 164-18-51 TITLE: NAVIGATION AND TRAFFIC CONTROL
ORGANIZATION: NASA WALLOPS STATION
MONITOR: LACHEMAN, E. R., JR.EL. 703-824-3411
TECHNICAL SUMMARY

THIS NAVIGATION AND TRAFFIC CONTROL PROGRAM WILL PROVIDE A LABORATORY TYPE ANALYSIS TO SEVERAL NEW NAVIGATIONAL CONCEPTS. IT IS PLANNED TO CONDUCT FIELD EXPERIMENTS TO EMPIRICALLY DEMONSTRATE THE VALUE OF THESE TECHNIQUES. THE STUDIES WILL INCLUDE RANGING SYSTEMS WITH VARIOUS SPATIAL DISTRIBUTIONS AND UTILIZING PHASE, ENVELOPE AND CORRELATION DETECTION SCHEMES IN THE TIME INTERVAL MEASUREMENT SYSTEMS. IT IS NOT THE PRIME PURPOSE OF THIS STUDY TO DEVELOP NEW HARDWARE BUT TO RECONFIGURE, STRATEGICALLY LOCATE, AND PROPERLY APPLY EXISTING HARDWARE TO ENHANCE ITS USE FOR PRACTICAL NAVIGATION MISSIONS. SPECIAL EMPHASIS WILL BE GIVEN TO THE ROLE OF SATELLITES IN NAVIGATION AND IN PARTICULAR USE OF EXISTING COMMUNICATIONS SATELLITES.

RTOP NO. 164-18-52 TITLE: DATA COLLECTION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: COTE, C. E. TEL. 301-982-4215
TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE AND DETERMINE FUTURE USER REQUIREMENTS, IDENTIFY MISSIONS, GENERATE CONCEPTS AND DEVELOP TECHNOLOGY FOR COLLECTING DATA FROM FIXED AND MOBILE DATA COLLECTION PLATFORMS USING SATELLITES. A SIGNIFICANT OBJECTIVE WILL BE TO DEVELOP SYSTEMS WHICH CAN BE IMPLEMENTED ECONOMICALLY, ALLOW FOR CONTINUED GROWTH IN NUMBER OF USERS, AND MEET INCREASED REQUIREMENTS IN TERMS OF DATA TRAFFIC DENSITIES, LOCATION ACCURACY, VELOCITY ESTIMATION, AND REAL-TIME TRACKING. EXPERIMENTAL SYSTEMS WILL BE DEVELOPED AND PROPOSED AS EXPERIMENTS ON NASA APPLICATION SATELLITES. KNOWN AND POTENTIAL USERS OF DATA COLLECTION WILL BE SURVEYED TO DETERMINE REQUIREMENTS. MISSIONS WILL BE ASSIGNED PRIORITIES AND CONCEPTUAL STUDIES WILL BE INITIATED. A STUDY TO DETERMINE THE IMPACT OF SATELLITE ON-BOARD PROCESSING IN REDUCING ON-BOARD STORAGE AND GROUND DATA PROCESSING REQUIREMENTS WILL BE PERFORMED. A CONTINUING PROGRAM OF COMPONENT TECHNOLOGY WILL BE CARRIED OUT WHEREIN A MASS-TO-AREA-RATIO OF LESS THAN 2 GRAMS PER SQUARE CENTIMETER WITH A GOAL IN DESIGN OF ANTENNAS, TRANSMITTERS AND DATA HANDLING CIRCUITRY FOR PLATFORMS. ALL KNOWN REQUIREMENTS CAN BE MET USING LOW ALTITUDE AND SYNCHRONOUS ALTITUDE SATELLITES CARRYING APPROPRIATE TRANSPONDERS. THE LOW ALTITUDE SYSTEMS PROVIDE FOR POSITION LOCATION AS WELL AS DATA COLLECTION OVER ALL AREAS OF THE EARTH. THESE SYSTEMS HAVE AN INHERENT CAPABILITY FOR HIGH ACCURACY BECAUSE OF LOW GEOMETRIC DILUTION OF POSITION (GDOP). THE SYNCHRONOUS SYSTEMS PROVIDE CONTINUOUS COVERAGE AND IN THE CASE OF OPLE REQUIRES ONLY A SINGLE SATELLITE FORHEMISPHERE COVERAGE. EITHER SYSTEM CAN BE RANDOM OR PROVIDED WITH AN INTERROGATION RECEIVER.

RTOP NO. 164-21-52 TITLE: COMMUNICATIONS SATELLITE MICROWAVE POWER RESEARCH TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ALEXOVICH, R. E. TEL. 216-433-6689
TECHNICAL SUMMARY

TO ADVANCE THE STATE-OF-THE-ART IN HIGH POWERSATELLITE COMMUNICATION COMPONENTS AND SUBSYSTEMSABOVE .5 GHZ, PRIMARILY IN SUPPORT OF APPLICATIONSOF SPACE BROADCASTING, INFORMATION NETWORKING,NAVIGATION, INTERPLANETARY COMMUNICATION, RADARMAPPING AND TO MEET FUTURE REQUIREMENTS IN POST1975 TIME PERIOD. SPECIFIC OBJECTIVE OF THIS RTOPIS TO PROVIDE THE BASIC HIGH POWER RF SYSTEMSTECHNOLOGY FOR ALL OF THE ABOVE APPLICATIONS, ANDTHE APPLICATIONS PECULIAR TECHNOLOGY FOR BRAODCASTAND INFORMATION NETWORKING SATELLITES. TO ACHIEVETHESE OBJECTIVES, RESEARCH AND TECHNOLOGYDEVELOPMENT PROGRAMS ARE UNDERWAY ON MICROWAVEAMPLIFIERS, ANTENNAS, RF HARDWARE, AND SIGNALPROCESSING TECHNIQUES FOR SPACE APPLICATIONS ANDGROUND RECEPTION. STUDIES AND INVESTIGATIONS OFSPACE-EARTH PROPAGATION AND INTERFERENCE ARE ALSOUNDERWAY. APPROACHES TO SPACECRAFT UPLINKCOMMUNICATIONS AND COMMAND ARE BEINGINVESTIGATION. SPECIFIC TECHNIQUES SUCH ASMULTISTAGE DEPRESSED BEAM COLLECTION FOR LINEARAND CROSS-FIELD AMPLIFIERS ARE AMONG PROMISINGTECHNIQUES BEING INVESTIGATED.----

RTOP NO. 164-21-54 TITLE: COMMUNICATION SATELLITE ANTENNA RESEARCH
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THIS EFFORT SYNTHESIZES ANTENNA APERTURE DISTRIBUTIONS AND DEMONSTRATES ANTENNA SYSTEM DESIGNS FOR NASA'S COMMUNICATION BROADCAST, AND DATA RELAY SATELLITES, SO AS TO PERMIT EFFICIENT OPERATION AT NEW AND HIGHER FREQUENCIES; TO REDUCE THE SIDELOBES FROM A SINGLE ANTENNA; TO CREATE MULTIPLE ANTENNA BEAMS; AND TO SHAPE BEAMS FOR AREA COVERAGE. OPERATION AT HIGHER FREQUENCIES IS A NECESSITY IN AN ALREADY CROWDED SPECTRUM; THEREFORE, DURING FY'72, EMPHASIS WILL BE PLACED ON K-BAND OPERATION. REDUCING SIDELOBE SPILLOVER WILL ALLOW MORE SATELLITES BY REDUCING MUTUAL INTERFERENCE BETWEEN SATELLITES. MULTIPLE AND STEERABLE BEAMS ARE NECESSARY TO ALLOW TRANSMISSION TO DIFFERENT GROUND STATIONS FROM THE SAME SATELLITE WITHOUT USING UP SPECTRUM SPACE AT EARTH LOCATIONS WHICH DO NOT REQUIRE TRANSMISSION. BEAM SHAPING WILL PERMIT COVERAGE OF UNIQUE AREAS AND SHARPER CUT-OFF AT INTERNATIONAL BOUNDARIES. A THEORETICAL IN-HOUSE EFFORT IS PLANNED IN WHICH TWO PARALLEL PROGRAMS WILL BE PURSUED. ONE IS A SPHERICAL WAVE EXPANSION PROGRAM WHICH WILL BE A SOLUTION TO MAXWELL'S EQUATIONS GIVING EXACT RESULTS; THE OTHER, THE ADDITION OF THE APERTURE DISTRIBUTIONS WHICH INDIVIDUALLY GENERATE PENCIL BEAMS, THE SUM OF THESE BEAMS BEING THE APPROXIMATE DESIRED SHAPED PATTERN. THESE TWO APPROACHES SHOULD LEAD TO THE SYNTHESIS OF AN APERTURE WHICH WILL BE PRACTICAL FOR IMPLEMENTATION.

RTOP NO. 164-21-54 TITLE: MULTIPLE NARROW BEAM SHAPED PATTERN ANTENNA TECHNOLOGY DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: LYNCH, T. J. TEL. 301-982-2265
TECHNICAL SUMMARY

ONE OF THE ESSENTIAL SUBSYSTEMS OF ADVANCED DOMESTIC COMMUNICATIONS SATELLITE SYSTEMS IS A SATELLITE ANTENNA CAPABLE OF MULTIPLE, NARROW-BEAM AND SHAPED-BEAM TRANSMISSION. DEVELOPMENT OF SUCH AN ANTENNA SYSTEM IS NEEDED SINCE THE STATE-OF-THE-ART IS RELATIVELY NEW IN THIS AREA. SUCH A SYSTEM MUST HAVE SHAPED BEAM PATTERNS WITH LOW SIDELOBES IN ORDER TO MINIMIZE SPILL-OVER INTO AREAS NOT INTENDED FOR RECEPTION, MAKE MORE EFFICIENT USE OF RADIATED ENERGY, DIMINISH THE PROBLEM OF INTERFERENCE WITH TERRESTRIAL SYSTEMS AND NEARBY COUNTRIES, AND MAKE MORE EFFICIENT USE OF THE GEOSTATIONARY ORBIT AND THE SHARED FREQUENCY SPECTRUM. DIFFERENT APPROACHES WILL BE ANALYZED FOR MEETING THE ABOVE ANTENNA REQUIREMENTS, INCLUDING DIELECTRIC LENS SYSTEMS, MULTIPORTED ARRAYS SUCH AS THE BUTLER ARRAY, RETRODIRECTIVE ANTENNAS, WAVEGUIDE LENSES, ETC.

RTOP NO. 164-21-55 TITLE: TRACKING AND DATA RELAY SATELLITE TECHNOLOGY DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CLARK, GEORGE Q. TEL. 301-982-6331
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR AN ORDERLY DEVELOPMENT OF THE COMMUNICATION TECHNIQUES REQUIRED FOR IMPLEMENTING A TRACKING AND DATA RELAY SYSTEM FOR SUPPORT OF NASA MISSIONS IN THE MID-1970'S AND BEYOND. VARIOUS STUDIES SHALL BE PERFORMED TO IDENTIFY THE PROBLEMS ASSOCIATED WITH SUCH A SYSTEM. THE IDENTIFIED PROBLEMS WILL THEN BE ATTACKED IN A UNIFIED MANNER. TRADE-OFF AREAS WILL BE IDENTIFIED AND BOTH DATA AND CRITERIA WILL BE DEVELOPED TO AID IN CHOICE OF THE TRADE-OFF. THE STATE OF THE ART WILL BE DETERMINED AND WHERE NECESSARY TECHNOLOGY DEVELOPMENT PROBLEMS WILL BE INITIATED. THE TDRS INVOLVES THE USE OF HIGHLY STABLE AND COMPLEX SATELLITES AT SYNCHRONOUS ALTITUDES WITH MULTIPLE, INDIVIDUALLY POINTABLE, ANTENNA BEAM.THEREFORE A CONSIDERABLE AMOUNT OF EFFORT WILL BE SPENT ON THE DEVELOPMENT OF UNIQUE SPACECRAFT TECHNOLOGY.

RTOP NO. 164-21-55 TITLE: PLANETARY TRACKING DATA RELAY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

TRACKING AND DATA RELAY SATELLITES HAVE SIGNIFICANT POTENTIAL FOR IMPROVING THE COST-EFFECTIVENESS OF PLANETARY TRACKING AND DATA ACQUISITION. A TRACKING AND DATA RELAY SATELLITE NETWORK (TDRSN) FOR EARTH BOUND SATELLITES HAS ALREADY BEEN SHOWN TO BE FEASIBLE AND ECONOMICAL. SINCE SOME OF THE ECONOMIC FACTORS IN THE EARTH CASE ARE NOT APPLICABLE, THE FEASIBILITY OF A PLANETARY TRACKING AND DATA RELAY MUST BE DEMONSTRATED. THE LONG TERM OBJECTIVE OF THIS RTOP IS

TO DETERMINE THE FEASIBILITY OF A PLANETARY TRACKING AND DATA RELAY AND UNDER WHAT CIRCUMSTANCES IT IS MOST ECONOMICAL. EMPHASIS WILL BE PLACED ON COST EFFECTIVE DESIGNS. THE OBJECTIVE WILL BE ACHIEVED BY DETERMINING THE ANTICIPATED FUNCTIONAL REQUIREMENTS, DATA VOLUMES, AND MISSION PROFILES. THESE FACTORS WILL BE USED TO ACCOMPLISH A SHORT FORM ADVANCED MISSION STUDY AS A PRELIMINARY ESTIMATE FOR THE NEED OF A FULL ADVANCED MISSION STUDY. THE COMMUNICATIONS SYSTEM FUNCTIONAL REQUIREMENTS WILL BE USED AS A BASIS FOR SYSTEM DEMONSTRATIONS OF CERTAIN DIFFICULT HARDWARE PERFORMANCE REQUIREMENTS IN PREPARATION FOR SUCH A MISSION. JUPITER WILL BE EXAMINED AS WELL AS MARS BECAUSE RELAY IS ESPECIALLY NECESSARY DUE TO THE DELETERIOUS EFFECTS OF THE JUPITER ATMOSPHERE ON COMMUNICATION.

RTOP NO. 164-21-57 TITLE: LASER COMMUNICATION DEVELOPMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: CARRION, W. J. TEL. 301-982-4942
TECHNICAL SUMMARY

OBJECTIVE IS TO DEVELOP EFFICIENT SYSTEMS FOR VERY WIDE-BAND COMMUNICATION SUITABLE FOR NASAMISSIONS REQUIRING HIGH DATA RATE LINKS BETWEEN TWO SPACECRAFT AND BETWEEN SPACECRAFT AND GROUND STATIONS. PRIMARY EFFORT WILL BE DEVELOPMENT OF TECHNIQUES AND COMPONENTS FOR SYSTEMS USING CARBON-DIOXIDE AND NEODYMIUM LASERS. THE GOALS ARE DIGITAL LINKS WITH CAPACITY OF 1.2 GIGABIT/SEC AND ANALOG MODULATION LINKS WITH INFORMATION BANDWIDTH OF 120 MHZ. BOTH CO2 AND ND SYSTEMS SHOW PROMISE OF PROVIDING SUCH CAPACITY WITH LOW POWER CONSUMPTION, LIGHT WEIGHT, SMALL ANTENNAS, AND NEGLIGIBLE INTERFERENCE AND SPECTRUM CROWDING. THEY WILL ULTIMATELY BE USED IN MISSIONS SUCH AS TDRS AND EARTH RESOURCES SATELLITES. GSFC IS THE ONLY ORGANIZATION DEVELOPING AND TESTING CO2 LASER SYSTEMS FOR SPACE COMMUNICATION. ND SYSTEMS ARE ALSO BEING DEVELOPED BY MSFC AND DOD, AND RELATED WORK IN THIS RTOP IS BEING CLOSELY COORDINATED TO OPTIMIZE ALL GOVERNMENT WORK IN REACHING OUR OBJECTIVES. IN FY71, THE CO2 LASER SYSTEM ELEMENT OF THIS RTOP WILL DEVOTE ITSELF TO SOLVING REMAINING ENGINEERING PROBLEMS PRIOR TO DESIGN OF S/C HARDWARE. A UNIVERSITY STUDY OF LASER LIFETIME LIMITING MECHANISMS WILL BE CONTINUED, AND AN ENGINEERING MODEL OF THE OPTO-MECHANICAL STRUCTURES AND CONTROL FUNCTIONS WILL BE DEVELOPED AND TESTED. IN FY72, THE ENGINEERING MODEL WILL BE COMPLETED BY THE ADDITION OF LASERS, MIXERS, AND ELECTRONICS SUITABLE FOR AN ATS-G EXPERIMENT, AND TESTED IN THE LABORATORY AND FIELD. ALSO, A SPACE QUALIFIED 10.6 MICRON RECEIVER CAPABLE OF GIGAHERTZ RESPONSE WILL BE DEVELOPED. THE ND LASER ELEMENT WILL BE DIRECTED TO DEVELOPMENT OF1.06 MICRON PHOTOMULTIPLIERS WITH NANOSECOND----

RTOP NO. 164-21-58 TITLE: EDUCATIONAL COMMUNICATIONS SATELLITE SYSTEM STUDY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MILLER, J. E. TEL. 301-982-5885
TECHNICAL SUMMARY

TO CONDUCT A COMPREHENSIVE STUDY OF THE TECHNOLOGICAL AND COST

FACTORS OF AN ADVANCED EDUCATIONAL COMMUNICATION SATELLITE SYSTEM BASED ON THE GOAL OF ESTABLISHING A PILOT EXPERIMENTAL SYSTEM IN THE 1976-77 TIME PERIOD. IN ADDITION DEVELOPING THE REQUIRED TECHNOLOGY TO MEET TOTAL SYSTEM NEEDS. TWO PARALLEL STUDY EFFORTS OF APPROXIMATELY 6 TO 8 MONTHS DURATION WILL BE INITIATED TO PROVIDE THE TIMELY DEVELOPMENT OF SUFFICIENT INFORMATION AND DATA TO JUSTIFY A NEW LINE ITEM IN THE FY74 BUDGET. THE STUDIES WILL CONSIDER ALL ELEMENTS OF GROUND AND SPACE TECHNOLOGY AND INTERFACES WITH EXISTING AND PLANNED TERRESTRIAL ITV, ETV, ITFS, CATV, REPEATER-TRANSLATORS, STATE-WIDE AND REGIONAL NETWORKS, PUBLIC BROADCASTING AND WHERE APPLICABLE PROPOSALS FOR THE DOMESTIC COMMUNICATION SATELLITE NETWORK. USER REQUIREMENTS WILL BE PROVIDED BY COGNIZANT GOVERNMENTAL ORGANIZATIONS SUCH AS HEW, DEPARTMENT OF THE INTERIOR AND THE CORPORATION FOR PUBLIC BROADCASTING. SYSTEM ANALYSES, COMPARISONS AND TRADEOFFS WILL BE CONDUCTED TO DETERMINE THE APPROPRIATE MIX OF SPACE AND GROUND SEGMENTS TO OPTIMIZE FLEXIBILITY AND MINIMIZE COST, DETERMINE THE MOST APPROPRIATE PORTIONS OF THE FREQUENCY SPECTRUM IS ALLOCATED AT WARC-71, ASSESS THE STATE-OF-THE-ART, DETERMINE CRITICAL TECHNOLOGY REQUIREMENTS, RECOMMEND PROMISING AREAS TO PURSUE R&D AND ESTABLISH COSTS AND SCHEDULES FOR DEVELOPING THE REQUIRED TECHNOLOGY TO MEET SYSTEM NEEDS. THE LATTER SHALL FORM THE BASIS FORM THE BASIS FOR FOLLOW-ON SRT WORK.

RTOP NO. 164-21-73 TITLE: COMMUNICATIONS TECHNICAL ADVISORY PROGRAM
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: ECKERMAN, J. TEL. 301-982-6786
TECHNICAL SUMMARY

THE WORK TO BE PERFORMED INVOLVES TECHNICAL CONSULTATION AND SUPPORT ON SPACE COMMUNICATIONS MATTERS. TO PROVIDE TECHNICAL SUPPORT TOORGANIZATIONS OUTSIDE OF NASA SUCH AS THE EXECUTIVE OFFICE OF THE PRESIDENT, FEDERAL COMMUNICATIONS COMMISSION (FCC), DEPARTMENT OF TRANSPORTATION (DOT), DEPARTMENT OF STATE (DOS), HEALTH, EDUCATION AND WELFARE (HEW), THE UNITED NATIONS, AND ON A REIMBURSIBLE BASIS, COMSAT CORP., IN ACCORDANCE WITH THE COMSAT ACT OF 1962. STUDIES AND ANALYZESRADIO CONFERENCE (WARC) ON SPACE FREQUENCY ALLOCATIONS SATELLITE TOSATELLITE COMMUNICATIONS SHARING STUDIES FOR COMSAT, BROADCAST ANDEARTH RESOURCES SERVICES ORBIT UTILIZATION.

RTOP NO. 164-76-51 TITLE: SYNCHRONOUS ORBIT SPACECRAFT TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HOFFMAN, HENRY C. TEL. 301-982-4496
TECHNICAL SUMMARY

THIS PROJECT WILL DEVELOP LONG LEAD TIME SPACECRAFT SYSTEM TECHNOLOGY, OF SPECIFIC APPLICABILITY TO SYNCHRONOUS EQUATORIAL MISSIONS, PLANNED FOR THE LATE 1970'S AND EARLY 1980'S. THE RESULTS COULD BE APPLICABLE TO MISSIONS SUCH AS ATS-H AND ATS-I TRACKING AND DATA RELAY SATELLITE AND TV DISTRIBUTION/DIRECT BROADCAST SATELLITES. THE EFFORTS WILL BE TOWARD BOTH HIGH ACCURACY POINTING SYSTEMS (.001 DEGREES) AND TOWARDS A DEEPER UNDERSTANDING OF PASSIVE SYSTEMS.

STUDIES WILL BE CARRIED OUT ON SYNCHRONOUS ALTITUDE SYSTEM DESIGN CONCEPTS, PRECISION MEASUREMENT SYSTEMS, ADVANCED DYNAMIC ANALYSES OF SPACECRAFT FLEXIBILITY, ADVANCED THRUSTERS AND TORQUERS FOR PRECISE EARTH ORIENTED SPACECRAFT, DAMPING MECHANISMS, AND HIGH POWER DISSIPATIONS. DAMPING MECHANISM STUDIES WILL INCLUDE BOTH ANALYSIS AND TEST OF DAMPERS FOR USE ON SPINNING AND MULTI-SPIN SATELLITES. IN ADDITION, COMPONENTS NOT INTENDED AS DAMPERS, SUCH AS HEAT PIPES AND FUEL IN THE TANKS WILL ALSO BE ANALYZED AND TESTED. HEAT PIPES WILL BE INVESTIGATED FOR HIGH POWER DISSIPATION IN LOCALIZED AREAS TO PROVIDE ADEQUATE RADIATION FROM THE SPACECRAFT.

RTOP NO. 164-76-52 TITLE: SYNCHRONOUS ORBIT KICK MOTOR TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

A SERIES OF OPTIMIZED GRAPHITE/EPOXY MOTOR DESIGNS WILL BE ACCOMPLISHED WHICH WILL RESULT IN CHAMBER FABRICATIONS. THESE CHAMBERS WILL DEMONSTRATE COST EFFECTIVENESS, DESIGN FLEXIBILITY, RELIABILITY, MASS FRACTION AND CASE MECHANICAL CHARACTERISTIC IMPROVEMENTS AVAILABLE FOR SATS APOGEEKICK MOTORS. THE GRAPHITE/EPOXY COMPOSITE CHAMBER WILL BE DESIGNED BY UTILIZING THE DATA OBTAINED FROM THE TESTING OF SATS SIZE BORON COMPOSITE KICK MOTORS. SEVERAL GRAPHITE/EPOXY CHAMBERS WILL BE FABRICATED AND DEVELOPMENT TESTED, SIMILAR TO THE BORON/EPOXY CHAMBERS, TO DETERMINE THEIR APPLICABILITY AS APOGEE KICK MOTORS FOR GEOSTATIONARY MISSIONS FROM THE 6 SOLID AND 9 SOLID IMPROVED THOR DELTA VEHICLES. THE MOTORS WILL BE TESTED ALSO TO DETERMINE THEIR PERFORMANCE WITH RESPECT TO SPECIFIC IMPULSE. THE DEVELOPMENT SCHEDULE WILL RESULT IN A FLIGHT MOTOR DESIGN CAPABLE FOR FLIGHT USE EARLY IN CY-74.

RTOP NO. 164-76-53 TITLE: APPLICATIONS MISSION THRUSTER STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO UPDATE PREVIOUS THRUSTER TRADEOFF STUDIES BY THE INCORPORATION OF RECENT ADVANCES IN AUXILIARY-PROPULSION STATE-OF-THE-ART, CRITICAL REVIEW OF SUGGESTIONS FROM PROJECT MANAGERS AND SYSTEM ENGINEERS, AND ADDITION OF FURTHER COMPARISONS OF CHEMICAL VS. ELECTRIC THRUSTER SYSTEMS FOR FUTURE SATELLITE MISSIONS. THIS WILL BE ACCOMPLISHED THROUGH A CONTINUING FAMILIARITY WITH ONGOING AUXILIARY-PROPULSION RESEARCH AND DEVELOPMENT UNDER OTHER RTOPS ALONG WITH PERIODIC CONTACT WITH PROJECT MANAGERS. AN UPDATE WILL ENHANCE THE PREVIOUS THRUSTER TRADEOFF STUDIES AND INCREASE THE USEFULNESS OF THE TRADEOFFTECHNIQUES TO PROGRAM PLANNERS AND SYSTEM---- ENGINEERS.

RTOP NO. 164-76-54 TITLE: REMOTE MANEUVERING UNIT/TELEOPERATORS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: PICKARD, R. H. TEL. 301-982-6682
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY PROGRAM IS TO INVESTIGATE FEASIBILITY AND DEFINE THE TECHNOLOGY FOR A REMOTELY CONTROLLED MANEUVERABLE SPACECRAFT CAPABLE OF RENDEZVOUS AND DOCKING AT SYNCHRONOUS ALTITUDE. AN APPLICATION OF THIS CAPABILITY IS THE DESPINNING OF ATS-5. OTHER APPLICATIONS INCLUDE OBSERVATION OF ATS-5 GRAVITY GRADIENT BOOM DEPLOYMENT AND ATS-F DISH ANTENNA DEPLOYMENT. THE APPROACH WILL EMPHASIZE THE EMPLOYMENT AND INTEGRATION OF EXISTING TECHNOLOGY AND HARDWARE IN ORDER TO EFFECT AN EXPEDIENT AND ECONOMICAL SPACECRAFT DESIGN.

RTOP NO. 164-76-55 TITLE: APOGEE MOTOR RELIABILITY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO IMPROVE THE RELIABILITY OF SOLID PROPELLANT APOGEE MOTORS THROUGH THE APPLICATION OF IMPROVED TECHNOLOGY DERIVED FROM PROGRAMS SUCH AS MINUTEMAN AND POLARIS. AN ANALYSIS OF PAST APOGEE MOTOR PROGRAMS WILL BE PERFORMED TO IDENTIFY AND SUMMARIZE PROBLEM AREAS. THESE PROBLEM AREAS WILL THEN BE COMPARED TO DEMONSTRATED TECHNOLOGY TO DETERMINE IF REASONABLE SOLUTIONS EXIST. A PROGRAM WILL BE DEVELOPED TO APPLY THE SOLUTIONS TO APOGEE MOTOR DEVELOPMENT AND FABRICATION ACTIVITIES. SPECIFIC APPROACHES INCLUDE THE DEVELOPMENT OF A USEFUL HISTORICAL FILE OF APOGEE MOTOR PROGRAMS, EMPHASIZING PROBLEM AREAS; INVESTIGATION OF COMMONALITY IN MOTOR DESIGNS; REVIEW OF TESTING TECHNIQUES AND WORKMANSHIP STANDARDS. RELATED SOLID ROCKET MOTOR RELIABILITY WORK WILL BE PERFORMED UNDER RTOP SYSTEM EFFECTS ON MOTOR RELIABILITY (180-32-52-02-55). THIS WORK WILL INCLUDE A DETAILED EXAMINATION OF THE OPERATIONAL ENVIRONMENT OF THE ROCKET MOTOR FROM FABRICATION TO FIRING IN THE SPACECRAFT AND THE DEVELOPMENT OF AN IMPROVED FUNCTIONAL SPECIFICATION FOR MOTORS.

RTOP NO. 180-06-50 TITLE: ANALYSIS OF ADVANCED PROPULSION SYSTEMS REQUIREMENTS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: COADY, R. E. TEL. 301-982-4731
TECHNICAL SUMMARY

A CONTINUING PROGRAM HAS BEEN UNDER WAY FOR SEVERAL YEARS AIMED AT EVALUATING AND ANALYZING THE CAPABILITY OF EXISTING AND PROPOSED PROPULSIVE SYSTEMS FOR ACCOMPLISHING PLANNED OR PROPOSED AUTOMATED MISSIONS. THE THEORY, ANALYTIC APPROACHES AND COMPUTER IMPLEMENTATION OF THE TASK NECESSARY TO CONDUCT THIS WORK HAVE BEEN PURSUED AT THE AEROSPACE SYSTEMS LAB OF PRINCETON UNIVERSITY AND BY

ANALYTICAL MECHANICS ASSOCIATES, INC. CURRENT EFFORTS ARE DIRECTED AT EXTENDING THE CAPABILITIES OF THESE COMPUTER PROGRAMS, AS WELL AS THE USE OF THE PROGRAMS ALREADY DEVELOPED, TOWARD THE GENERATION OF MISSION DATA FOR A BROAD CHANGE OF MISSIONS AND TOWARD UPDATING NASA'S LAUNCH VEHICLE ESTIMATING FACTORS BOOKLET FOR SOLAR ELECTRIC PROPULSION. COMPARISONS ARE BEING MADE BETWEEN HIGH AND LOW THRUST MISSIONS TO ESTABLISH WHICH IS THE PREFERRED SYSTEM. INCLUDED IN THE CURRENT EFFORTS HAS BEEN WORK DIRECTED TOWARD MAKING THE RELATIONSHIP BETWEEN IMPULSIVE AND FINITE THRUST TRAJECTORIES MATHEMATICALLY EXPLICIT AND THE IMPLEMENTATION OF THIS WORK INTO AN OPERATIONAL TOOL. THE BEHAVIOR OF SEVERAL PROPOSED GUIDANCE SCHEMES WILL BE ANALYZED IN AN ATTEMPT TO ESTABLISH THE CRITERIA ON WHICH A JUDGMENT MAY BE MADE ABOUT THE RELATIVE MERITS OF ONE MODE OVER ANOTHER.

RTOP NO. 180-06-50 TITLE: ANALYSIS OF VEHICLE REQUIREMENTS
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: ZIMMERMAN, A. V. TEL. 216-433-6486
TECHNICAL SUMMARY

PERFORMANCE, TRAJECTORY AND PAYLOAD CHARACTERISTICS OF LAUNCH VEHICLES WILL BE INVESTIGATED TO EVALUATE THE CAPABILITY OF EFFICIENTLY PERFORMING THE PRESENT AND PLANNED SPECTRUM OF AUTOMATED MISSIONS. THIS WILL INCLUDE PRESENT VEHICLES, MODIFICATIONS OF PRESENT VEHICLES AND CONSIDERATION OF APPROPRIATE NEW LAUNCH VEHICLES AND UPPER STAGES. IN ADDITION, THE USE OF THE SPACE SHUTTLE AS APPLIED TO THE UNMANNED MISSION PROGRAM WILL BE INVESTIGATED.

RTOP NO. 180-06-50 TITLE: LAUNCH OPERATIONS AND FACILITIES FOR FLUORINE UPPER STAGES
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: TRITTO, J. TEL. 305-853-9451
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS A PLAN WITH COMPREHENSIVELY DETAILED SCHEDULE AND COST ESTIMATES FOR CHANGES REQUIRED IN FACILITIES, EQUIPMENT, AND OPERATIONS AT THE KENNEDY SPACE CENTER TO ACCOMPLISH THE RECEIPT THROUGH POST LAUNCH REFURBISHMENT CYCLE FOR UPPER STAGES CONTAINING FROM 3 TO 15 THOUSAND POUNDS OF FLUORINE IN THE PROPELLANTS. THE VEHICLES AND FACILITIES OF INTEREST ARE: THRUST AUGMENTED THOR/COMPLEX 17, TITAN III-D CENTAUR/COMPLEX 41, AND SPACE SHUTTLE/COMPLEX 39. THIS OBJECTIVE CAN BE ACHIEVED BY THE STRAIGHT FORWARD APPLICATION OF APPROPRIATE EXISTING OPERATIONS ANALYSIS, ENGINEERING, AND ECONOMIC ANALYSIS METHODS. THE RESULTS MUST REFLECT THE CURRENT BEST OF STATE-OF-THE-ART INFORMATION ON HANDLING FLUORINE IN THE AREAS OF PERSONAL HEALTH AND SAFETY; SPILL AND LEAK PREVENTION, CONTROL, AND DECONTAMINATION; THE TRANSPORTATION, STORAGE, TRANSFER, SAMPLING, TEST, AND DISPOSAL OF FLUORINE, AND THE OPERATION AND MAINTENANCE OF FLUORINE HANDLING FACILITIES AND EQUIPMENT. THE DEVELOPED PLAN MUST PROVIDE A SCHEME OF FACILITIES, EQUIPMENT, AND OPERATIONS OPTIMIZED FOR SAFETY, COST, AND ASSURANCE OF LAUNCH ON TIME.

RTOP NO. 180-06-51 TITLE: MISSION REQUIREMENTS FOR NUCLEAR ELECTRIC SPACECRAFT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO INVESTIGATE THE DIRECT CONSEQUENCE OF USING NUCLEAR ELECTRIC PROPULSION TO PROVIDE PRIME PROPULSION ABOARD PLANETARY SPACECRAFT. THIS TASK IS TO DETERMINE UNIQUE MISSION FEATURES, PAYLOAD CAPABILITY, LAUNCH VEHICLE CHARACTERISTICS, SPACECRAFT INTEGRATION PROBLEMS AND SOLUTIONS, GROUND SUPPORT EQUIPMENT, PRELAUNCH TESTING REQUIREMENTS, RESTRICTIONS DUE TO NUCLEAR SAFETY, AND OVERALL MISSION COSTS FOR NUCLEAR REACTOR ELECTRIC PROPULSION SYSTEMS. THIS TASK WILL COMPLIMENT OVERALL SPACECRAFT DESIGN STUDIES PRESENTLY BEING CONDUCTED WHICH PRIMARILY EMPHASIZE THE NUCLEAR ELECTRIC PROPULSION SYSTEM. THE PROGRAM WILL BE CONDUCTED PRIMARILY UNDER INDUSTRY STUDY CONTRACTS SUPPLEMENTED BY IN-HOUSE SUPPORT ANALYSES. THE INDUSTRY STUDY CONTRACTS WILL OUTLINE THE MISSION OPERATIONAL ASPECTS, DEFINE CERTAIN SPACECRAFT CONSTRAINTS INCLUDING NUCLEAR SAFETY, EVALUATE DEVELOPMENT SCHEDULES AND COSTS FOR THE NUCLEAR ELECTRIC PROPULSION SYSTEM AND DELINEATE THE DESIRED PROPULSION SYSTEM TECHNOLOGY LEVEL. THE IN-HOUSE EFFORT WILL PROVIDE MISSION ANALYSIS, SPACECRAFT STRUCTURAL ANALYSES (STATIC AND DYNAMIC), PROPULSION TECHNOLOGY, SCIENCE PAYLOAD ESTIMATES AND NUCLEAR ELECTRIC SPACECRAFT PROJECT COSTS TO PERFORM THE MISSION.

RTOP NO. 180-06-52 TITLE: LAUNCH VEHICLE CONCEPTS AND ANALYSIS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: AILOR, S. J. TEL. 703-827-2614
TECHNICAL SUMMARY

THE FOLLOWING PROGRAMS WILL BE ACCOMPLISHED. A. TO DETERMINE THE FEASIBILITY OF USING A LAUNCH VEHICLE WITH A SPIN-STABLIZED FINAL STAGE TO ACHIEVE LUNAR ORBIT. AN INVESTIGATION WILL IDENTIFY ALLOWABLE TOLERANCES ON INJECTION ERRORS TO INSURE ENTRY INTO THE LUNAR SPHERE OF INFLUENCE, THE TRANSLUNAR TRAJECTORY WHICH IS LEAST SENSITIVE TO THESE ERRORS ON LUNAR ARRIVAL CONDITIONS AND BODY ATTITUDE DEVIATIONS IN THE VICINITY OF THE MOON. B. TO EXTEND THE SUCCESFUL DESIGN PRINCIPLES, EXPERIENCE, AND OPERATIONS TECHNOLOGY OF THE SCOUT BOOSTER SYSTEM BY MODIFICATIONS WHICH WILL ENHANCE ITS CURRENT CAPABILITY AND COST EFFECTIVENESS. THE BROAD STUDY WILL EVALUATE CONFIGURATIONAL CHANGES IN TERMS OF PERFORMANCE, COST, AND SCHEDULED PHASE-IN WITH THE PRESENT SYSTEM. C. TO PROVIDE A TRAJECTORY ANALYSIS TOOL ENABLING A MORE RAPID AND REALISTIC DETERMINATION OF THE ACTUAL ROCKET MOTOR PERFORMANCE. ANY OFF-NOMINAL SYSTEM PERFORMANCE OR SYSTEM CONSTANTS WILL ALSO BE REVEALED. THIS WILL BE OF SPECIAL VALUE IN EVALUATING NEW CONFIGURATIONS. D. TO COMPARE MEASURED BENDING MOMENTS OF THE SCOUT VEHICLE DURING FLIGHT WITH MOMENTS CALCULATED BASED ON MEASURED INFLIGHT INPUT PARAMETERS.

RTOP NO. 180-06-60 TITLE: PLANNING RESEARCH IN THE AREA OF LAUNCH VEHICLE AND PROPULSION PROGRAMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: LAM, B. C. TEL. 202-962-4553
TECHNICAL SUMMARY

UNDER THIS PROCUREMENT, STUDIES ARE CONDUCTED TO AID NASA OSSA LAUNCH VEHICLE AND PROPULSION PROGRAMS DIVISION IN SATISFYING ITS RESPONSIBILITIES FOR PLANNING AND MAINTAINING AN ECONOMICAL AND RELIABLE SPACE TRANSPORTATION SYSTEM FOR FUTURE OSSA, OTHER NASA, OTHER U. S. GOVERNMENT, FOREIGN, AND COMMERCIAL DOMESTIC USERS. DOCUMENTS ARE ASSEMBLED AND MAINTAINED THAT PROVIDE DATA AND OTHER INFORMATION ON SPACE TRANSPORTATION SYSTEM PERFORMANCE, MISSION ANALYSIS, SPACE TRANSPORTATION SYSTEM RELIABILITY, AND SPACE TRANSPORTATION SYSTEM COSTS. STUDIES ARE PERFORMED TO: 1. EVALUATE NEW SPACE TRANSPORTATION SYSTEM CONCEPTS AND RELATED TECHNOLOGY; 2. ANALYZE PRESENT AND FUTURE SPACE TRANSPORTATION SYSTEM CAPABILITIES IN TERMS OF REQUIREMENTS; 3. CONTINUE TO IMPROVE AND APPLY METHODS FOR ESTIMATING FUTURE SPACE TRANSPORTATION SYSTEM COSTS; 4. ANALYZE THE EFFECT OF SPACE TRANSPORTATION SYSTEM COMPOSITION AND PROJECTED MISSION PLANS ON PROJECTED SPACE TRANSPORTATION SYSTEM COSTS; 5. PROVIDE ECONOMIC AS WELL AS TECHNICAL INFORMATION AND ANALYSES TO SERVE AS A BASIS FOR COMMUNICATING TECHNOLOGY NEEDS TO OART AND NASA CENTERS; AND 6. GENERATE TRAJECTORIES AND OTHER INFORMATION TO SUPPORT MISSION ANALYSES AND OTHER MISSION PLANNING ACTIVITIES AS REQUIRED.

RTOP NO. 180-17-50 TITLE: SYSTEM PERFORMANCE AND TECHNOLOGY ASSESSMENT FOR UNMANNED MISSIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY

METHODS AND COMPUTER PROGRAMS, DEVELOPED UNDER NAS12-550 AND UPDATED AND TESTED UNDER NAS8-26491, ALLOW THE DEFINITION OF SYSTEMS PARAMETERS FOR PLANNED OSSA MISSIONS. THESE PARAMETERS INCLUDE DATA NEEDED TO IDENTIFY ASTRIONICS/AVIONICS SUBSYSTEMS AND HARDWARE REQUIREMENTS. THE SENSITIVITIES OF THESE REQUIREMENTS TO MISSION AND SYSTEMS CHANGES OR MODIFICATIONS WILL BE INCLUDED. THE METHODS AND COMPUTER PROGRAMS ALLOW ONE TO ENTER TECHNICAL DATA OF KNOWN APPLICABLE AEROSPACE OR COMMERCIAL SUBSYSTEMS. THE OUTPUT WILL BE A COMPARISON OF REQUIREMENTS FOR SPECIFIC OSSA MISSIONS WITH AVAILABLE SUBSYSTEMS. THIS COMPARISON WILL AID NASA MANAGEMENT TO TAKE ADVANTAGE OF SUBSYSTEMS ALREADY DEVELOPED OR BEING DEVELOPED FOR OTHER PROGRAMS AND TO IDENTIFY NEW TECHNOLOGY NEEDED WHERE APPLICABLE SUBSYSTEMS ARE NOT AVAILABLE.

RTOP NO. 180-17-50 TITLE: ASTRIONICS SYSTEMS EVALUATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

FEASIBILITY STUDY WILL BE CONDUCTED TO DEFINE A GUIDANCE AND

CONTROL SYSTEM CONCEPT FOR APPLICATION TO THE FINAL STAGE OF A LAUNCH VEHICLE, BASED ON TRADE-OFF STUDIES, STABILITY AND CONTROL ANALYSES, GUIDANCE AND TRAJECTORY ERROR EVALUATIONS, AND A PRELIMINARY DESIGN UTILIZING THE CONCEPT SELECTED. TRADE-OFF STUDIES WILL EMPHASIZE VERSATILITY OF USE IN SATISFYING VARIED MISSION REQUIREMENTS, CAPABILITY FOR IMPROVING VEHICLE OVERALL PERFORMANCE ACCURACY, AND MINIMAL IMPACT ON VEHICLE INTERFACE CHANGES, SYSTEM WEIGHT, AND COST OF IMPLEMENTATION. ALSO, A SURVEY OF INDUSTRY AND GOVERNMENT AGENCIES WILL BE CONDUCTED TO DETERMINE THE AVAILABILITY OF A STATE-OF-THE-ART INERTIAL GUIDANCE (MINIATURIZED GIMBAL OR STRAP-DOWN, CONVENTIONAL GYROS OR LASER GYROS) SYSTEMS WHICH COULD BE UTILIZED IN LAUNCH VEHICLES OR AIRCRAFT. EVALUATION POINTS WILL BE WEIGHT, VOLUME, COST, EASE OF MAINTENANCE, RELIABILITY, AND ACCURACY.

RTOP NO. 180-17-50 TITLE: ASTRIONIC SYSTEMS EVALUATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BECKHAM, J. M. TEL. 301-982-6356
TECHNICAL SUMMARY

THE PURPOSE OF THIS TASK IS TO PERFORM AN ANALYTICAL EVALUATION OF THE ACCURACY OF STRAPDOWN GUIDANCE SYSTEMS CONSIDERING THE EFFECTS OF A DYNAMIC ENVIRONMENT PRESENT IN A LAUNCH VEHICLE. AS A BASIS FOR EVALUATION, THE STRAPDOWN GUIDANCE SYSTEM SELECTED FOR USE ON THE DELTA LAUNCH VEHICLE IS BEING STUDIED IN A TWO PHASE PROGRAM. IN PHASE 1, NOW COMPLETE, AVAILABLE DATA ON SYSTEMS THEN COMPETING FOR SELECTION WERE COMPILED ALONG WITH THE PREDICTED VEHICLE DYNAMIC ENVIRONMENT. IN PHASE 2, CURRENTLY UNDERWAY, THE MAJOR SYSTEM ERRORS ARE BEING STUDIED. THIS EFFORT INCLUDES A STUDY OF SENSOR ERRORS IN ORDER TO IDENTIFY THE MAJOR NAVIGATION ERROR SOURCES AND GUIDANCE PROGRAM MECHANIZATION IN ORDER TO IDENTIFY BOTH ALGORITHMIC AND COMPUTATIONAL ERRORS. IN ADDITION A POST-FLIGHT ANALYSIS PROGRAM IS BEING DEVELOPED TO PROVIDE VERIFICATION OF PRE-FLIGHT PREDICTIONS. FY 72 FUNDING WILL BE USED TO EXTEND THE PHASE 2 EFFORT UNTIL AFTER THE FIRST LAUNCHES UTILIZING THE NEW STRAPDOWN GUIDANCE SYSTEM IN ORDER TO PERFORM POST FLIGHT ANALYSIS AND FOR INVESTIGATING SYSTEM ERRORS APPLICABLE TO LUNAR OR INTERPLANETARY TRANSFER TRAJECTORIES.

RTOP NO. 180-17-52 TITLE: SYSTEM AND TRAJECTORY ANALYSIS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY

THE EVALUATION OF STRAPDOWN INERTIAL SYSTEMS FOR LAUNCH VEHICLES REQUIRES A DETERMINATION OF THE PERFORMANCE IN THE LAUNCH ENVIRONMENT. STUDIES AND EXPERIMENTS COMPLETED SHOW THAT THE LAUNCH ENVIRONMENT OF THE VEHICLE MODIFIES THE STATIC ERROR MODEL OF THE SYSTEM. THESE EFFECTS MUST BE IDENTIFIED AND CONCEPTS DEVELOPED AND TESTED FOR REDUCING THESE ERRORS TO AN ACCEPTABLE LEVEL. STUDIES WILL BE PERFORMED TO DEVELOP GUIDELINES FOR SELECTING SUBSYSTEM APPROACHES. EXPERIMENTAL STUDIES WERE ALSO CONTINUED TO QUANTIFY THE SENSITIVITY OF SENSORS AND SYSTEMS TO THE LAUNCH ENVIRONMENT. CANDIDATE SENSORS WILL BE MODIFIED AS APPROPRIATE TO INCLUDE CURRENT

DEVELOPMENT.

RTOP NO. 180-17-53 TITLE: DYNAMIC TESTS OF INERTIAL SENSORS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY
TO DETERMINE THE PERFORMANCE QUALITY OF INERTIAL SENSORS DESIGNED FOR ASTRIONICS APPLICATIONS. 1. DETERMINE THE SUITABILITY OF EXISTING METHODS AND EQUIPMENT FOR DYNAMIC TESTS OF INERTIAL SENSORS DEVELOPED AS EXPERIMENTAL PROTOTYPES FOR ASTRIONICS APPLICATIONS. 2. DEVELOP THE NECESSARY TEST DATA REDUCTION METHODS. 3. EVALUATE THE SENSOR COEFFICIENTS OF DESIGNATED ERROR MODELS FOR ASTRIONICS SYSTEMS, WITH AND WITHOUT ANY ERROR COMPENSATION EQUIPMENT. 4. CONDUCT PERFORMANCE TESTS WITH THE INERTIAL SENSORS COMBINED INTO AN ASTRIONICS SENSOR PACKAGE.

RTOP NO. 180-17-54 TITLE: GUIDANCE COMPUTER TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: CRAWFORD, R. TEL. 205-453-0480
TECHNICAL SUMMARY
THE COMING DECADE OF VIGOROUS SPACE ACTIVITY BY NASA AND OTHER ORGANIZATIONS WILL REQUIRE AN INCREASINGLY RELIABLE LAUNCH VEHICLE FAMILY. THIS INCLUDES THE DEVELOPMENT OF TECHNOLOGY TO PROVIDE FLEXIBLE AND RELIABLE GUIDANCE COMPUTATION FOR FUTURE SPACE MISSIONS. HIGH PERFORMANCE DATA PROCESSING CONFIGURATIONS WITH USEFUL LIFETIMES UP TO FIVE YEARS FOR LONG DURATION EARTH ORBITAL AND PLANETARY MISSIONS ARE TO BE EMPHASIZED. DIGITAL LOGIC, CIRCUITS AND PACKAGING TECHNIQUES ARE TO BE DEVELOPED TO MEET THE RELIABILITY AND ENVIRONMENTAL CONSTRAINTS OF THESE ADVANCED MISSIONS. EMPHASIS WILL BE GIVEN TO CONTINUATION OF RESEARCH IN MODULAR COMPUTER CONFIGURATIONS INCLUDING EVALUATION OF MODULAR COMPUTER BREADBOARD WHICH HAS BEEN DEVELOPED AND FABRICATED BY NASA ELECTRONICS RESEARCH CENTER. EXISTING SOFTWARE WILL BE REFINED AND EXPANDED AND NEW SOFTWARE DEVELOPED IN THE AREAS OF FAILURE DETECTION, SWITCHING CONTROL, AND RECOVERY. THE CULMINATION OF THESE DEVELOPMENTS AND EVALUATIONS WILL RESULT IN THE FABRICATION OF A PROTOTYPE MODULAR COMPUTER SYSTEM UTILIZING LSI TECHNOLOGY. ASSOCIATED SOFTWARE WILL BE DEVELOPED CONCURRENTLY.

RTOP NO. 180-24-51 TITLE: ENGINEERING INSTRUMENTATION
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY
THIS IS AN APPLIED RESEARCH PROGRAM DESIGNED TOWARDS DEVELOPING AND DEMONSTRATING ELECTROTHERMAL NONDESTRUCTIVE TEST TECHNIQUES FOR ELECTROEXPLOSIVE DEVICES. SUCH DEVICES PRESENTLY REQUIRE THE DESTRUCTIVE TESTING OF A LARGE NUMBER OF UNITS FROM A LOT TO DEMONSTRATE HIGH ATTRIBUTED RELIABILITY AND CONFIDENCE TO THE

REMAINDER OF THE GROUP. BY NONDESTRUCTIVE TESTING ALL DEVICES IN A LOT, BOTH HIGHER INHERENT RELIABILITY OF FLIGHT HARDWARE AND REDUCED COSTS TO SCREEN AND QUALIFY WILL RESULT. INSTRUMENTATION IS BEING DEVELOPED TO ELECTROTHERMALLY MEASURE THE MOST CRITICAL PORTION OF SUCH DEVICES, THE BRIDGEWIRE, AND ITS IMMEDIATE SURROUNDINGS. THE RESULTANT SIGNALS WILL BE UTILIZED TO EVALUATE THE INTEGRITY AND FUNCTIONAL RELIABILITY OF THE DEVICE BY IDENTIFYING EXISTING PROBLEMS OR ANOMALIES. DURING PROGRAM DEVELOPMENT, DEVICES WITH KNOWN ANOMALIES OR FAILURE MECHANISMS WILL BE TESTED TO CORRELATE THE DATA WITH PARTICULAR TYPES OF DISCREPANCIES SUCH _AS POOR BRIDGEWIRE WELDS, AND INCORRECT WARNING LOADING PRESSURE. THE RESULTS OF THIS EFFORT WILL PROVIDE REALISTIC ACCEPTANCE INSPECTION TECHNIQUES OF ACTUAL FLIGHT HARDWARE THEREBY REDUCING THE NUMBER OF DEVICES THAT PRESENTLY MUST BE DESTRUCTIVE TESTED TO DEMONSTRATE HIGH RELIABILITIES. THESE TEST TECHNIQUES ALSO ARE BEING INVESTIGATED FOR APPLICABILITY TO ELECTRONIC COMPONENTS LIKE FUSES, AND RESISTORS.

RTOP NO. 180-31-50 TITLE: TANKAGE DEVELOPMENT AND EVALUATION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SMITH, G. T. TEL. 216-433-6221
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TO PROVIDING THE DATA, DESIGN TECHNIQUES AND APPLIED TECHNOLOGY ESSENTIAL TO THE DESIGN AND FABRICATION OF LOW COST, HIGH PERFORMANCE, RELIABLE PRESSURE VESSELS FOR UPPER STAGE VEHICLES. INVESTIGATIONS WILL BE CONDUCTED USING CONCEPTS AND METHODS OF LINEAR-ELASTIC FRACTURE MECHANICS FOR SELECTION OF MATERIAL, WORKING STRESS, PROOF TEST STRESS, AND OPERATIONAL CONTROLS. SPECIFIC EMPHASIS WILL BE DIRECTED TO THE CHARACTERIZATION OF THE GROWTH OF FLAWS WHICH ARE DEEP WITH RESPECT TO THE MATERIAL THICKNESS. BOTH CRITICAL AND SUBCRITICAL FLAW GROWTH DATA WILL BE OBTAINED IN BOTH AGGRESSIVE AND INERT ENVIRONMENTS. MATERIALS WHICH ARE CURRENT CANDIDATES FOR HIGH ENERGY, UPPER-STAGE VEHICLE TANKAGE WILL BE USED TO CONDUCT THESE STUDIES.

RTOP NO. 180-31-51 TITLE: THERMAL AND FLUID SYSTEMS MANAGEMENT
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: AUKERMAN, C. A. TEL. 216-433-6538
TECHNICAL SUMMARY

THE GENERAL OBJECTIVES OF THE PROGRAMS TO BE CONDUCTED UNDER THIS RTOP ARE TO PROVIDE THE TECHNOLOGY REQUIRED FOR EFFECTIVE DESIGN, FABRICATION, MAINTENANCE AND OPERATION OF THERMAL PROTECTION AND FLUID SYSTEMS FOR USE WITH CRYOGENIC PROPELLANTS IN LAUNCH VEHICLES AND UPPER STAGES. IN THE AREA OF THERMAL SYSTEMS, EXPERIMENTAL AND ANALYTICAL STUDIES WILL BE CONDUCTED TO (1) DEVELOP AND EVALUATE THERMAL PROTECTION SYSTEM CONCEPTS FOR CRYOGENIC TANKS, (2) EVALUATE MULTILAYER INSULATION PERFORMANCE UNDER SURFACE TEMPERATURE CONDITIONS CORRESPONDING TO THOSE TO BE ENCOUNTERED IN SPACE, (3) EVALUATE CONCEPTS TO THERMALLY UNCOUPLE TANK PENETRATIONS FROM THE INSULATION AND PROPELLANT, (4) ASSESS THE EFFECT OF

INTERSTITIAL OUTGASSING ON MULTILAYER INSULATION PERFORMANCE (INCLUDING THE EFFECT OF PERFORATIONS), AND (5) IMPROVE THERMAL PERFORMANCE PREDICTION CAPABILITIES. IN THE AREA OF FLUID SYSTEMS, A LOW THRUST ATTITUDE CONTROL SYSTEM USING PROPELLANTS FROM THE MAIN FUEL TANK WILL BE EVALUATED. IN THIS CONCEPT, THE CRYOGENIC FUEL WILL BE COVERTED TO A WARM GAS USING STORED THERMAL ENERGY.

RTOP NO. 180-31-52 TITLE: LIQUID PROPULSION TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

A MAJOR OBJECTIVE IS TO DEMONSTRATE AND EVALUATE A COMBINATION MONO- AND BIPROPELLANT ROCKET ENGINE FOR UNMANNED PLANETARY SPACECRAFT APPLICATIONS. THE ENGINE WILL BE CAPABLE OF OPERATINGCONTINUOUSLY FOR 1000 SECONDS AT 1000 LBF THRUST FOR ORBIT-INSERTION OR PLANE-CHANGE MANEUVERS,AT A REDUCED THRUST OF ABOUT 300 LBF WITH MONOPROPELLANT N2H4 FOR TRAJECTORY CORRECTION AND ORBIT MODIFICATION BURNS, WITH A SINGLE THRUST CHAMBER. THE INVESTIGATION OF THE REQUIREMENTS FOR A MIDCOURSE PROPULSION SYSTEM CAPABLE OF MULTIPLE FIRINGS DURING A LONG-DURATION MISSION, AND THE INTERFACE CONSTRAINTS PLACED UPON THE PROPULSION SYSTEM WHICH ARISE FROM INTEGRATING THE SYSTEM WITH THE ATTITUDE PROPULSION SYSTEM AND OTHER SYSTEMS OF AN ADVANCED SPACECRAFT WILL BE COMPLETED FOR TOPS. THE DESIGN, FABRICATION, AND TEST OF A PROTOTYPE SYSTEM WILL BE CONDUCTED IN ORDER TO DETERMINE FEASIBILITY AND DISCOVER ANY UNFORESEEN SYSTEM OR ENVIRONMENTAL INTERACTIONS. EXISTING COMPONENTS WILL BE USED AS AVAILABLE. ANOTHER OBJECTIVE IS TO ADVANCE OUR UNDERSTANDING OF THE CHEMICAL AND MECHANICAL PROCESSES OCCURRING WITHIN A CATALYST BED DURING MONOPROPELLANT DECOMPOSITION, WITH SPECIAL EMPHASIS ON THE PHENOMENON KNOWN AS "WASHOUT." A SYSTEMS EFFORT SIMILAR IN SCOPE TO THE TOPS MONOPROPELLANT UNIT NOW BEING COMPLETED WILL IDENTIFY REQUIREMENTS FOR FUTURE UNMANNED SPACECRAFT MAIN PROPULSION. COORDINATING WITHTHE 100 LBF BIMODAL ENGINE UNIT AND WITH RELEVANT OART ACTIVITIES, FURTHER TECHNOLOGY ADVANCEMENTS WHICH WOULD ENHANCE THE MISSIONS UNDER CONSIDERATION, AND WHICH COULD BE ACHIEVED PRIOR TO A MISSION START, WILL BE RECOMMENDED.

RTOP NO. 180-32-51 TITLE: SOLID ROCKET PROPULSION SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

A REVIEW WILL BE MADE OF THE CRITERIA AND METHODS OF ANALYSIS USED IN THE DESIGN, PROCESSES, AND TECHNIQUES USED IN THE FABRICATION OF SOLID FUEL ROCKET MOTORS, PARTICULARLY THOSE USED IN THE SCOUT VEHICLE, AND IDENTIFY THOSE AREAS WHERE THE DESIGN AND/OR PROCESS CONTROLS ARE INADEQUATE. A STUDY WILL BE PERFORMED TO DEFINE THE EXTENT AND SEVERITY OF THE SOLID ROCKET MOTOR OUTGASSING. OPTIMUM MOTOR CASE MATERIALS AND/OR FABRICATION TECHNIQUES WILL BE SELECTED. AN INVESTIGATION WILL BE CONDUCTED TO DETERMINE AND VERIFY BY TESTS A TECHNIQUE FOR PREDICTING THE AERODYNAMIC COEFFICIENTS OF CONTROL

SURFACES IMMERSED IN A ROCKET EXHAUST FLOW EXTERNAL TO THE NOZZLE. A STUDY WILL SURVEY THE EXISTING MOTORS, DEFINE AN OPTIMUM CONFIGURATION FOR AN UPPER STAGE MOTOR, AND SELECT ONE OR MORE CANDIDATES AS THE STARTING POINT FOR DEVELOPMENT OF THE OPTIMUM MOTOR. THE APOLLO STANDARD INITIATOR WILL BE QUALIFIED TO A DELAY INITIATOR ASSEMBLY IN A MODULAR CONCEPT. IN THIS CONCEPT, THE APOLLO STANDARD INITIATOR SHALL BE USED TO FUNCTION HIGHER LEVEL HERMETICALLY-SEALED PYROTECHNIC ASSEMBLIES. SEPARATE MOTOR DELAY INITIATOR ASSEMBLIES WILL BE DEVELOPED TO MEET THREE DIFFERENT SPECIFIED CONDITIONS. AN INVESTIGATION WILL BE MADE TO EVALUATE THE EFFECTIVENESS OF RADIOGRAPHIC AND ULTRASONIC NONDESTRUCTIVE TEST METHODS CURRENTLY USED FOR DETERMINING THE ACCEPTANCE OF SOLID PROPELLANT MOTORS. METHODS FOR UPGRADING THE QUALITY OF NONDESTRUCTIVE TEST ACCEPTANCE CRITERIA, THROUGH IMPROVEMENTS IN EXISTING EQUIPMENT AND PROCEDURES, AND/OR THE USE OF ADVANCED TECHNIQUES WILL ALSO BE INVESTIGATED. _ A DEVELOPMENT PROGRAM WILL BE CONDUCTED TO DETERMINE THE SELECTION OF AN IMPROVED MATERIAL----

RTOP NO. 180-32-52 TITLE: SOLID AND HYBRID PROPULSION TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MEEKS, P. J. TEL. 213-354-2546
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS STUDY ARE TO: (1) DETERMINE REQUIREMENTS FOR AND EFFECTIVENESS OF SOLID AND HYBRID PROPULSION SYSTEMS IN PLANETARY SPACECRAFT ORBIT INSERTION MANEUVERS AND SOLID PROPELLANT MOTORS FOR PLANETARY PROBE APPLICATIONS; (2) STUDY THE SYSTEM AND ENVIRONMENTAL EFFECTS ON SOLID MOTOR RELIABILITY. THE WORK RELATING TO PLANETARY MISSIONS FIRST WILL DETERMINE THE MISSION PROPULSION REQUIREMENTS FOR A WIDE SPECTRUM OF PLANETARY ORBITER AND PROBE MISSIONS, AND IDENTIFY PECULIAR PROPULSION ORIENTED MISSION AND SPACECRAFT INTERFACE REQU_IREMENTS. THEN AN ASSESSMENT WILL BE MADE OF THE COMPETITIVE PERFORMANCE, COST, RELIABILITY, STORABILITY AND PACKAGING CHARACTERISTIC RELATIVE TO COMPETING MONOPROPELLANT AND BIPROPELLANT CANDIDATES. STANDARDIZATION OF CERTAIN CLASSES OF PROPULSION SYSTEMS FOR MULTI-MISSION APPLICATION WILL BE SOUGHT. TO ATTAIN THE SECOND OBJECTIVE, SYSTEMS AND ENVIRONMENTAL EFFECTS ON MOTOR RELIABILITY WILL BE EVALUATED, AND CHANGES TO FUNCTIONAL SPECIFICATIONS RECOMMENDED.

RTOP NO. 185-47-51 TITLE: ABSOLUTE PRESSURE, ATOMIC OXYGEN, AND ENERGETIC BEAM CALIBRATION FOR MASS SPECTROMETERS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: NIEMANN, H. B. TEL. 301-982-5776
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP LABORATORY TECHNIQUES AND CONSTRUCT TEST FACILITIES FOR THE TESTING AND CALIBRATION OF

INSTRUMENTS TO MEASURE THE NEUTRAL PARTICLE COMPOSITION AND TEMPERATURE IN THE ATMOSPHERE. THE LARGE PRESSURE RANGE OVER WHICH THE INSTRUMENTS ARE REQUIRED TO OPERATE AND THE DIFFERENT CHEMICAL PROPERTIES OF THE VARIOUS ATMOSPHERIC CONSTITUENTS MAKE IT NECESSARY TO BUILD SEVERAL SEPARATE SYSTEMS EACH WITH A LIMITED RANGE AND FLEXIBILITY WHICH TOGETHER SATISFY THE TEST REQUIREMENTS. AN ABSOLUTE PRESSURE CALIBRATION SYSTEM WILL BE CONSTRUCTED FOR MASS SPECTROMETER CALIBRATION WITH NON-REACTIVE GASES, I.E., N2, O2, CO2, ETC., AND NOBLE GASES. A DUAL CHAMBER SYSTEM WITH LIQUID HELIUM CRYOGENIC PUMPS AND SPUTTER ION PUMPS WILL BE USED IN ORDER TO PROVIDE FOR LARGE PUMPING LOW ULTIMATE PRESSURE AND HYDROCARBON FREE OPERATIONS. PRESSURE MEASUREMENT WITH REFERENCE MANOMETER AND HIGH SPEED COMPUTER COMPATIBLE DATA RECORDING ASSURES IMPROVED MEASUREMENT ACCURACY AND HIGH EFFICIENCY. FOR THE EVALUATION OF SPECTROMETERS WITH CHEMICALLY ACTIVE GASES, I.E., O AND H, SUBSTANTIAL IMPROVEMENTS ARE PLANNED FOR THE USE OF BOTH (1) THE THERMAL DISSOCIATION BEAM SYSTEM WHICH PRODUCES ATOMIC CONSTITUENTS BY MEANS OF DISSOCIATION INDUCED BY A HEATED FILAMENT, AND (2) THE SATELLITE ENERGY SPUTTERED BEAM SYSTEM WHICH PRODUCES MEDIUM ENERGY ATOMIC BEAMS BY MEANS OF ENERGETIC ION SPUTTERING OF VACUUM DEPOSITED GAS LAYERS. WITH FURTHER DEVELOPMENT, COMPLEMENTARY STUDIES TO BE CARRIED OUT WITH THESE SYSTEMS WILL INCLUDE (1) CALIBRATION OF SENSOR RESPONSE TO ACTIVE GASES OF HIGH CONCENTRATIONS, WITH VERY LOW BACKGROUND PRESSURES, AND (2) AN EVALUATION OF THE EFFECT OF

RTOP NO. 185-47-52 TITLE: DEVELOPMENT OF NEUTRAL MASS SPECTROMETERS FOR PLANETARY ATMOSPHERE EXPERIMENTS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SPENCER, N. W. TEL. 301-982-5001

TECHNICAL SUMMARY

THIS RESEARCH PLAN IS CONCERNED WITH THE OVERALL IMPROVEMENT OF NEUTRAL GAS COMPOSITION MEASUREMENTS PLANNED FOR THE ATMOSPHERES OF THE EARTH AND OF THE PLANETS. IN GENERAL, IMPROVEMENTS ARE SOUGHT IN TWO BASIC AREAS, (1) SENSOR CONCEPT AND APPLICATION, AND (2) OPTIMIZATION OF BASIC INSTRUMENT PARAMETERS IN ANTICIPATION OF RESTRICTIVE MISSION CONSTRAINTS. IN THE FIRST AREA, SENSOR DEVELOPMENT WILL BE DIRECTED TOWARD (A) THE IMPROVEMENT OF AMBIENT GAS SAMPLING TECHNIQUES FOR HIGH VELOCITY PROBES INTO HIGH DENSITY ATMOSPHERES (E.G. THE JOVIAN TURBOPAUSE PROBE), (B) THE DESIGN OF MORE EFFICIENT ION SOURCES OF BOTH THE "OPEN" TYPE WHICH PROVIDES SIDE-ENERGY FOCUSING, AND THE "CLOSED" TYPE WHICH INCREASES THE THERMALIZATION OF THE GAS BEING MEASURED. IN THE SECOND AREA, NEUTRAL SPECTROMETER SYSTEM DEVELOPMENT WILL BE DIRECTED TOWARD OPTIMIZING EXISTING TECHNIQUES IN VIEW OF RIGOROUS REQUIREMENTS ANTICIPATED IN FORTH-COMING EARTH AND PLANETARY FLIGHT OPPORTUNITIES. THIS WORK WILL CONCENTRATE ON (1) DEVELOPMENT OF SMALLER, LIGHTER, HIGHER RESOLUTION, LESS EXPENSIVE ANALYZERS USING HYPERBOLIC RODS, (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. EARTH ATMOSPHERE FLIGHT TESTS WILL BE PERFORMED TO TEST AND COMPARE IMPROVED MEASUREMENT SUBSYSTEMS UNDER TRUE FLIGHT

CONDITIONS. THESE PERIODIC FLIGHT TESTS WILL BE PLANNED TO EMPHASIZE THE EVALUATION OF DEVELOPMENTS IN THE ION SOURCE AREA AND IN THE ON-BOARD DATA PROCESSING SYSTEM.

RTOP NO. 185-47-53 TITLE: DEVELOPMENT OF ION MASS SPECTROMETER FOR PLANETARY ATMOSPHERIC EXPERIMENT
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: TAYLOR, H. A., JR. TEL. 301-982-6610
TECHNICAL SUMMARY

THE BENNETT RADIO FREQUENCY ION MASS SPECTROMETER INSTRUMENT IS BEING PREPARED FOR FUTURE PLANETARY FLIGHT OPPORTUNITIES, INCLUDING BOTH ENTRY PROBES AND ORBITERS. THE OBJECTIVES OF THE EXPERIMENTS TO BE PERFORMED WITH THESE INSTRUMENTS WILL BE THE DIRECT IN-SITU MEASUREMENT OF AMBIENT THERMAL POSITIVE IONS DISTRIBUTED IN THE PLANETARY IONOSPHERE. THE BENNETT ION SPECTROMETER INSTRUMENT HAS BEEN USED EXTENSIVELY IN BOTH ROCKET AND SATELLITE INVESTIGATIONS OF THE EARTH'S ATMOSPHERE, AND EXISTING TECHNIQUES HAVE PROVEN QUITE SUCCESSFUL FOR SUCH PURPOSES. HOWEVER, CHARACTERISTICS OF FUTURE MISSIONS SUCH AS THE PLANETARY EXPLORER PLACE IMPORTANT NEW CONSTRAINTS UPON INSTRUMENT WEIGHT, POWER, AND DATA REQUIREMENTS. AT THE SAME TIME, THESE CONSTRAINTS ARE ACCOMPANIED BY THE REQUIEMENTS FOR IMPROVED LONG-TERM RELIABILITY, AND REDUCED COSTS. THE DEVELOPMENT WORK PLAN EMPHASIZES FOUR SPECIFIC GOALS, NAMELY (1) OPTIMIZATION OF A LIGHT-WEIGHT, LOW COST, SENSOR DESIGN, (2) IMPROVEMENTS IN ON-BOARD DATA PROCESSING TECHNIQUES, (3) EVALUATION AND UPGRADING OF INSTRUMENT OPERATING PROCEDURES AND, (4) EARTH ATMOSPHERE TEST FLIGHTS OF PROTOTYPE INSTRUMENTS. THE FIRST TWO TASKS INVOLVE MECHANICAL AND ELECTRICAL DESIGN IMPROVEMENTS, EMPHASIZING THE OPTIMIZATION OF EXISTING TECHNIQUES. THE THIRD TASKS INVOLVE SOME ADDITIONAL LABORATORY STUDIES OF POTENTIAL IMPROVEMENTS IN OPERATING PROCEDURES MADE POSSIBLE AS A RESULT OF ADVANCES UNDER TASKS 1 AND 2. FINALLY, ALL OF THE IMPROVEMENTS REALIZED IN TASKS 1 THRU 3 WILL BE INCORPORATED IN A PROTOTYPE INSTRUMENT WHICH WILL BE FLIGHT TESTED AS A PIGGY-BACK INSTRUMENT ON AN EXISTING JAVELIN ROCKET PAYLOAD.

RTOP NO. 185-47-54 TITLE: EXPERIMENT DEVELOPMENT FOR THE DETERMINATION OF VENUS CLOUD PARTICLE COMPOSITION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: NIEMANN, H. B. TEL. 301-982-5776
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP A PRACTICAL TECHNIQUE FOR THE DETERMINATION OF THE COMPOSITION OF CLOUD PARTICLES IN THE LOWER ATMOSPHERE OF VENUS. ALTHOUGH THE COMPLEXITY OF THE VENUS CLOUD STRUCTURE, WHICH IS EXPECTED TO BE AT LEAST EQUAL TO THE COMPLEXITY OF THE TERRESTRIAL CLOUD STRUCTURE, REQUIRES A STUDY OF MANY DIFFERENT TECHNIQUES, THE RELATIVELY STRAIGHTFORWARD AND LABORATORY PROVEN METHOD OF MASS SPECTROMETERS FOR THE COMPOSITION DETERMINATION OF SOLID MATERIALS AND CONDENSIBLES WILL BE ADAPTED FOR

SPACE FLIGHT APPLICATIONS. THE MAJOR EFFORT WILL BE EXTENDED IN THE AREA OF MINIATURIZATION, WEIGHT REDUCTION AND EFFICIENCY IN POWER CONSUMPTION.

RTOP NO. 185-47-55 TITLE: SPECTROSCOPY AND PHOTOCHEMISTRY OF PLANETARY AND COMETARY MOLECULES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: STIEF, L. J. TEL. 301-982-2529
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE TO MEASURE THE OPTICAL AND CHEMICAL PROPERTIES OF ATOMS AND MOLECULES WHICH ARE IMPORTANT IN UNDERSTANDING THE COMPOSITION OF PLANETARY ATMOSPHERES AND COMETS. EMPHASIS IS PLACED ON THOSE PROBLEMS WHICH ARE OF IMMEDIATE CONCERN FOR INTERPRETING THE RESULTS OF ROCKET AND SATELLITE OBSERVATIONS. IN THESE INVESTIGATIONS THE WELL KNOWN TECHNIQUES OF OPTICAL SPECTROSCOPY AND OF PHOTOCHEMISTRY ARE APPLIED UNDER WELL DEFINED EXPERIMENTAL CONDITIONS. SOPHISTICATED TECHNIQUES HAVE BEEN DEVELOPED FOR DATA REDUCTION AND FOR HANDLING THE SMALL SIGNAL LEVELS WHICH ARE USUALLY ENCOUNTERED. AN ADDITIONAL OBJECTIVE IS TO STUDY ATMOSPHERIC DYNAMICS THEORETICALLY BY INTEGRATING EQUATIONS DESCRIBING THEIR DYNAMICAL BEHAVIOR. THE PHOTOABSORPTION EXPERIMENT HAS BEEN COMPLETELY AUTOMATED USING AN IBM 1800 COMPUTER. CROSS SECTIONS ARE BEING MEASURED FOR THE PRODUCTION OF THE CO FOURTH POSITIVE BAND SYSTEM AND O RESONANCE LINE EMISSION FROM PHOTODISSOCIATION OF CO2. DISSOCIATIVE EXCITATION CROSS SECTIONS FOR ELECTRON IMPACT OF NO ARE CURRENTLY BEING MEASURED. A FLASH PHOTOLYSIS-RESONANCE FLOURESCENCE APPARATUS HAS BEEN DESIGNED IN DETAIL TO DIRECTLY MEASURE QUANTUM YIELDS FOR PRIMARY PHOTOCHEMICAL PROCESSES. THE APPARATUS WILL BE IN OPERATION IN THE NEXT FISCAL YEAR. IT HAS BEEN ESTIMATED FROM EXPERIMENTS EMPLOYING ISOTOPIC LABELLING AND PRODUCT ANALYSIS THAT, CONTRARY TO A MODEL PROPOSED TO EXPLAIN THE PERSISTENCE OF CO2 ON MARS, THE RATE OF THE REACTION CO3 + CO TO 2CO2 IS SEVERAL ORDERS OF MAGNITUDE SLOWER THAN THAT FOR 2CO3 TO O2 + 2CO2.

RTOP NO. 185-47-56 TITLE: NEGATIVE IONS IN PLANETARY ATMOSPHERES002200014000
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: AIKIN, A. C. TEL. 301-982-4913
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE ALTITUDE DISTRIBUTION AND SPECIES OF NEGATIVE IONS PRESENT IN PLANETARY ATMOSPHERES SUCH AS VENUS AND MARS. SINCE NEGATIVE ION FORMATION AND SPECIES WILL DEPEND ON THE PRESENCE OF MINOR NEUTRAL ATMOSPHERIC CONSTITUENTS SUCH AS MOLECULAR OXYGEN AND WATER VAPOR, IDENTIFICATION OF NEGATIVE IONS CAN BE USED AS A TRACER OF THESE NEUTRAL CONSTITUENTS. THE PRESENT STUDY WILL SIMULATE THE LOWER IONOSPHERE OF A CO2 ATMOSPHERE WITH TRACE NEUTRAL CONSTITUENTS AND IDENTIFY SPECIES OF NEGATIVE IONS. A NEGATIVE ION DETECTION SYSTEM FOR SAMPLING IN PLANETARY ATMOSPHERES WILL ALSO BE DEVELOPED. THIS SYSTEM WILL INITIALLY BE UTILIZED FOR

THE EARTH'S ATMOSPHERE. THE RESEARCH HAS APPLICATION TO THE MANNED AND UNMANNED EXPLORATION OF THE MARTIAN SURFACE, SINCE IT DEFINES THE ELECTRICAL ENVIRONMENT IN WHICH SYSTEMS OPERATE. IT HAS APPLICATION TO METEOROLOGY IN THAT POSITIVE IONS FOUND IN THE MESOSPHERE CAN BE UTILIZED AS TRACERS TO DETERMINE FACTORS INVOLVED IN LARGE SCALE CIRCULATION AND INTERACTION BETWEEN THE STRATOSPHERE AND MESOSPHERE.

RTOP NO. 185-47-61 TITLE: SPECTROSCOPY OF PLANETARY ATMOSPHERES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HUDSON, R. D. TEL. 713-483-6234
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE, BY INFRARED AND ULTRAVIOLET SPECTROMETRIC TECHNIQUES, BOTH IN THE LABORATORY OR BY MEANS OF SOUNDING ROCKET PROBES, GROUND BASED TELESCOPES, HIGH ALTITUDE AIRCRAFT, OR SPACE VEHICLE PLATFORMS, FUNDAMENTAL DATA, WHICH CAN BE USED TODEVELOP ANDEXPLORE THE FEASIBILITY OF SPACE FLIGHT EXPERIMENTS FOR THE DETERMINATION OF THE TEMPERATURE AND COMPOSITION OF PLANETARY ATMOSPHERES. THIS WILL BE ACHIEVED BY (1) LABORATORY STUDIES OF THE ABSORPTION OF ULTRAVIOLET LIGHT BY ATMOSPHERIC GASES AT HIGH RESOLUTION, (2) LABORATORY STUDIES OF THE CHEMICAL REACTIONS THAT LEAD TO THE PRODUCTION OF AIRGLOW, (3) USING ROCKET PROBES, HIGH ALTITUDE AIRCRAFT, AND SPACE PLATFORMS TO STUDY ATMOSPHERIC COMPOSITION, TEMPERATURE, DISSOCIATION RATES AND AIRGLOW, AND (4) TELESCOPE STUDIES OF THE ATMOSPHERES OF MERCURY, VENUS, MARS, JUPITER, AND SATURN, IN THE INFRARED AT HIGH SPECTRAL RESOLUTION.

RTOP NO. 185-47-66 TITLE: ATMOSPHERIC CHEMICAL PHYSICS - RESEARCH STUDIES OF PROCESSES IN PLANETARY ATMOSPHERES, COMETS, AND INTERSTELLAR SPACE
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, GLEN TEL. 415-961-2265
TECHNICAL SUMMARY

TO DETERMINE PRODUCTS, RATES, AND YIELDS OF ENERGY TRANSFER REACTIONS OCCURRING IN PLANETARY ATMOSPHERES, COMETS, AND INTERSTELLAR SPACE. SOLAR AND GALACTIC RADIATIONS INTERACT WITH THE CONSTITUENTS OF PLANETARY ATMOSPHERES, COMETS, AND INTERSTELLAR SPACE TO PRODUCE EXCITED AND IONIZED SPECIES AND FREE RADICALS, WHICH SUBSEQUENTLY REACT TO FORM OTHER IONIZED AND EXCITED SPECIES, AND/OR NEUTRAL UNEXCITED SPECIES, AND/OR RERADIATE SPECTRAL ENERGY.REGARDING THE NATURE OF PLANETARY ATMOSPHERES, PLANTARYY ATMOSPHERES, COMETS, AND INTERSTELLAR MATTER CAN BE OBTAINED FROM INVESTIGATION OF ENERGY TRANSFER REACTIONS UNDER WELL-DEFINED CONDITIONS. EXPERIMENTAL EFFORTS WILL BE DIRECTED TOWARD THE DETERMINATION OF RATE COEFFICIENTS OF VARIOUS REACTIONS AND EXCITATION PROCESSES AND SPECTRAL ENERGY DISTRIBUTIONS OF RADIATIVE PROCESSES. INITIAL INVESTIGATIONS WILL BE CONCERNED WITH A STUDY OF THESE PHENOMENA IN CO2-RICH ATMOSPHERES. AFTERGLOW AND PHOTOCHEMICAL TECHNIQUES WILL BE USED IN THESE INVESTIGATIONS; RATES AND PRODUCTS WILL BE DETERMINED USING OPTICAL AND MASS SPECTROMETRIC TECHNIQUES.

RTOP NO. 185-47-67 TITLE: STRUCTURE OF PLANETARY ATMOSPHERES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, GLEN TEL. 415-961-2265
TECHNICAL SUMMARY

THE GOAL OF OBSERVATIONS, LABORATORY MEASUREMENTS, AND THEORETICAL INVESTIGATIONS OF PLANETARY ATMOSPHERES IS TO DEVELOP DESCRIPTIVE AND PREDICTIVE MODELS. THE MODELS ARE USEFUL FORBOTH GEOPHYSICAL RESEARCH FOR THE DESIGN OF SPACECRAFT AND SYSTEMS FOR PLANETARY EXPLORATION. THE OBJECTIVE OF THIS WORK IS THE PREPARATION OF SUCH MODELS IN ORDER TO EXPLAIN THE EVOLUTION, STRUCTURE AND MAINTENANCE OF PLANETARY ATMOSPHERES. TO THIS END, ALL PERTINENT THEORY, LABORATORY MEASUREMENTS, OBSERVATIONS AND MODELS ARE USED; THERMODYNAMICS OF EVOLVING PLANETS, PHOTOCHEMISTRY AND KINETICS OF ATMOSPHERIC GASES, AND TRANSPORT PROCESSES IN ATMOSPHERES ARE CONSIDERED.

RTOP NO. 185-47-68 TITLE: PLANETARY ATMOSPHERES - STRUCTURE AND COMPOSITION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

EXPLORATORY MISSIONS TO THE OTHER PLANETS WILL EMPLOY ATMOSPHERE-ENTRY PROBES FOR THE PURPOSE OF MAKING OBSERVATIONS OF THE CHARACTERISTICS OF THE ATMOSPHERE DURING DESCENT AS WELL AS FROM THE SURFACE. COMPREHENSIVE STUDIES HAVE RESULTED IN THE DEFINITION OF MEASUREMENT TECHNIQUES AND INSTRUMENTATION SUITABLE FOR A MARS ATMOSPHERE ENTRY. SUCH INSTRUMENTATION WILL BE PART OF THE 1975 VIKING MISSION PAYLOAD. THE PLANETARY ATMOSPHERE EXPERIMENTS TEST, SUPPORTED IN PART BY THIS RTOP, IS BEING PERFORMED TO DEMONSTRATE AND CONFIRM IN THE EARTH'S ATMOSPHERE THE SOUNDNESS OF THIS CONCEPT. UPON SUCCESSFUL COMPLETION OF THE LAUNCH, SCHEDULED FOR JUNE 1971, FLIGHT DATA WILL BE ANALYZED TO EVALUATE THE PERFORMANCE OF THE ONBOARD INSTRUMENTATION. STUDIES WILL ALSO BE PERFORMED AS NEEDED IN RESPONSE TO REQUESTS OF THE VIKING PROJECT ENTRY SCIENCE TEAM, TO EVALUATE EFFECTS OF PROPOSED CHANGES OR TO DEVELOP NEW APPROACHES TO PLANNED EXPERIMENTS FOR THE LANDER VEHICLES. FURTHER STUDIES WILL BE MADE TO DETERMINE IMPLEMENTATION REQUIREMENTS OF THESE OR SIMILAR EXPERIMENTS FOR ENTRY INTO VENUS AND JUPITER.

RTOP NO. 185-47-71 TITLE: ATMOSPHERIC EXPERIMENT DEVELOPMENT
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO DEFINE IN DETAIL THE KEY INVESTIGATIONS TO BE CONDUCTED IN STUDYING THE ATMOSPHERES OF THE PLANETS, IN PARTICULAR VENUS, JUPITER AND SATURN. THE RESULTS OF THE WORK WILL BE THE DEFINITION AND RECOMMENDATION OF CONCEPTS TO BE DEVELOPED FOR BOTH SPACE FLIGHT AND GROUND-BASED EXPERIMENTS TO SUPPORT THESE INVESTIGATIONS. THEORETICAL AND LABORATORY STUDIES WILL BE CARRIED OUT IN TWO MAIN AREAS: 1. NUMERICAL STUDIES TO

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DEVELOP METHODS FOR THE INTERPRETATION OF BOTH SPECTRAL AND BROADBAND RADIOMETRIC DATA IN THE _SPECIAL CASE OF INHOMOGENEOUS SCATTERING ATMOSPHERES. 2. LABORATORY EVALUATION OF INSTRUMENTAL CONCEPTS WHICH EVOLVE FROM THE STUDY.

RTOP NO. 185-47-72 TITLE: THEORETICAL STUDY - PLANETARY ATMOSPHERES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

A PROGRAM OF EXPERIMENTAL AND THEORETICAL STUDIES RELATED TO PLANETARY ATMOSPHERES WILL BE CONDUCTED WITH THE OBJECTIVES OF ADDING TO _OUR UNDERSTANDING OF THE PROPERTIES OF PLANETARY ATMOSPHERES, APPLYING THE FINDINGS TO THE DESIGN OF BOTH GROUND BASED AND SPACECRAFT EXPERIMENTS, AND INTERPRETING THE DATA OBTAINED FROM THESE AS WELL AS OTHER OBSERVATIONS. THIS PROGRAM CONTRIBUTES TO THE NASA PLANETARY MISSIONS BOTH IN ITS DIRECT RESEARCH ACCOMPLISHMENTS RELEVANT TO PLANETARY ATMOSPHERE SCIENCE, AND ALSO IN THE CONTRIBUTIONS OF ITS STAFF OF _SPECIALISTS TO THE DEFINITION OF SCIENTIFIC OBJECTIVES AND EVALUATION OF SPECIFIC EXPERIMENT ALTERNATIVES FOR PLANETARY FLIGHT PROJECTS. THE STUDIES TO BE CONDUCTED IN FY'72 PERTAIN TO: A._ PHOTOCHEMISTRY OF PLANETARY ATMOSPHERES. B. RADIATION TRANSPORT THEORY AND THE THEORY OF SPECTRAL LINE FORMATION. C. MICROWAVE SPECTRAL STUDIES OF PLANETARY ATMOSPHERES. D. ATMOSPHERIC EVOLUTION. E. ELECTRON COLLISIONS WITH MOLECULES AND ATOMS IN PLANETARY ATMOSPHERES.

RTOP NO. 185-47-80 TITLE: EXPERIMENT DEVELOPMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE INSTRUMENTATION CAPABILITY REQUIRED FOR SPACE-CRAFT EXPLORATION AND STUDY OF PLANETARY ATMOSPHERES AND COMETARY GASES. NEW CONCEPTS WILL BE SOUGHT AND EVALUATED, AND KNOWN TECHNIQUES AND INSTRUMENTS WILL BE MODIFIED AND DEVELOPED FOR SPECIALIZED APPLICATION. STUDIES ESSENTIAL TO UNDERSTANDING THE RESPONSE AND BEHAVIOR CHARACTERISTICS OF SENSORS AND INSTRUMENTS WILL BE CONDUCTED. EMPHASIS IS BEING PLACED ON TWO AREAS OF DEVELOPMENT: (1) SPECIALIZED SENSORS AND INSTRUMENTS REQUIRED FOR INVESTIGATION OF THE LOWER ATMOSPHERE AND CLOUD PHENOMENA OF VENUS BY ENTRY PROBES. (2) INSTRUMENTATION AND EXPERIMENTS REQUIRED FOR INVESTIGATIONS OF THE ATMOSPHERES OF THE OUTER PLANETS FROM FLY-BY AND ORBITER SPACECRAFT.

RTOP NO. 185-47-81 TITLE: THEORY AND MODELS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO FOSTER AND TO DEVELOP A BROAD BASE OF THEORY

EXPLAINING THE PHENOMENA OF PLANETARY ATMOSPHERES INCLUDING THEIR ORIGINS, EVOLUTIONS, PRESENT STATES, AND FUTURE HISTORY. THEORETICAL MODELS OF THE ATMOSPHERES OF THE PLANETS ARE DERIVED, MODIFIED, CRITIQUED, AND IMPROVED ON A CONTINUOUS BASIS USING THE FUNDAMENTAL PRINCIPLES OF PHYSICS AND CHEMISTRY SUPPLEMENTED BY THE MOST CURRENT INFORMATION OBTAINED FROM FLIGHT EXPERIMENTS, LABORATORY RESEARCH, AND ASTRONOMICAL OBSERVATIONS.

RTOP NO. 185-47-82 TITLE: ATMOSPHERIC CHEMISTRY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO SUPPORT A BROAD BASED PROGRAM OF LABORATORY INVESTIGATIONS DIRECTED AT OBTAINING DATA ESSENTIAL TO THE ANALYSIS OF FLIGHT EXPERIMENTS AND THE DEVELOPMENT OF NEW AND IMPROVED THEORIES AND EXPLANATIONS OF ATMOSPHERIC CHEMICAL PROCESSES. RESEARCH INCLUDED UNDER THIS PROGRAM INCLUDES INVESTIGATIONS OF CHEMICAL KINETICS, PHOTOCHEMISTRY, REACTION MECHANISMS, IDENTIFICATION OF INTERMEDIATES AND META-STABLE REACTION SPECIES, COLLISION PROCESSES AND OTHER PHENOMENA CONNECTED WITH THE INTERCHANGE OF ENERGY BETWEEN PHOTONS, ATOMS, IONS, MOLECULES AND THE INTERACTION OF SUCH SPECIES WITH ELECTROMAGNETIC RADIATION.

RTOP NO. 185-47-83 TITLE: SPECTROSCOPIC INVESTIGATIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

RESEARCH CONDUCTED UNDER THIS RTOP INCLUDES SPECTROSCOPIC, PHOTOMETRIC, AND RADIOMETRIC INVESTIGATIONS OF PLANETARY ATMOSPHERES AND COMETS, AND OF THEIR COMPONENTS, FOR THE PURPOSE OF OBTAINING INFORMATION ABOUT COMPOSITION, STRUCTURE, AND REACTIONS. THIS INFORMATION IS REQUIRED FOR THE DESIGN AND DEVELOPMENT OF FLIGHT EXPERIMENTS AND FOR THE INTERPRETATION OF DATA OBTAINED BY FLIGHT EXPERIMENTS. LABORATORY INVESTIGATION AND THEORETICAL STUDIES CONCERNED WITH THE INTERACTION OF ELECTROMAGNETIC RADIATION AND THE COMPONENTS OF PLANETARY ATMOSPHERES ARE PURSUED WITH THE OBJECTIVE OF OBTAINING INFORMATION ABOUT COMPOSITION, DENSITY, TEMPERATURE OR OTHER PHYSICAL OR CHEMICAL CHARACTERISTICS. THE MAJORITY OF TASKS ARE CONCERNED WITH INFRARED AND ULTRAVIOLET SPECTROSCOPIC STUDIES OF GASEOUS SPECIES ALTHOUGH EXPLORATORY STUDIES TO DEFINE THE POTENTIAL OF MICROWAVE TECHNIQUES ARE ALSO INCLUDED. TASKS ALSO INCLUDE WORK DIRECTED AT UNDERSTANDING AURORAL AND AIRGLOW EMISSIONS SINCE SPECTROSCOPIC SCRUTINY OF THESE NATURAL PROCESSES OFFER STRONG CLUES TO THE COMPOSITION AND CHARACTERISTICS OF THE ATOMIC AND MOLECULAR SPECIES INVOLVED.

RTOP NO. 185-47-84 TITLE: CHEMISTRY OF THE OUTER PLANETS AND COMETS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: FELLOWS, R. F. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE OF THE RESEARCH CONDUCTED UNDER THIS RTOP IS TO OBTAIN IN THE LABORATORY, INFORMATION REQUIRED FOR THE INTERPRETATION OF DATA PERTAINING TO THE OUTER PLANETS AND COMETS. THE RESEARCH TASKS INCLUDED IN THIS PROGRAM ARE CONCERNED WITH DETERMINING THE PHYSICAL AND CHEMICAL PROPERTIES OF LOW MOLECULAR WEIGHT MOLECULES, FREE RADICALS AND OTHER SPECIES STABLE AT CRYOGENIC TEMPERATURES THAT ARE LIKELY TO BE PRESENT IN COMETS OR THE ATMOSPHERES OF THE OUTER PLANETS.IN ADDITION TO LABORATORY INVESTIGATIONS, THEORETICAL INVESTIGATIONS ARE ALSO PERFORMED IN WHICH MODEL ATMOSPHERES ARE CONSTRUCTED FROM CONSIDERATIONS OF THE EQUILIBRIA RESULTING FROM APPLYING CHEMICAL REACTION AND THERMODYNAMIC THEORY TO AN ASSUMED ASSEMBLAGE OF ATOMS UNDER PRIMEVAL CONDITIONS (I.E., SOLAR OR COSMIC ABUNDANCES, AND A THEORY OF PLANETARY EVOLUTION).

RTOP NO. 185-47-91 TITLE: PLANETARY ATMOSPHERIC PROCESSES AND MEASUREMENTS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE PURPOSE OF THIS PROGRAM IS TO STUDY PLANETARY ATMOSPHERIC PROPERTIES AND PROCESSES AND TO IMPROVE THE INTERPRETATION OF ATMOSPHERIC MEASUREMENTS BY MEANS OF LABORATORY SIMULATIONS OF THE ATMOSPHERIC PROCESSES AND PROPERTIES, SUCH AS CONDENSATION, SUBLIMATION, AND HEAT TRANSFER IN THE MARTIAN ATMOSPHERE, AND BY CONCURRENT THEORETICAL STUDIES OF THESE PROPERTIES AND PROCESSES. EXISTING LANGLEY RESEARCH CENTER FACILITIES WILL BE UTILIZED WITH ADDITIONAL EQUIPMENT AND INSTRUMENTATION ADDED AS REQUIRED. THE VERTICAL DISTRIBUTION OF OZONE AND PERHAPS OTHER TRACE GASES IN EARTH'S ATMOSPHERE WILL BE DETERMINED BY SPECTROPHOTOMETRY OF SOLAR RADIATION REFLECTED FROM SATELLITES DURING SOLAR OCCULTATION WITH RESPECT TO THE SATELLITES.

RTOP NO. 185-47-94 TITLE: EXPERIMENTAL AND THEORETICAL STUDIES OF PLANETARY ATMOSPHERES
ORGANIZATION: NASA, WALLOPS STATION
MONITOR: HOLLAND, A. TEL. 703-824-3411
TECHNICAL SUMMARY

AN INTEGRATED EXPERIMENTAL AND THEORETICAL STUDY AIMED AT IMPROVING OUR UNDERSTANDING OF THE OPTICAL PROPERTIES OF PLANETARY ATMOSPHERES INCLUDING THE EFFECT OF AEROSOLS ON SLANT PATH VISIBILITY THROUGH THE ATMOSPHERE. SPECIAL EMPHASIS WILL BE PLACED ON (1) DEVELOPING AND IMPROVING MODEL ATMOSPHERES FOR USE IN REMOTE SENSING, (2) DEVELOPMENT OF INSTRUMENTATION FOR MEASURING OPTICAL PARAMETERS OF THE ATMOSPHERES, (3) IMPROVING EXISTING THEORETICAL MODELS OF RADIATIVE TRANSFER THROUGH THE ATMOSPHERES CONTAINING SIGNIFICANT AMOUNTS OF PARTICULATE MATTER (I.E. HAZE, DUST, ICE CRYSTALS, FOG

DROPLETS).

RTOP NO. 185-50-50 TITLE: GEOPHYSICAL PROCESSES RELATED TO ORGIN AND EVOLUTION OF THE PLANETS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: WALTER, L. S. TEL. 301-982-2282
TECHNICAL SUMMARY

THE BASIC PURPOSE OF THIS RESEARCH WILL BE TWOFOLD: A) TO DEVELOP AND EVALUATE THEORIES CONCERNING THE COMPOSITION AND STRUCTURE OF THE PLANETS - ESPECIALLY MARS, VENUS AND THE EARTH. B) TO CONCEIVE DEFINITIVE FLIGHT EXPERIMENTS WHICH WOULD SERVE TO ESTABLISH THE VALIDITY OR DISPROVE THE THEORIES. THE SEVERAL SEGMENTS UNDER THIS RESEARCH PLAN PERTAIN TO A BROAD VARIETY OF DISCIPLINES: A) PETROLOGY AND IMPACT STUDIES B) CHEMICAL C) ASTRONOMICAL D) PLANETARY BODY STUDIES A GREAT DEAL OF INFORMATION BASIC TO OUR UNDERSTANDING OF THE PLANETS HAS BEEN AND WILL BE RETURNED FROM SPACECRAFT.

RTOP NO. 185-50-60 TITLE: PLANETOLOGY - GEOMORPHOLOGY AND SURFACE PROCESSES OF PLANETARY BODIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

MARINERS IV, VI, VII SHOWED THAT PARTS OF THE MARTIAN SURFACE ARE CRATERS SIMILAR TO THE MOON BUT THE MORPHOLOGY OF THE CRATERS IS DIFFERENT. FURTHERMORE, MARS HAS TERRAIN TYPES TOTALLY UNLIKE THE MOON. THESE DIFFERENCES CAN BE ATTRIBUTED PARTLY TO: 1) DIFFERENT PRIMARY STRUCTURES AND PROVINCES WHICH POSSIBLY RESULTED FROM DIFFERENT EVOLUTIONARY HISTORIES, AND 2) DIFFERENT EROSIVE AGENTS RESULTING FROM DIFFERENT PLANETARY ENVIRONMENTS. EOLIAN PROCESSES, FOR EXAMPLE, ARE ABSENT ON THE MOON BUT PROBABLY ARE VERY SIGNIFICANT ON MARS. SIMILAR DIFFERENCES MAY BE EXPECTED FOR MERCURY, VENUS, AND THE GALILEAN SATELLITES OF JUPITER. THE OBJECTIVE OF THIS PROGRAM IS TO CONSIDER THE EXISTENCE OF LIKELY PLANETARY SURFACE FEATURES AND TO DETERMINE THEIR GEOMORPHIC CONFIGURATION, AND SECONDLY, TO ACCESS THE EFFECTIVENESS OF VARIOUS EROSIVE AGENTS ON SPECIFIC GEOMORPHIC FEATURES IN INDIVIDUAL PLANETARY ENVIRONMENTS. VARIOUS GEOMORPHIC FEATURES OF PLANETARY AND SATELLITE SURFACES WILL BE STUDIED AS PHOTOGRAPHS BECOME AVAILABLE. BECAUSE IMPACT CRATERS ARE ONE FEATURE COMMON TO ALL SURFACES, SIZE FREQUENCY DISTRIBUTIONS AND MORPHOLOGIC TYPES OF CRATERS ON EACH SURFACE WILL BE DETERMINED TO MAKE INFERENCE REGARDING THE GEOLOGIC HISTORIES OF THOSE SURFACES AND TO MAKE COMPARISONS BETWEEN SURFACES. MODELS OF METEOROID BOMBARDMENT WILL BE EXTENDED AND REFINED. ADDITIONALLY, GEOMORPHIC PROVINCES WILL BE OUTLINED AND THEIR ORIGINS INTERPRETED IN THE LIGHT OF EXISTING KNOWLEDGE OF SURFACE ROCK COMPOSITION AND WITH THE AID OF TERRESTRIAL ANALOGS, CONSIDERING THE EFFECTS OF MODIFICATION BY EROSIVE AGENCIES PECULIAR TO EACH PLANET.

RTOP NO. 185-50-61 TITLE: PLANETARY MAGNETISM
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO CONTINUE STUDIES INVOLVING MAGNETIC FIELDS DURING THE FORMATION OF THE SOLAR SYSTEM. MAGNETIC FIELDS ARE INVOLVED IN THE ESTABLISHMENT OF PERMANENT MAGNETISM AS FOUND ON APOLLO. THESE FIELDS SERVE AS A TRACER IN ESTABLISHING THE EARLY PHYSICAL PARAMETERS OF THE SUN AND THE PLANETS. THE EARLY SOLAR FIELD CAN ALSO BE IMPORTANT IN THE THERMAL EVOLUTION OF THE PLANETS. THE PRESENT EVIDENCE SUGGESTS THAT FOSSIL NUCLIDES WERE NOT IMPORTANT IN THE HEATING CYCLE, LEAVING ELECTRICAL HEATING AS THE MAJOR POSSIBLE SOURCE. ONE FORM OF THIS TYPE OF HEATING HAS BEEN PROGRAMMED FOR COMPUTATION. THE REMAINING TYPE DUE TO THE INTERPLANETARY ELECTRICAL FIELD IS REQUIRED, AND OTHER PARTIAL SOURCES SUCH AS ACCRETION AND RADIONUCLIDES ARE TO BE INCLUDED IN AN ALL ENCOMPASSING COMPUTER ROUTINE WHICH WILL GIVE THE MOST GENERAL THERMAL HISTORY.

RTOP NO. 185-50-71 TITLE: PLANETOLOGY STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

A PROGRAM OF THEORETICAL AND EXPERIMENTAL PLANETOLOGY WILL BE CONDUCTED WITH THE OBJECTIVES OF CONTRIBUTING TO THE UNDERSTANDING OF BASIC ATMOSPHERIC, SURFACE, AND SUBSURFACE PROPERTIES OF THE PLANETS; AND OF APPLYING THE RESULTS TO THE DESIGN OF EXPERIMENTS AND THE INTERPRETATION OF DATA FROM EXPERIMENTS ON UNMANNED FLYBY, ORBITING AND LANDED SPACECRAFT. THIS PROGRAM IS INTENDED TO CONTRIBUTE SPECIFICALLY TO NASA PLANETARY MISSIONS IN THAT 1) THE RESEARCH TOPICS ARE DIRECTLY RELEVANT TO PLANETARY SCIENCE, 2) THE STAFF OF SPECIALISTS INVOLVED ALSO CONTRIBUTE TO THE DEFINITION OF SCIENTIFIC OBJECTIVES AND RATIONALE FOR PLANETARY MISSIONS, AND 3) ANALYTICAL INSTRUMENTS BEING DEVELOPED MAY BE USED FOR SURFACE MEASUREMENTS ON PLANETS BY FUTURE UNMANNED MISSIONS. THE STUDIES TO BE CONDUCTED IN FY'72 PERTAIN TO: 1. SURFACE ANALYSIS BY COMBINED ALPHA-SCATTERING X-RAY FLUORESCENCE. 2. PROPERTIES OF METALLIC HYDROGEN. 3. OPTICAL PROPERTIES OF SURFACE AND POSSIBLE ATMOSPHERIC MATERIALS. 4. SURVEY AND SAMPLE ANALYSIS BY COMBINED SCANNING ELECTRON MICROSCOPE AND X-RAY ANALYZER.

RTOP NO. 185-50-81 TITLE: PLANETARY GEOSCIENCE STUDIES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DWORNIK, S. E. TEL. 202-962-1151
TECHNICAL SUMMARY

PLANETARY GEOSCIENCE STUDIES IS A PROGRAM ENCOMPASSING GEOLOGY, GEOCHEMISTRY, GEOPHYS AND SOIL PHYSICS WHICH HAS THE BROAD OBJECTIVE OF UNDERSTANDING THE GENESIS, DISTRIBUTION, COMPOSITION AND INTER-RELATIONSHIPS OF THE CONDENSED MATTER IN PLANETS AND THEIR SATELLITES, COMETS, ASTEROIDS, AND OTHER SOLID MATERIALS IN THE SOLAR

SYSTEM. THE GEOLOGY OF THE PLANETS BEARS DIRECTLY ON THREE BASIC AIMS OF LUNAR AND PLANETARY EXPLORATION: DETERMINATION OF THE ORIGIN AND EVOLUTION OF THE SOLAR SYSTEM; DETERMINATION OF THE ORIGIN AND EVOLUTION OF LIFE; AND CLARIFICATION OF THE NATURE OF THE PROCESSES SHAPING MAN'S TERRESTRIAL ENVIRONMENT (NATIONAL ACADEMY OF SCIENCES, 1966). IN ORDER TO MEET THESE OBJECTIVES, IT IS NECESSARY TO PERFORM THEORETICAL ANALYSIS, INSTRUMENT DEVELOPMENT AND SPACECRAFT EXPERIMENTS THAT LEAD TO UNDERSTANDING THE NATURE AND PROPERTIES OF THE SURFACE, REGOLITH, CRUST AND CORE. THIS KNOWLEDGE WILL LEAD TO AN UNDERSTANDING OF INDIVIDUAL PLANETS; THE ORIGIN OF THE SOLAR SYSTEM; PLANETARY PHYSICAL AND CHEMICAL PROPERTIES INTERACTIONS BETWEEN THE ATMOSPHERE AND LITHOSPHERE INTERACTIONS OF THE FLUX OF INTERPLANETARY PARTICLES AND FIELDS WITH PLANETARY BODIES AND WILL ALSO AID IN THE DISCOVERY AND UNDERSTANDING OF THE ORIGIN OF EXTRATERRESTRIAL LIFE. ONE IMPORTANT RESULT OF GEOLOGICAL EXPLORATION OF THE PLANETS WILL BE INCREASED KNOWLEDGE OF THE EARTH. VERY LITTLE IS KNOWN OF THE FIRST 2 BILLION YEARS OF THE EARTH'S HISTORY. MARS, MERCURY, AND THE MOON ON THE OTHER HAND, HAVE NO OCEANS, AND THE EROSIVE EFFECTS OF WATER ARE, THEREFORE, VIRTUALLY ABSENT. THEORETICAL MODELING, LABORATORYTERRESTRIAL ANALOGUES FOR COMPARATIVE FIELD----

RTOP NO. 186-68-50 TITLE: ADVANCED SYSTEM TECHNOLOGY/THERMOELECTRIC OUTER PLANET SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

THE OBJECTIVES OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT ARE TO PERFORM DESIGN AND DEVELOPMENTAL TESTING OF AN OUTER PLANET SPACECRAFT SYSTEM, AND SELECTED SUBSYSTEMS AND SUBASSEMBLIES USING TECHNOLOGIES CRITICAL TO THE OUTER PLANET MISSIONS. THE TOPS _PROJECT WILL CONTINUE TO INVESTIGATE THE INTERACTIONS OF THE SUBSYSTEMS (SCIENCE AND ENGINEERING) IN THE INTEGRATED SYSTEM CONSIDERING THE SIGNIFICANT AND NEW ENVIRONMENTS SO THAT REALISTIC PERFORMANCE, TESTING AND RELIABILITY FOR LONG-LIFE CAN BE ASSESSED AND ASSOCIATED COST ESTIMATES CAN BE MADE. ADVANCED SYSTEM TECHNOLOGY WILL BE USED IN _SYSTEM AND DETAILED DESIGN OF THE SPACECRAFT AND DEVELOPMENTAL TESTING WILL BE PERFORMED ON SELECTED HARDWARE. THE TOPS RESULTS WILL BE _USED AS AN AID IN ESTABLISHING OUTER PLANET GRAND TOUR PRE-PROJECT REQUIREMENTS. MISSION REQUIREMENTS WILL BE DEVELOPED TO SUPPORT OPGT _PRE-PROJECT PLANNING. IN ADDITION, SYSTEM TEST AND DESIGN LIAISON REQUIREMENTS WILL BE STUDIED; AND, IN SUPPORT OF MISSION STUDIES, TOPS NAVIGATION TECHNIQUES WILL BE DEVELOPED. SCIENCE INTEGRATION WORK WILL CONTINUE BY INTEGRATING THE SSG PAYLOAD ON TOPS. NEW ENVIRONMENTAL DESIGN RESTRAINTS AND TEST REQUIREMENTS WILL BE ESTABLISHED FOR THE SPACECRAFT SYSTEM AND SUBSYSTEMS. THE APPROACH WILL BE TO INVESTIGATE 1) THE DESIGN OF A COMPLETE SPACECRAFT, 2) S/C-RTG INTEGRATION PROBLEMS, 3) CRITICAL MISSION REQUIREMENTS AND

OPERATIONS, 4) RELIABILITY, AND 5) SELECTED SCIENCE PAYLOADS. ELEMENTS OF SELECTED SUBSYSTEMS AND SELECTED BREADBOARDS FOR FUNCTIONAL SIMULATION WILL BE FABRICATED AND INTEGRATED TO EXPLORE FEASIBILITY OF DESIGN AND COMPATIBILITY. A FINAL REPORT ON THE TOPS EFFORT WILL BE PREPARED WITH EMPHASIS ON 1) S/C SYSTEM

RTOP NO. 186-68-51 TITLE: HEAT SHIELD EVALUATION FOR JUPITER PROBE MISSIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE HEAT-PROTECTION TECHNOLOGY SO THAT HEAT-PROTECTION SYSTEMS FOR UNMANNED PROBES ENTERING THE ATMOSPHERE OF JUPITER CAN BE DESIGNED WITH A MINIMUM WEIGHT, THUS, MAXIMIZING THE SCIENTIFIC PAYLOAD CAPABILITY. CANDIDATE HEAT SHIELD MATERIALS WILL BE SELECTED, SCREENED, AND TESTED UNDER CONDITIONS THAT SIMULATE THE HIGH HEATING RATES TYPICAL OF THOSE TO BE EXPECTED AT JOVIAN ENTRY VELOCITIES OF 50 KM/SEC. THE TESTS WILL BE CONDUCTED IN ELECTRIC-ARC-HEATED STREAMS AND HIGH-INTENSITY ARGON ARC AND LASER RADIATION FLUXES BOTH SINGLY AND IN COMBINATION. ANALYTICAL TECHNIQUES FOR PREDICTING THE CHARACTERISTICS OF THE HEAT-SHIELD MATERIALS WILL BE DEVELOPED CONCURRENTLY WITH THE EXPERIMENTS. THE DEVELOPMENT OF A PULSED CONSTRICTED-ARC FACILITY CAPABLE OF DUPLICATING JUPITER ENTRY HEATING CONDITIONS WILL CONTINUE. THIS TECHNOLOGY IS REQUIRED TO PERMIT THE DESIGN OF HEAT PROTECTION SYSTEMS FOR UNMANNED PROBES ENTERING PLANETARY ATMOSPHERES AT VELOCITIES OF 50 KM/SEC.

RTOP NO. 186-68-52 TITLE: SCIENCE SUBSYSTEM TECHNOLOGY FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

IN ORDER TO PREPARE FOR THE TECHNICALLY CHALLENGING MISSIONS TO THE OUTER PLANETS PLANNED FOR THE LATE 1970'S, IT IS NECESSARY TO GET AN EARLY START ON THE SOLUTION OF THE ANTICIPATED DIFFICULT OUTER PLANETS SCIENCE SYSTEMS PROBLEMS. AMONG THE OUTSTANDING PROBLEMS ARE: 1) TO DEFINE IMAGING EXPERIMENTS AND IMAGING SYSTEM FUNCTIONAL REQUIREMENTS FOR THESE MISSIONS IN ORDER TO ENSURE THAT A SUITABLE IMAGING SYSTEM WILL BE DEVELOPED IN TIME FOR SUCH MISSIONS AND 2) TO PRESERVE THE INTEGRITY OF THE SCIENTIFIC MEASUREMENTS BY DEVELOPING APPROPRIATE TECHNIQUES TO REDUCE THE EFFECTS OF RADIATIONS FROM ON-BOARD RTGS AND NATURAL RADIATION SOURCES, SUCH AS THE INTENSE JOVIAN RADIATION BELTS, TO TOLERABLE LEVELS. BY MEANS OF IN-HOUSE STUDIES AND CONTACTS WITH OUTSIDE SCIENTISTS, IMAGING SCIENCE OBJECTIVES WILL BE GENERATED, AND KEPT CURRENT. THESE WILL BE USED TO DERIVE OUTER PLANETS IMAGING SYSTEM FUNCTIONAL REQUIREMENTS AND TO DEVELOP BASELINE IMAGING SYSTEM DESIGNS. NEW IMAGING SENSORS WILL BE EVALUATED FOR APPLICABILITY IN THE IMAGE SYSTEM DESIGN. A STUDY OF RADIATION TOLERANCES OF VARIOUS INSTRUMENTS IS BEING PERFORMED.

PARTICULARLY SENSITIVE COMPONENTS ARE STUDIED ANALYTICALLY, EXPERIMENTALLY AND BY MEANS OF PREVIOUSLY PUBLISHED DATA. MEANS ARE THEN DEVISED TO REDUCE THE NATURAL AND RTG RADIATION EFFECTS BY TECHNIQUES SUCH AS SHIELDING, ORIENTATION, LOCATION, ELECTRONIC DISCRIMINATION AND USE OF ALTERNATE COMPONENTS.

RTOP NO. 186-68-53 TITLE: TELECOMMUNICATIONS TECHNOLOGY FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS ACTIVITY IS TO DEVELOP THE TELECOMMUNICATIONS TECHNOLOGY NECESSARY TO PERFORM MISSIONS TO THE OUTER PLANETS IN A RELIABLE AND COST-EFFECTIVE MANNER. THE COMMUNICATION RANGE FOR THESE MISSIONS INCREASES FROM ABOUT 1 AU FOR MARS UP TO 31 AU FOR NEPTUNE. FURTHERMORE, THE MISSION DURATION INCREASES FROM LESS THAN 1 YEAR FOR A MARS MISSION UP TO 11 YEARS FOR A GRAND TOUR. THUS, AN INCREASE OF AT LEAST 30 DB IS REQUIRED IN COMMUNICATION PERFORMANCE CAPABILITY RELATIVE TO MARINER '69 AND THE SPACECRAFT OPERATING LIFE MUST BE INCREASED ACCORDINGLY. THE REQUIRED IMPROVEMENTS ARE BEING DEVELOPED BY IN-HOUSE AND CONTRACTED ACTIVITIES. FIRST, A 4.3 METER UNFURLABLE ANTENNA SYSTEM IS BEING DEVELOPED AND TESTED TO PROVIDE THE INCREASED GAIN AND SMALLER POINTING ERROR LOSSES. SECOND, AN EFFICIENT X-BAND DATA DUMP TELEMETRY SYSTEM IS BEING DEVELOPED AND TESTED AS PART OF UNIFIED DUAL FREQUENCY RADIO DEVELOPMENT. THIRD, DIGITAL CIRCUIT TECHNIQUES ARE BEING UTILIZED IN THE COMMAND TELEMETRY SYSTEMS; MICROWAVE POWER TUBES ARE BEING LIFE TESTED; REDUNDANT MECHANIZATIONS ARE BEING ANALYZED; ALL FOR THE PURPOSE OF ACHIEVING STABILITY AND LONG-LIFE. FOURTH, THE OVERALL TELECOMMUNICATION SYSTEM IS BEING ANALYZED TO OPTIMIZE THE TRACKING, TELEMETRY AND COMMAND PERFORMANCE, EMPHASIZING BOTH RELIABILITY AND OPERATIONAL FLEXIBILITY. THE GOAL OF THIS RTOP IS A SMOOTH TECHNOLOGY TRANSFER FROM ADVANCED TECHNICAL DEVELOPMENT TO PROJECT WHEN THE OUTER PLANET GRAND TOUR PROJECT STARTS ON DEC. 1, 1971. SEVERAL KEY COMPONENTS FOR THIS RTOP ARE DEPENDENT UPON THE OART EFFORT, "MICROWAVE DEEP SPACE COMMUNICATION AND TRACKING," RTOP NO. 115-21-20.

RTOP NO. 186-68-53 TITLE: TELECOMMUNICATIONS TECHNOLOGY FOR OUTER PLANET PROBES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

TO PREDICT THE PERFORMANCE AND DETERMINE THE DESIGN DIFFERENCES REQUIRED FOR RELIABLE RADIO COMMUNICATIONS THROUGH OUTER PLANET ATMOSPHERES, RELATIVE TO COMMUNICATION LINK DESIGNS FOR FREE SPACE AND EARTH ATMOSPHERE. THEORETICAL DEDUCTIONS OF ABSORPTION, REFRACTION, AND SCATTERING LOSSES, AND PLANETARY RADIO NOISE, WILL BE MADE FROM EARTH-BASED OBSERVATIONS DATA FROM OPTICAL AND RADIO ASTRONOMY, SPECTROSCOPY, AND METEOROLOGY. THEORETICAL PREDICTIONS

ARE VERIFIED BY LABORATORY SIMULATIONS WHENEVER FEASIBLE. TO ENABLE RELIABLE LINK DESIGN FOR SPACECRAFT IN VICINITY OF OUTER PLANETS, THE FOLLOWING WILL BE INVESTIGATED: 1. SIGNAL ATTENUATION BY VARIED PROPORTIONS OF AMMONIA, WATER, AND METHANE, IN DOMINANTLY HYDROGEN AND HELIUM ATMOSPHERES; 2. EXTRAPOLATION OF TURBULENCE FADING FACTORS DEDUCED FROM VENUS DATA, TO THE JUPITER ATMOSPHERE; 3. TOTAL SIGNAL ATTENUATION FOR OCCULTATION AND ENTRY PROBE TRANSMISSION THROUGH JUPITER'S OUTER ATMOSPHERE, AND AT AND BELOW CLOUD LAYERS USING MOROZ AND JPL/LEWIS MODELS; 4. EFFECT OF JUPITER NOISE ON COMMUNICATIONS FOR SPACECRAFT IN TYPICAL TRAJECTORIES IN THE JUPITER ENVIRONMENT; 5. POSSIBLE PROPAGATION EXPERIMENTS BY SMALL PRECURSOR SPACECRAFT, OR THROUGH ADDITIONAL IMPLEMENTATION OF EARTH-BASED TRACKING SYSTEMS; 6. EXTENSION OF JUPITER FINDINGS TO OTHER OUTER PLANET ENVIRONMENTS.

RTOP NO. 186-68-54 TITLE: GUIDANCE AND CONTROL TECHNOLOGY FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE GUIDANCE AND CONTROL TECHNOLOGY FOR FUTURE LONG TERM MISSIONS TO THE OUTER PLANETS. TYPICAL OF THESE MISSIONS ARE THE PROPOSED GRAND TOUR MISSION, A FLY-BY OF SEVERAL PLANETS WITH A DURATION OF 8-12 YEARS. LATER MISSIONS ENVISION OUTER PLANET ORBITERS, PROBES, AND LANDERS. THE TECHNOLOGY REQUIRED TO MEET EXPANDING MISSION REQUIREMENTS WILL REQUIRE INCREASING MEASURES OF OPERATIONAL LIFE, RELIABILITY, AUTONOMY, AND IMMUNITY TO ENVIRONMENTAL STRESSES. PAST YEARS EFFORTS HAVE CONCENTRATED ON THE SUPPORT REQUIREMENTS FOR THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT. FY'72 EFFORTS WILL BRING THESE EFFORTS TO FRUITION AND WILL CULMINATE WITH THE PREPARATION OF PRE-PROJECT DOCUMENTS THAT DESCRIBE THE DESIGN REQUIREMENTS AND PROGRAMMATIC CONTROLS REQUIRED FOR A SMOOTH TRANSITION TO PROJECT ACTIVITY. THE AREAS TO BE COVERED DURING FY'72 INCLUDE EFFORTS ON APPROACH GUIDANCE DEVELOPMENT, EXTENDED LIFE ATTITUDE CONTROL SYSTEM DESIGN (ELACS), TOPS THRUST VECTOR CONTROLLER DESIGN, ELACS DEVELOPMENT AND TEST, AUTOMATIC TEST TECHNIQUES FOR REDUNDANT SYSTEMS, DIGITAL STAR TRACKER DEVELOPMENT, IMAGE DISSECTOR DEVELOPMENT, DIGITAL SUN SENSOR DEVELOPMENT, AND INERTIAL DEVICE DEVELOPMENT. THESE EFFORTS WILL BE LIMITED TO THE CONTINUATION OF WORK STARTED IN PRIOR YEARS AND PREPARATION OF PRE-PROJECT DOCUMENTATION. WHEN THE OUTER PLANET GRAND TOUR PROJECT IS INITIATED, THESE EFFORTS, CONSISTING OF THE HARDWARE DEVELOPMENTS AND TESTS, WILL BE CONTINUED UNDER THE PROJECT.

RTOP NO. 186-68-55 TITLE: G&C TECHNOLOGY FOR MARS ROVING VEHICLES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE WORK PROPOSED UNDER THIS RTOP WILL PROVIDE TECHNICAL

ASSISTANCE AND DIRECTION TO TWO NASA HEADQUARTERS UNIVERSITY RESEARCH CONTRACTS AT CORNELL UNIVERSITY AND RENSSELAER POLYTECHNIC INSTITUTE. THESE CONTRACTS PROVIDE FOR RESEARCH AND ADVANCED DEVELOPMENT IN THE AREA OF MARS SURFACE EXPLORATION. IN PARTICULAR, THE WORK IS DIRECTED TOWARD DEVELOPING SUBSYSTEM AND COMPONENT TECHNOLOGY FOR AN UNMANNED MARS ROVING VEHICLE.

RTOP NO. 186-68-55 TITLE: MARS ROVING VEHICLE TECHNOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: TARVER, P. TEL. 202-963-4352
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PROGRAM IS TO PROMOTE THE CAPABILITY FOR DEVELOPING CONCEPTS, SUBSYSTEMS AND COMPONENTS FOR CONTROLLING THE MOTION OF UNMANNED PLANETARY SURFACE ROVING VEHICLES. THE PROGRAM IS A LONG-TERM RESEARCH AND ADVANCED DEVELOPMENT EFFORT AND WILL INCLUDE ANALYSES, SIMULATIONS AND HARDWARE DEVELOPMENT FOR MARS ROVING VEHICLE MISSIONS. THE EFFORT IN FY '72 WILL SUPPORT RESEARCH CONTRACTS AT CORNELL UNIVERSITY AND RENSSELAER POLYTECHNIC INSTITUTE. THE BENEFITS DERIVED FROM THESE CONTRACTS ARE TWOFOLD. FIRST, THE RESULTS ARE USEFUL IN MAINTAINING AND IMPROVING THE CAPABILITY OF NASA TO DEVELOP AN UNMANNED ROVING VEHICLE FOR PLANETARY EXPLORATION. AND SECOND, THE STUDENT PARTICIPANTS ARE CONFRONTED WITH A PRACTICAL ENGINEERING PROBLEM DURING THEIR COURSE OF STUDY. THIS SIGNIFICANTLY INCREASES THE STUDENT'S ABILITY TO COPE WITH ENGINEERING PROBLEMS UPON HIS GRADUATION.

RTOP NO. 186-68-56 TITLE: CENTRAL DATA SUBSYSTEM FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVE OF THE RTOP IS TO DEVELOP THE ADVANCED S/C DATA SYSTEMS TECHNOLOGY FOR THE OUTER PLANET MISSIONS. RESULTS WILL BE IN THE FORM OF DESIGNS, BREADBOARDS, OR PROTOTYPES. THIS WILL BE ACCOMPLISHED THRU IN-HOUSE DESIGN COMPLEMENTED BY DEVICE AND SUBSYSTEMS DEVELOPMENTS CONTRACTS. THE S/C DATA SYSTEM INCLUDES THOSE DATA SUBSYSTEMS WHICH PERFORM THE FUNCTION OF CONTROL, MEASUREMENT, AND STORAGE. "CONTROL" INCLUDES THE GENERATION AND DISTRIBUTION OF TIMING SIGNALS, SEQUENCING THE S/C THRU ITS DESIRED STATES (MODES), PERFORMING MAINTENANCE AND FAILURE DIAGNOSTICS ON OTHER S/C SUBSYSTEMS, AND SWITCHING IN REDUNDANT UNITS OR PERFORMING THE EQUIVALENT FUNCTIONS. "MEASUREMENT" CONSISTS OF CONDITIONING, SAMPLING, ENCODING, MULTIPLEXING, COMPRESSING, AND FORMATTING DATA FOR TRANSMISSION OR STORAGE. "STORAGE" INCLUDES MASS STORAGE (TAPE RECORDERS) BUFFER STORAGE (EITHER MAGNETICS OR SEMICONDUCTORS) AND WORKING STORAGE (READ-WRITE OR READ-ONLY MEMORIES). THE S/C DATA SYSTEM IS CONSIDERABLY MORE CENTRALIZED THAN ITS MARINER-CLASS PREDECESSORS AS A DIRECT CONSEQUENCE OF THE NEED FOR GREATLY INCREASED RELIABILITY AND ON-BOARD DECISION-MAKING. CENTRALIZATION

PROVIDES FOR INCREASED COMPUTATIONAL CAPABILITY AND MORE EFFICIENT ALLOCATION OF REDUNDANCY. DURING FY'72 THE DETAILED FUNCTIONAL DESIGN OF MOST OF THE DATA SYSTEM WILL BE COMPLETED. THE MEASUREMENT PROCESSOR SUBSYSTEM (MPS) WILL BE BREADBOARDED AND TESTED WITH SIMULATED MEASUREMENT INPUTS. CONTRACTED EFFORTS IN FY'72 INCLUDE COMPLETION OF THE CUSTOMIZED METALLIZED MULTI-GATE ARRAY (CMMA) DEVELOPMENT AND DELIVERY OF SUFFICIENT DEVICES FOR BREADBOARDING OF ONE CCS PROCESSOR. ALSO, A

RTOP NO. 186-68-57 TITLE: ENGINEERING MECHANICS TECHNOLOGY FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

MAJOR CHARACTERISTICS OF OUTER PLANET SPACECRAFT INCLUDE: INCREASED COMMUNICATION CAPABILITIES, RTG POWER SOURCES, NEW PROPELLANTS, EXTREME LOW TEMPERATURE ENVIRONMENTS, AND VERY LONG LIFE. THIS RTOP CONSISTS OF A NUMBER OF TASKS HAVING AS THEIR COMMON GOAL THE IDENTIFICATION OF NEW ENGINEERING MECHANICS REQUIREMENTS OF SUCH SPACECRAFT AND THE DEVELOPMENT OF THE TECHNOLOGIES NEEDED TO SATISFY THEM. SUBSTANTIALLY ALL OF THE CURRENT EFFORT SUPPORTS TOPS. A 4.25-M DIAMETER DEPLOYABLE HIGH GAIN ANTENNA IS BEING DEVELOPED IN-HOUSE IN COOPERATION WITH THE TELECOMMUNICATIONS RTOP 186-68-53. ASSEMBLY AND ADJUSTMENT ARE TO BE COMPLETE IN NOVEMBER 1971, AND IT IS PLANNED THAT R.F. AND ENVIRONMENTAL TESTING WILL BE DONE UNDER THE OUTER PLANETS PROJECT. MAGNETOMETER BOOMS AND LONG-LIFE FLUID PUMPS WERE INVESTIGATED IN FY'71; PREPARATIONS WILL CONTINUE IN FY'72 TO PERMIT THE EARLY AWARD OF DEVELOPMENT CONTRACTS FOR THESE ITEMS BY THE OUTER PLANETS PROJECT. IN ADDITION TO PROVIDING GENERAL SUPPORT TO THE TOPS PROJECT, A FULL-SCALE RADIATION TEST MODEL IS BEING FABRICATED. NUCLEAR RADIATION FIELDS WERE CALCULATED FOR CONFIGURATIONS 12J AND 12K IN FY'71. IN FY'72, FIELDS WILL BE CALCULATED FOR CONFIGURATION 12L AND FOR THE RADIATION TEST MODEL, AND THE LATTER WILL BE COMPARED WITH ACTUAL MEASUREMENTS. TOPS TEMPERATURE CONTROL SUPPORT, FORMERLY UNDER RTOP 124-09-26, WILL BE PROVIDED BY THIS RTOP IN FY'72. HIGH PERFORMANCE POLYMERIC ADHESIVES, SELECTED AND SUBJECTED TO HIGH TEMPERATURE AND THERMAL CYCLING TESTS IN FY'71, WILL BE SUBJECTED TO LONG DURATION EXTREME LOW TEMPERATURE TESTS IN FY'72. STRESS CORROSION STUDIES CONCERNED WITH TITANIUM PRESSURE VESSEL----

RTOP NO. 186-68-58 TITLE: PACKAGING AND CABLING TECHNOLOGY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

THE OBJECTIVES OF THE PACKAGING AND CABLING TECHNOLOGY HAS BEEN TO MEET THE INCREASINGLY COMPLEX SPACE MISSIONS REQUIREMENTS FOR LONGER LIFE AND IMPROVED PACKAGING EFFICIENCY. MISSIONS REQUIRE GREATER RELIABILITY TO OPERATE IN INCREASINGLY SEVERE ENVIRONMENTS FOR LONGER TIMES. THIS CREATES A PARADOX FOR PACKAGING IN THAT A

LARGER NUMBER OF SMALLER AND MORE FRAGILE COMPONENTS MUST BE ASSEMBLED AND INTERCONNECTED TO PERFORM RELIABLY FOR A LONGER TIME. THE APPROACH WAS TO REVIEW EXISTING AND PROPOSED JPL AND OTHER PACKAGING AND CABLING METHODS AND TECHNIQUES. THROUGH EVALUATION AND ANALYSIS IN CONJUNCTION WITH ELECTRONIC COMPONENT AND ELECTRONIC CIRCUIT DEVELOPMENTS, APPROPRIATE TECHNOLOGIES WERE CHOSEN FOR FURTHER DEVELOPMENT AND INTEGRATION INTO A PACKAGING SYSTEM. THE PACKAGING SYSTEM CONCEIVED FOR TOPS INCLUDED THE DEVELOPMENT OF AN ELECTRONIC COMPARTMENT HAVING SINGLE SIDE ACCESS ASSEMBLIES, EFFICIENT STRUCTURAL ASPECTS AND SHORT CABLING LENGTHS. THE GOAL WAS TO PROVIDE 10 TIMES THE PACKAGING PARTS DENSITY AND 4 TIMES THE INTERCONNECTION CAPABILITY OF MARINER '69. THIS WORK TASK ALSO FURNISHES THE NONDEVELOPMENT BUT NECESSARY HOUSEKEEPING ACTIVITIES OF THE PACKAGING AND CABLING FUNCTIONS NECESSARY FOR THE TOPS PROJECT. FOR FY'72 THE COMPLETION OF THOSE PREVIOUSLY INITIATED TASKS WILL BE PURSUED THROUGH NOVEMBER. THE CONTINUING ACTIVITIES ARE ANTICIPATED TO BE CARRIED ON WITH THE START AT THAT TIME OF THE OUTER PLANET PROJECT.

RTOP NO. 186-68-59 TITLE: JUPITER ATMOSPHERIC ENTRY PROBE HIGH SPEED BRAKING SURVIVAL ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

JUPITER ATMOSPHERIC ENTRY PROBE PLANS MUST INCLUDE AN ASSESSMENT OF THE PROBABILITY OF SURVIVAL DURING AERODYNAMIC BRAKING FROM SPEEDS OF 60 KM/SEC. THE EXTREME AND PROLONGED ABLATION AND STRUCTURAL STRAIN RESULTING FROM ACTION OF THE HOT, HIGH PRESSURE SHOCK LAYER GASES SURROUNDING THE ENTRY PROBE LIMITS THE CHANCE OF SURVIVAL. WE INTEND TO COMPUTE (1) THE EFFECT OF THE JUPITER ATMOSPHERIC PROBE ON THE THERMOCHEMISTRY AND RADIATION CHARACTERISTICS OF ATMOSPHERIC GASES, AND (2) THE ABLATION RESPONSE OF THE VEHICLE HEAT SHIELD AND THE THERMAL AND PRESSURE LOADS TO THE STRUCTURE DUE TO THIS HIGH TEMPERATURE RADIATING ENVIRONMENT. WE INTEND TO PREDICT THE ABLATION, LOADING, AND DYNAMIC RESPONSE OF SEVERAL ENTRY PROBES WITH EXISTING TRAJECTORY, THERMOCHEMISTRY, SPECTRAL INTENSITY, FLOWFIELD, AND DYNAMIC MOTION COMPUTER PROGRAMS. WITH THE LIMITED DATA DESCRIBING THE JOVIAN ATMOSPHERE, WE WILL USE THE MOST LIKELY COMPOSITION, TEMPERATURE, AND DENSITY DISTRIBUTION, AND THE EXTREME ATMOSPHERES DESCRIBED IN THE MONOGRAPH - THE PLANET JUPITER (1970). WE WILL DETERMINE THE ENTRY PROBE RESPONSE AT THE MOST PROBABLE ATMOSPHERIC PROPERTIES AND THE SENSITIVITY TO CHANGES IN THESE PROPERTIES.

RTOP NO. 186-68-60 TITLE: VENUS ENTRY PROBE TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MARCOTTE, P. G. TEL. 301-982-4646
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEFINE AND OPTIMIZE ON A SYSTEM AND SUBSYSTEM BASIS THE SELECTED TECHNOLOGIES AND DESIGN

CONCEPTS REQUIRED FOR THE PROPOSED PLANETARY EXPLORER VENUS MISSIONS. THE APPROACH WILL TAKE THE EXISTING STUDIES AS A BASELINE AND PERFORM ADDITIONAL SYSTEM ANALYSIS AND TRADEOFF STUDIES IN ALL SPACECRAFT/PROBE AREAS LEADING TO THE ONE OPTIMUM CHOICE FOR EACH SUBSYSTEM AND SYSTEM REQUIRED TO SUPPORT THE MISSION OBJECTIVES. THE SPACECRAFT AND PROBE AREAS TO BE STUDIED INCLUDE: THE TOTAL PROBE AND SPACECRAFT SUBSYSTEM AND SYSTEM DESIGN VS. THE MISSION OBJECTIVES; UNIVERSAL SPACECRAFT DATA SYSTEM; HIGHLY STABLE TRANSMITTER OSCILLATORS, TRANSPONDER AND ANTENNA DESIGNS, THERMAL LOUVER AND CRITICAL ANALYSIS OF ENTRY STRUCTURAL SUBSYSTEMS; DETAIL DESIGN OF CRITICAL STRUCTURAL SUBSYSTEMS; LOW BIT RATE TELEMETRY SYSTEM STUDIES; POWER SYSTEMS PARAMETERS, BATTERY & SOLAR ARRAY OPTIMIZED DESIGNS; THERMAL INSULATION, ALUMINUM AND TITANIUM MATERIAL CHARACTERISTICS AT HIGH TEMPERATURES AND PRESSURES; MISSION ANALYSIS, GUIDANCE AND NAVIGATION STUDIES.

RTOP NO. 186-68-62 TITLE: PROPULSION AND PYROTECHNIC TECHNOLOGY FOR TEN-YEAR MISSIONS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R., JR.EL. 213-354-6186

TECHNICAL SUMMARY

THE PURPOSE OF THIS PLAN IS TO PROVIDE THE TECHNOLOGY FOR PROPULSION AND PYROTECHNIC SUBSYSTEMS THAT WILL BE USED ON LONG-LIFE (TEN-YEAR) MISSIONS. THIS INCLUDES SUPPORT OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) ADVANCED SYSTEM IN SPECIFIC TECHNOLOGY AREAS. THE OBJECTIVES OF THIS PLAN ARE TO DETERMINE WHICH MATERIALS ARE ACCEPTABLY INERT FOR USE IN THE CONSTRUCTION OF PROPULSION SUBSYSTEM COMPONENTS IN CONTACT WITH LIQUID PROPELLANTS FOR TEN YEARS. TEST DATA FOR MATERIAL TEST SPECIMENS IMMERSED IN EARTH STORABLE PROPELLANTS WILL BE GENERATED. THE TEST PROGRAM INVOLVES PREPARATION OF TEST CAPSULES, ACTUAL STORAGE TESTS IN A CONTROLLED ENVIRONMENT, AND DETAILED CHEMICAL AND PHYSICAL ANALYSES OF SPECIMENS AND PROPELLANTS AFTER SPECIFIED STORAGE PERIODS. THE COMPATIBILITY TEST FACILITY AT THE JPL EDWARDS TEST STATION WILL BE USED. COMPATIBILITY DATA CURRENTLY AVAILABLE WERE DERIVED FROM TESTS WHICH RARELY EXCEEDED TWO-YEARS DURATION.DATA FROM MUCH LONGER TESTS ARE REQUIRED FOR THE SOUND DESIGN OF PROPULSION SYSTEMS WHICH MUST PERFORM FOR TEN YEARS ON TOPS TYPE MISSIONS. TO EXAMINE POWER SWITCHING CIRCUITS FOR PYROTECHNIC DEVICES PECULIAR TO LONG-TERM MISSIONS (TOPS); ACCOMPLISH A PRELIMINARY DESIGN AND EVALUATE COMPONENTS; FABRICATE BREADBOARD SWITCHING UNITS AND SUBJECT TO ENVIRONMENTS CONSISTENT WITH LONG-TERM MISSIONS. COMPONENTS WILL BE PROCURED. ALL DESIGN, COMPONENT EVALUATION, FABRICATION AND ENVIRONMENTAL QUALIFICATION WILL BE ACCOMPLISHED IN-HOUSE. PYROTECHNICS FOR LONG-TERM MISSIONS REQUIRE NEW INTERFACES WITH COMMAND SUBSYSTEMS, DIAGNOSTIC SELF-CORRECTING CAPABILITIES AND LONG-DURATION FUNCTIONAL CAPABILITIES NOT INHERENT IN PAST MISSION SUBSYSTEM DESIGNS.

RTOP NO. 186-68-63 TITLE: VENUS PROBE SCIENCE INSTRUMENT TECHNOLOGY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MARCOTTE, P. G. TEL. 301-982-4646
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO CONDUCT LONG LEAD ADVANCE DEVELOPMENT OF CRITICAL ITEMS IN SUPPORT OF THE P.E. PROBE MISSION SCIENCE INSTRUMENTS. BASED ON THE RECOMMENDATIONS OF THE PLANETARY EXPLORER MISSION DIFINITION PANEL, GSFC WITH THE APPROVAL OF NASA HEADQUARTERS, WILL SELECTIVELY FUND LONG LEAD ADVANCE DEVELOPMENT OF CRITICAL ITEMS IN SUPPORT OF THE P.E. PROBE MISSION SCIENCE INSTRUMENTS. THIS EFFORT WILL REQUIRE CLOSE WORKING RELATIONSHIP OF THE SCIENTIST AND THE STUDY TEAM TO FIRM UP INSTRUMENT AND PROBE DESIGN INTERFACES AND REQUIREMENTS. BREADBOARDING OF CRITICAL ITEMS WILL BE INITIATED. THIS EFFORT WILL BE AN EXTENSION OF CRITICAL ITEMS AND SENSORS NOW IN THE DEVELOPMENT STAGE.

RTOP NO. 186-68-64 TITLE: COMET AND ASTEROID RENDEZVOUS AND DOCKING (CARD) - SRT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GUTTMAN, C. H. TEL. 205-453-5584
TECHNICAL SUMMARY

THIS RTOP REPRESENTS THE TOTAL CARD SRT PROGRAM EFFORT FOR FY-72. THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE THE INITIAL RESEARCH AND DEVELOPMENT NECESSARY TO ASSURE ADEQUATE AND TIMELY TECHNOLOGY DEVELOPMENT FOR CARD PROGRAM. THE TASKS TO BE PURSUED UNDER THIS PROGRAM INCLUDE A HIERARCHAL ATTITUDE CONTROL SYSTEM, SPACECRAFT STABILITY AND DYNAMIC ANALYSIS, SPACECRAFT VECTOR CONTROL, AUTONOMOUS TARGET RELATIVE NAVIGATION, SPACECRAFT ONBOARD VIDEO GUIDANCE/DETECTION/PROCESSING SYSTEM, SPACECRAFT TERMINAL SENSORS FOR RENDEZVOUS AND DOCKING, COMPUTER TECHNOLOGY, OPTICAL CONTAMINATION OF INSTRUMENTS AND EXPERIMENTS, COMET AND ASTEROID ENVIRONMENTAL STUDY, METEOR STREAM SPECTRAL ANALYSIS, SPACECRAFT METEOROID DETECTION AND PROTECTION SYSTEM, SPACECRAFT SAMPLING SYSTEM, SPACECRAFT ONBOARD VELOCITY MEASUREMENT, LANDER MASS AND DENSITY MEASUREMENT OF COMETS AND ASTEROIDS. A MAJORITY OF THE TASKS SHOWN WILL BE SPIN-OFFS OF ONGOING INHOUSE EFFORTS CURRENTLY BEING WORKED.

RTOP NO. 186-68-66 TITLE: ADAPTIVE SCIENCE LABORATORY TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO PROVIDE STUDIES OF AN ADAPTIVE SCIENCE LABORATORY (ASL) TO DETERMINE THE FEASIBILITY AND TECHNOLOGY REQUIREMENTS ASSOCIATED WITH THE USE OF AN ASL BY PLANETARY MISSIONS. THESE STUDIES INCLUDE ANALYSES OF SCIENCE AND ASSOCIATED INSTRUMENT REQUIREMENTS, MISSION MODE STUDIES, CONCEPTUAL SPACECRAFT DESIGN STUDIES, AND COST STUDIES. BECAUSE SAMPLE RETURN MISSIONS ARE QUITE COMPLEX AND, THEREFORE, EXPENSIVE, IT IS DESIRABLE TO ANALYZE AN ASL CONCEPT AS A POSSIBLE ALTERNATIVE TO A SAMPLE RETURN MISSION. IN ANY EVENT, A MISSION WHOSE SCIENTIFIC CAPACITY LIES BETWEEN THE VIKING

(ABOUT _75 LB OF SCIENCE) AND A SAMPLE RETURN MISSION IS A DESIRABLE MISSION AND SHOULD BE STUDIED THROUGHLY TO DETERMINE ITS FEASIBILITY AND TECHNOLOGICAL IMPLICATIONS. STUDIES WILL BE A COMBINATION OF IN-HOUSE AND CONTRACTUAL ACTIVITIES.

RTOP NO. 186-68-67 TITLE: RELIABLE DATA MANAGEMENT SUBSYSTEMS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: TARVER, P. TEL. 202-963-4352
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO PERMIT NASA TO BENEFIT FROM TECHNOLOGY DEVELOPMENT THAT HAS RESULTED FROM DOD PROGRAMS IN THE AREAS OF DATA MANAGEMENT SUBSYSTEMS, RADIATION HARDENED ELECTRONIC PARTS AND SYNTHETIC APERTURE RADAR. IT WILL BE IMPLEMENTED BY THE NAVAL RESEARCH LABORATORY (NRL) ON AN INTER-AGENCY TRANSFER OF FUNDS. NRL WILL SURVEY THE REQUIREMENTS OF SELECTED PLANETARY MISSIONS AND WILL RECOMMEND ADAPTATIONS OF DOD TECHNOLOGIES WHERE IMPROVEMENT CAN BE EFFECTED. DESIGN OR DEVELOPMENT IN SELECTED AREAS WILL BE CONDUCTED IF REQUIRED.

RTOP NO. 186-70-51 TITLE: ELECTRONIC PARTS FOR OUTER PLANET MISSIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: MCDONALD, R. R. TEL. 213-354-6186
TECHNICAL SUMMARY

AN INTEGRATED EFFORT TO DEVELOP AND EVALUATE THE ELECTRONIC PARTS AND THE ASSOCIATED RELIABILITY AND QUALITY ASSURANCE TECHNIQUES NEEDED FOR THE OUTER PLANET MISSIONS. THE INITIAL ACTIVITIES WILL BE CONDUCTED IN SUPPORT OF THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS). EMPHASIS WILL BE PLACED ON THE DEVELOPMENT AND/OR EVALUATION OF MICROELECTRONIC DEVICES NEEDED FOR TOPS-TYPE OUTER PLANET SPACECRAFT. THE IMPLEMENTATION OF THIS EFFORT WILL BE COORDINATED BY THE TOPS MICROELECTRONICS COMMITTEE. THE PURPOSE OF THIS COMMITTEE IS TO DETERMINE THE VARIOUS NEEDS OF THE TOPS SUBSYSTEMS, FOSTER STANDARDIZATION OF COMPONENTS THROUGHOUT THE SPACECRAFT SYSTEM, PURSUE DEVICE DEVELOPMENT WHERE SUBSYSTEM NEEDS DICTATE AND DEVELOP THE NECESSARY RELIABILITY AND QUALITY ASSURANCE TECHNIQUES FOR MICROELECTRONICS. IN THE AREA OF DISCRETE PARTS, EMPHASIS WILL BE PLACED ON THE PREPARATION OF _A TOPS RECOMMENDED PARTS LIST FOR USE BY SUBSYSTEM DESIGNERS. THIS _WILL INCLUDE RADIATION RESISTANCE, DERATING FACTORS AND SUITABILITY FOR LONG LIFE APPLICATIONS. DESIGN APPRAISAL INVESTIGATION OF APPROPRIATE COMPONENTS WILL BE CONDUCTED TO DEVELOP A BETTER UNDERSTANDING OF THE PROCESSES AND TECHNIQUES USED IN FABRICATING THESE COMPONENTS. RESULTS OF SUCH APPRAISALS WILL BE USED TO DETERMINE THEIR CAPABILITY FOR SUCCESSFUL OPERATION IN LONG LIFE MISSIONS. IN ADDITION, EFFORT WILL BE EXPENDED TO DEVELOP RELIABILITY ANALYSIS AND PREDICTION TECHNIQUES, PERFORM SUBSYSTEM RELIABILITY TRADEOFFS, ELECTRONIC PART FAILURE RATE COMPILATIONS AND A HARDWARE INSPECTION PROGRAM IN SUPPORT OF THE TOPS MICROELECTRONIC ACTIVITIES AND FEASIBILITY DEMONSTRATIONS.

RTOP NO. 188-36-51 TITLE: DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: OSANTOWSKI, J. F. TEL. 301-982-5861
TECHNICAL SUMMARY

RESEARCH PROGRAM TO INVESTIGATE OPTICAL TECHNIQUES AND DEVICES FOR USE IN THE ULTRAVIOLET AND X-RAY SPECTRAL REGION (8A TO 3000A). THE PROGRAM IS DESIGNED TO SUPPLY UNAVAILABLE CRITICAL DATA THAT MAY BE REQUIRED BY SCIENTISTS IN DESIGNING AND/OR PROPOSING ADVANCED INSTRUMENTATION PRINCIPALLY, BUT NOT EXCLUSIVELY, FOR SOLAR OBSERVATIONS. DEVELOPMENTS IN ULTRAVIOLET AND X-RAY OPTICAL TECHNOLOGY MAY IMPACT DECISIONS RELATED TO TRADE-OFFS IN REQUIREMENTS FOR OPTICAL THROUGHPUT (ACCEPTANCE), EFFICIENCY, FIELD OF VIEW, AND SPATIAL OR SPECTRAL RESOLUTION. RESEARCH EFFORTS WILL BE CONDUCTED IN COOPERATION WITH SPACE SCIENTISTS AT GSFC AND OTHER NASACENTERS, TO MAXIMIZE TECHNICAL INPUT TO ACTIVE OR PROPOSED FLIGHT PROGRAMS. TO ACCOMPLISH THIS OBJECTIVE, GSFC WILL CONDUCT IN-HOUSE EXPERIMENTAL AND THEORETICAL STUDIES IN THE FOLLOWING KEY AREAS; DESIGN, FABRICATION AND TESTING OF GLANCING INCIDENCE OPTICAL SYSTEMS FOR THE 8A TO 300A SPECTRAL REGION, OPTICAL STUDIES OF VACUUM DEPOSITED THIN FILMS AND SPECIALIZED MULTILAYER FILM COMBINATIONS AS REQUIRED FOR HIGH EFFICIENCY REFLECTANCE COATINGS, BAND PASS FILTERS, ETC., AND AN ASSESSMENT OF THE PRINCIPLES, OF LARGE OPTICAL APERTURE SYNTHESIS FOR SPACE FLIGHT APPLICATIONS. THIS METHOD IS ESPECIALLY APPEALING FOR HIGH SPATIAL RESOLUTION STUDIES OF BRIGHT OBJECTS SUCH AS THE SUN.

RTOP NO. 188-36-55 TITLE: MAGNETOSPHERE PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: OGILVIE, K. W. TEL. 301-982-5904
TECHNICAL SUMMARY

THE OBJECT OF THIS RESEARCH IS TO INCREASE THE KNOWLEDGE AND UNDERSTANDING OF NON-THERMAL PLASMAS OCCURRING IN NATURE, AND ALSO TO IMPROVE THE THEORETICAL DESCRIPTION OF THEIR PROPERTIES. THIS REQUIRES A CONCOMITANT IMPROVEMENT IN MEASUREMENT TECHNIQUES

RTOP NO. 188-36-55 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP HIGH SENSITIVITY INSTRUMENTATION FOR THE DETECTION OF NONTHERMAL PLASMAS AND MAGNETIC FIELDS, WHICH HAVE SIGNIFICANT IMPROVEMENT IN DETECTION CHARACTERISTICS AND RELIABILITY OVER EXISTING INSTRUMENTATION. AN ADDITIONAL OBJECTIVE IS TO INVESTIGATE TECHNIQUES WHEREBY CALIBRATION AND TESTING PROCEDURES AND COMPUTER COMPUTATION METHODS FOR CALIBRATION AND TEST DATA ANALYSIS CAN BE SIGNIFICANTLY IMPROVED OVER EXISTING METHODS. AN ADDITIONAL OBJECTIVE OF THIS RTOP IS TO CONDUCT THEORETICAL INVESTIGATIONS OF THE INTERACTION OF THE SOLAR WIND WITH

PLANETARY BODIES. THIS INFORMATION IS NEEDED FOR A BETTER UNDERSTANDING OF THE EARTH/SUN ENVIRONMENT, AND IS ALSO IMPORTANT IN ASSESSING THE PERFORMANCE OF PRESENT MAGNETOMETER SYSTEMS SO THAT INFORMATION IS PROVIDED FOR IMPROVEMENTS FOR FUTURE MISSIONS. FOR PLASMA DETECTORS, THESE STUDIES COVER THE NUMBER AND POSITION OF FLUX COLLECTORS, POSITION AND ATTITUDE OF PARTICLE MULTIPLIERS, SUPPRESSION OF SECONDARY ELECTRONS, SHAPE OF APERTURES, POST-ANALYZER ELECTRICAL FIELD REQUIREMENTS, AND OPTIMUM ELECTRIC FIELD CONFIGURATIONS FOR THE ENERGY TO CHARGE ANALYZER-SECTION.

RTOP NO. 188-36-55 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

DISCONTINUITIES: THOUGH MUCH WORK HAS BEEN DONE IN IDENTIFYING AND CLASSIFYING DISCONTINUITIES IN THE SOLAR WIND, NOT MUCH HAS BEEN DONE TO DETERMINE THE MECHANISMS BY WHICH THESE DISCONTINUITIES DEGENERATE INTO SIMPLER FORMS OF DISTURBANCE. SUCH STUDIES WILL NOT ONLY ENLARGE OUR CONCEPT OF BOTH STATIONARY AND MOVING DISCONTINUITIES, BUT WILL ALSO INCREASE OUR KNOWLEDGE OF FUNDAMENTAL PLASMA PHYSICS AS WELL. FOR EXAMPLE, IN ORDER TO EXPLAIN THE OBSERVED MAGNETIC TURBULENCE ASSOCIATED WITH A TANGENTIAL DISCONTINUITY, A THEORETICAL INVESTIGATION OF DRIFT WAVE INSTABILITIES HAS BEEN COMPLETED. THIS NOT ONLY HELPED EXPLAIN THE STRUCTURE OF A TANGENTIAL DISCONTINUITY IN THE SOLAR WIND, BUT IN ADDITION LED TO AN IMPROVEMENT AND ENLARGEMENT OF THE EXISTING THEORY OF MAGNETIC DRIFT WAVES. INTERACTION OF SOLAR WIND WITH SOLAR SYSTEM BODIES: THE INTERACTION OF THE SOLAR WIND WITH THE MOON IS A PROTOTYPE FOR INTERACTION OF THE SOLAR WIND WITH OTHER BODIES HAVING LITTLE OR NO MAGNETIC FIELD. FURTHERMORE, A STUDY OF THE INTERACTION OF THE SOLAR WIND WITH THE MOON IS OF INTEREST FOR THE CREATION OF A MODEL FOR THE CONDUCTIVITY OF THE LUNAR SURFACE. BY COMPARING SATELLITE DATA WITH DATA RECORDED AT THE LUNAR SURFACE, IT CAN BE SEEN THAT FIELD AND PLASMA FLUCTUATIONS ARE SELECTIVELY ENHANCED AS THE SOLAR WIND APPROACHES THE LUNAR SURFACE. AN ATTEMPT WILL BE MADE TO INTERPRET THIS PHENOMENON AS WAVES PROPAGATE BACK INTO THE SOLAR WIND, THESE WAVES BEING GENERATED FROM THE CURRENTS INDUCED IN THE MOON BY THE SOLAR WIND. RADIO EMISSIONS: CLASSICAL RADIATION MECHANISMS (SYNCHROTRON RADIATION, BREMSSTRAHLUNG, ETC.) DO NOT EXPLAIN SOME OF THE OBSERVED INTENSE RADIO EMISSIONS FROM EXTRATERRESTRIAL SOURCES.

RTOP NO. 188-36-55 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE MAJOR OBJECTIVE IS TO DEVELOP THE VECTOR HELIUM MAGNETOMETER FOR USE ON SPACE MISSIONS WHERE EXTREMELY WEAK INTERPLANETARY OR INTERSTELLAR FIELDS ARE TO BE MEASURED BUT WHERE LARGE PLANETARY

FIELDS MAY ALSO BE ENCOUNTERED. THE TASK INVOLVES EXPERIMENTATION AND TESTING THAT WILL LEAD TO IMPROVED OR MORE OPTIMUM COMPONENTS, DESIGN OR MODES OF OPERATION. A MODEST AMOUNT OF THEORETICAL SUPPORT IS ALSO PROVIDED, PARTICULARLY IN AREAS RELATED TO OPTICAL PUMPING AND GAS DISCHARGES.

RTOP NO. 188-36-55 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/FIELD INTERACTIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY
INVESTIGATE THE PROCESSES OCCURRING IN THE MAGNETOSPHERE OF THE EARTH AND IN INTERPLANETARY SPACE THROUGH A STUDY OF ENERGETIC NEUTRAL AND CHARGED PARTICLES AND THEIR INTERACTIONS WITH MAGNETIC AND ELECTRIC FIELDS. AREAS OF INVESTIGATION INCLUDE TRAPPED AND AURORAL PARTICLES, THE MAGNETOPAUSE, GEOMAGNETIC TAIL AND SOLAR WIND. INVESTIGATE THE PROCESSES WHICH RESULT FROM THE ARRIVAL OF SOLAR PARTICLES NEAR THE EARTH, AND THE CONSEQUENCES OF VARIATIONS IN THE INCIDENT FLUX.DEVELOP INSTRUMENTS FOR MEASURING NEUTRAL AND CHARGED PARTICLES FROM SEVERAL EV TO SEVERAL TENS OF MEV; DC MAGNETIC FIELDS FROM BELOW 0.1 GAMMA TO SEVERAL OERSTED; ELECTRIC FIELDS AND VLF WAVE ACTIVITY. DEVELOP THE THEORY NEEDED TO UNDERSTAND THE MAGNETOSPHERE, THE AURORAS, THE SOLAR WIND, THE INTERPLANETARY REGIONS AND THE OBSERVED BOUNDARY EFFECTS, DOWN TO ROUGHLY THE PLASMAPAUSE.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY
INVESTIGATE THE ABSORPTION OF SOLAR PHOTONS AND PARTICLES IN THE EARTH'S UPPER ATMOSPHERE, THE PROCESSES BY WHICH THE ABSORPTION PRODUCTS ARE DISSIPATED, AND THE EFFECTS WHICH ARISE THEREFROM. INCLUDED ARE THE COLLISIONAL, PHOTOCHEMICAL AND ELECTROMAGNETIC INTERACTIONS WHICH ARE FOUND IN THE UPPER ATMOSPHERE, THE IONOSPHERE AND THE INNER MAGNETOSPHERE. DEVELOPMENT OF INSTRUMENTS FOR THE DIRECT AND INDIRECT MEASUREMENT OF NEAR-THERMAL PLASMAS, ELECTRIC AND MAGNETIC FIELDS.COORDINATED INVESTIGATIONS TO BE CONDUCTED FOR CAUSE-AND-EFFECT STUDIES, TOGETHER WITH THE DEVELOPMENT OF THE APPROPRIATE THEORIES. THE REGION COVERED EXTENDS ROUGHLY FROM THE LOWEST IONOSPHERE TO THE PLASMAPAUSE.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY
TO INVESTIGATE THE PHYSICS OF THE EARTH'S TOPSIDE IONOSPHERE AND

PLASMASPHERE AND THE COUPLING OF THESE REGIONS WITH THE MAGNETOSPHERE AND SOLAR WIND. THEORETICAL STUDIES OF THE TERMAL CHARGED-PARTICLE COMPOSITION, DENSITY AND TEMPERATURES ARE BEING PERFORMED. COMPUTER PROGRAMS ARE BEING CODED BASED ON THE CONTINUITY, MOMENTUM AND ENERGY BALANCE EQUATIONS APPROPRIATE TO THESE REGIONS. DATA FROM THE ALOUETTE, ISIS AND OTHER SATELLITES WILL BE USED AS BOUNDARY CONDITIONS.SPECIAL CORRELATIVE STUDIES ARE ALSO BEING PERFORMED TO INVESTIGATE THE GLOBAL NATURE OF CERTAIN ANEMALOUS FEATURES, E. G., THE PLASMAPAUSE AND IONOSPHERIC TROUGHS. THE RESULTS OF THESE EFFORTS ARE VITAL TO THE UNDERSTANDING OF THE EARTH'S CHARGED PARTICLE ENVIRONMENT, AND HAVE APPLICATION TO COMMUNICATIONS BETWEEN TERMINALS IMMERSED IN THESE MEDIA. THE THEORY AND TECHNIQUES INVOLVED ARE APPLICABLE TO THE STUDIES OF ATMOSPHERES AND IONOSPHERS OF OTHER PLANETS. PRELIMINARY EFFORTS ARE BEING INITIATED TO INVESTIGATE THE CHARGED PARTICLE ENVIRONMENT OF THE JUPITER IONOSPHERE.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE APPROACH IS TO UTILIZE IONIZED CLOUDS OF BARIUM FROM CHEMICAL RELEASES IN VARIOUS REGIONS OF THE GEOMAGNETOSPHERE FOR THE PURPOSE OF MEASURING MAGNETIC AND ELECTRIC FIELDS. THE METHOD IS TO RELEASE, BY A CHEMICAL PROCESS, FREE BARIUM VAPOR AT SUCH POINTS IN SPACE THAT IT CAN BE PHOTOIONIZED BY SOLAR RADIATION. THE IONIZED PARTICLES BECOME IN TIME FROZEN TO THE MAGNETIC FIELD LINES AND CAN BE OPTICALLY OBSERVED THROUGH RESONANT SCATTERING OF SUNLIGHT IN THE VISIBLE SPECTRUM. THE LONG-RANGE OBJECTIVES ARE: (A) TO MEASURE ELECTRIC AND MAGNETIC FIELDS IN THE MAGNETOSPHERE; (B) TO ACHIEVE A BETTER UNDERSTANDING OF THE PHYSICS OF THE INTERACTION OF AN ION CLOUD RELEASED IN THE MAGNETOSPHERE WITH THE AMBIENT FIELD INFILTRATED PLASMA; AND (C) TO DEVELOP HIGHER YIELD BARIUM PAYLOADS TO MAKE POSSIBLE MAGNETIC AND ELECTRIC FIELD EXPERIMENTS AT GREAT DISTANCES FROM THE EARTH. THE IMMEDIATE OBJECTIVES ARE: (A) A BARIUM CLOUD WAS RELEASED FROM A SCOUT ROCKET AT AN ALTITUDE OF ABOVE FIVE EARTH RADII IN APRIL 1971. PHOTOGRAPHIC, PHOTOMETRIC AND GEOPHYSICAL DATA OBTAINED WILL PROVIDE NEEDED INPUTS TO THEORETICAL STUDIES OF INTERACTION PHENOMENA AND MEASUREMENT OF ELECTRIC AND MAGNETIC FIELDS. THE AFOREMENTIONED WILL LEAD TO: (B) ESTABLISHMENT OF NECESSARY OPTICAL OBSERVATIONS AND DATA REDUCTION TECHNIQUES TO BE USED IN FOLLOW-ON EXPERIMENTS, AND (C) "IN-HOUSE" STUDY AND TRAJECTORY ANALYSES TO MEET FUTURE MISSION OBJECTIVES.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN ENGINEERING MODEL OF AN INSTRUMENT SYSTEM FOR MEASUREMENT OF COMPOSITION OF THE EARTH'S UPPER ATMOSPHERE DURING SUB-ORBITAL AND ORBITAL MISSIONS. IN ADDITION, SUCH A SYSTEM MAY BE APPLIED DURING THE ENTRY PHASE OF MISSIONS TO OTHER PLANETS. SPECIAL ATTENTION WILL BE GIVEN TO MEANS OF OBTAINING GAS SAMPLES WITHOUT GAS-SURFACE SCATTERING DURING SUCH FLIGHTS. THE PROPER SAMPLING TECHNIQUES SHOULD ALLOW THE MEASUREMENT OF REACTIVE GASES SUCH AS ATOMIC OXYGEN. SCOPE OF WORK INCLUDES FEASIBILITY STUDIES, THE INSTRUMENT DESIGN AND FABRICATION, AND ITS PERFORMANCE IN A MOLECULAR BEAM TO VERIFY THE MEASUREMENT TECHNIQUE.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: DAILEY, C. C. TEL. 205-453-3431
TECHNICAL SUMMARY

DEVELOP MORE REPRESENTATIVE MODELS OF THE EARTH'S UPPER ATMOSPHERE FOR USE IN VEHICLE DEVELOPMENT PROGRAMS. THE THEORETICAL STUDIES OF TRAVELING IONOSPHERIC DISTURBANCES WILL PROVIDE A GREATER INSIGHT INTO THE COUPLING BETWEEN THE LOWER (LESS THAN 90 KM) AND UPPER (GREATER THAN 90 KM) ATMOSPHERES, BETWEEN THE CHARGED AND NEUTRAL ATMOSPHERES, AND THE SOLAR-TERRESTRIAL RELATIONSHIPS. THE AIRGLOW RESEARCH WILL PROVIDE US WITH DATA ON THE DYNAMICS OF THE LOWER THERMOSPHERE, THE CHEMICAL AND PHYSICAL PROCESSES OCCURRING THERE, AND HOW ALL OF THESE PROCESSES CONTROL THE EARTH'S UPPER ATMOSPHERE.

RTOP NO. 188-36-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: HEPPNER, J. P. TEL. 301-982-4797
TECHNICAL SUMMARY

THE OBJECTIVES ARE: (A) TO CONCEIVE, DESIGN, DEVELOP AND TEST NEW TECHNIQUES AND INSTRUMENTS FOR SPACE MEASUREMENTS OF ELECTRIC FIELDS, MAGNETIC FIELDS, WAVE PARTICLE INTERACTIONS, AURORAL PARTICLES, TRAPPED PARTICLES, SOLAR-INTERPLANETARY PARTICLES, AND (B) TO CONDUCT FUNDAMENTAL THEORETICAL STUDIES OF MAGNETODYNAMIC PROCESSES IN SPACE. THE APPROACH INCLUDES DETECTOR AND SUPPORTING ELECTRONICS, DESIGN, LABORATORY AND CONTRACTOR FABRICATION AND TESTING, AND THEORETICAL STUDIES OF FIELD AND PARTICLE PHENOMENA AND DISTRIBUTIONS IN SPACE. THIS EFFORT IS EXPECTED TO PRODUCE: (A) FLIGHT INSTRUMENTATION HAVING THE CAPABILITY TO MAKE MEASUREMENTS THAT PREVIOUSLY HAVE NOT BEEN POSSIBLE, PARTICULARLY IN AREAS WHERE THERE ARE SIGNIFICANT GAPS IN OUR KNOWLEDGE AS A CONSEQUENCE OF THERE BEING FEW OR NO MEASUREMENTS, (B) ACCURATE MODELS OF FIELDS IN SPACE

WHICH HAVE BOTH SCIENTIFIC AND TECHNOLOGICAL UTILITY, (C) INDICES WHICH DESCRIBE THE INSTANTANEOUS DEGREE OF DISTURBANCE IN THE IONOSPHERE AND MAGNETOSPHERE, AND (D) ADVANCES IN THE UNDERSTANDING OF PLASMA INSTABILITIES AND OTHER FIELD AND PARTICLE INTERACTIONS WHICH PRODUCE RADIATIONS AND PERTURBATIONS OF THE SPACE ENVIRONMENT.

RTOP NO. 188-36-57 TITLE: MAGNETOSPHERIC PHYSICS - RADIO SCIENCE
ORGANIZATION: NASA HEADQUARTERS
MONITOR: SCHMERLING, E. R. TEL. 202-962-1973
TECHNICAL SUMMARY

TO INVESTIGATE THE INTERPLANETARY MEDIUM, THE ENVIRONMENTS OF THE EARTH, THE MOON, THE PLANETS AND THE SUN, AS WELL AS CELESTIAL MECHANICS AND RELATIVITY, BY THE PROPAGATION OR SCATTERING OF RADIO WAVES. TO DEVELOP TECHNIQUES FOR INTERPRETING THE REFRACTION, SCATTERING, POLARIZATION ROTATION AND PHASE SHIFTING OF RADIO SIGNALS OCCURRING NATURALLY OR GENERATED ARTIFICIALLY IN TERMS OF PHYSICAL PROPERTIES OF THE INTERVENING MEDIUM. TO DEVELOP INSTRUMENTS FOR GENERATING ELECTROMAGNETIC WAVES IN SPACE AND MEASURING THE EFFECTS OF THE MEDIUM, TOGETHER WITH THE APPROPRIATE THEORY. TO MODEL, IN THE LABORATORY, THE PLASMA INTERACTIONS AND RESONANCES OBSERVED IN SPACE, AND TO TEST THE THEORIES DEVELOPED TO EXPLAIN THEM.

RTOP NO. 188-38-51 TITLE: DEVELOPMENT OF EXPERIMENTS AND HARDWARE FOR SOLAR PHYSICS RESEARCH
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OERTEL, G. K. TEL. 202-962-0157
TECHNICAL SUMMARY

THE OBJECTIVE OF THE WORK UNDER THIS RTOP IS THE DEVELOPMENT OF EXPERIMENTS FOR SPACE OR LABORATORY APPLICATION TO SOLAR PHYSICS RESEARCH AND THE DEVELOPMENT OF CRITICAL TECHNOLOGY ITEMS WHICH ARE NEEDED FOR SOLAR OBSERVATIONS, OR WHICH CAN IMPROVE THEM SIGNIFICANTLY. INCLUDED ARE THE FOLLOWING ACTIVITIES: DEFINITION AND DEVELOPMENT OF SOLAR EXPERIMENTS FOR EVENTUAL FLIGHT ON A ROCKET FOR OBSERVATIONS ABOVE THE ATMOSPHERE DEVELOPMENT OF A DEVICE FOR THE PRODUCTION OF OPTICAL COMPONENTS FOR USE IN SOLAR AND ASTRONOMICAL TELESCOPES, SPECTROGRAPHS, ETC., ON THE GROUND AND IN SPACE DEVELOPMENT OF TECHNIQUES FOR IMPROVING THE PERFORMANCE OF OPTICAL INSTRUMENTATION IN SPACE AND ON THE GROUND DEVELOPMENT OF TECHNIQUES FOR ACCURATE CALIBRATION OF SOLAR EXPERIMENTS IN SPACE AND ON THE GROUND IN PARTS OF THE SPECTRUM WHERE THE AVAILABLE ACCURACY IS INSUFFICIENT FOR EFFECTIVE USE OF DATA FROM SPACE DEVELOPMENT OF NOVEL TECHNIQUES FOR INCREASING THE INFORMATION VALUE OF PRESENT SOLAR EXPERIMENTS.

RTOP NO. 188-38-52 TITLE: GROUND BASED OBSERVATIONS OF THE SUN - REAL TIME SOLAR MAGNETOGRAPH
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: OLIVER, J. R. TEL. 205-453-3427
TECHNICAL SUMMARY

THE REAL TIME SOLAR MAGNETOGRAPH, BEING BUILT JOINTLY BY THE NAVAL RESEARCH LABS AND MSFC, WILL ALLOW STUDIES OF SMALL SCALE VARIATIONS OF THE SUN'S MAGNETIC FIELD IN ORDER TO DETERMINE THIS ROLE IN SOLAR ACTIVITY. THE SYSTEM USES A NARROW BAND FILTER, POLARIZERS, AND A SEC VIDICON TV SYSTEM TO MEASURE THE ZEEMAN EFFECT IN CHROMOSPHERIC ABSORPTION LINES. IN DIRECT SUPPORT OF THE REAL TIME SOLAR MAGNETOGRAPH A STUDY WILL BE UNDERTAKEN WITH THE OBJECTIVE TO DETERMINE THE BASIC PHENOMENA INVOLVED IN THE ERUPTION OF SOLAR FLARES BY STUDYING THE INTERACTIONS OF THE SOLAR PLASMA AND LOCAL MAGNETIC FIELDS IN THE ACTIVE REGIONS AND TO ANALYZE BASIC SOLAR DATA SUCH AS MAGNETIC FIELDS AND THE ABSORPTION LINE PROFILES AND INTERPRET THEM ON THE BASIS OF THESE INTERACTIONS.

RTOP NO. 188-38-52 TITLE: GROUND-BASED OBSERVATIONS OF THE SUN
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OERTEL, G. K. TEL. 202-962-0157
TECHNICAL SUMMARY

GROUND-BASED OBSERVATIONS OF THE SUN IN WAVELENGTHS FOR WHICH THE ATMOSPHERE IS TRANSPARENT ARE CARRIED OUT AT A NUMBER OF SUITABLE OBSERVATORIES AND GROUND STATIONS THROUGHOUT THE UNITED STATES. THE PURPOSE OF THESE GROUND-BASED OBSERVATIONS IS TO OBTAIN INFORMATION ON THE SOLAR ATMOSPHERE FROM THE PHOTOSPHERE AND SUN SPOTS, TO THE CHROMOSPHERE AND THE CORONA, AND ON THE FINE AND GROSS STRUCTURE OF THE SOLAR ATMOSPHERE, AND ACTIVITY IN IT. THIS INFORMATION IS THEN USED IN CORRELATION WITH OBSERVATIONS FROM SOUNDING ROCKETS, OSOS, ATM AND OTHER SPACECRAFT TO DETERMINE THE PHYSICAL CONDITIONS IN THE OBJECTS STUDIES, AND TO UNDERSTAND THE PHYSICAL MECHANISMS AT WORK IN THEM. SPECIFICALLY THE FOLLOWING TYPES OF ACTIVITY ARE COVERED UNDER THIS RTOP (GROUND-BASED HERE REFERS TO AIRCRAFT AND BALLOONS AS WELL AS TO FIXED INSTALLATIONS ON THE GROUND): THE DEFINITION AND DESIGN OF EXPERIMENTS FOR GROUND-BASED OBSERVATORIES THE CONSTRUCTION OR PURCHASE AND OPERATION OF SUCH EXPERIMENTS THE OBSERVING OF THE SUN, AND FEATURES IN IT, FROM THE GROUND THE ANALYSIS OF GROUND-BASED DATA IN CORRELATION WITH DATA FROM SPACE OR FROM OTHER GROUND-BASED OBSERVATORIES SCIENTIFIC INTERPRETATION IN TERMS OF PHYSICAL CONDITIONS AND MECHANISMS.

RTOP NO. 188-38-52 TITLE: SOLAR PHYSICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: HOHL, F. TEL. 703-827-2144
TECHNICAL SUMMARY

THE RATE AT WHICH DIELECTRONIC RECOMBINATION OCCURS IN PLASMAS OF ASTROPHYSICAL INTEREST WILL BE INVESTIGATED. THIS PROCESS IS IMPORTANT IN SEVERAL ASTROPHYSICAL SITUATIONS; FOR EXAMPLE, THE IONIZATION BALANCE OF THE SOLAR CORONA AND THE INTERSTELLAR MEDIUM.

PREVIOUSLY UNIDENTIFIED SPECTRAL LINES OF HIGHLY IONIZED ELEMENTS ARE PRODUCED IN THE LABORATORY AND ARE IDENTIFIED. RADIATION SOURCES INCLUDE THE PLASMAS IN A THETAPINCH FACILITY, A PLASMA-FOCUS APPARATUS, AND THE PLASMA PRODUCED BY A GIANT PULSE LASER. THE RESULTS ARE OF WIDE DEMAND BY THE SCIENTIFIC COMMUNITY AND WILL ALSO BE USED TO IDENTIFY MANY OF THE SPECTRAL LINES EMITTED BY THE SOLAR CORONA THAT ARE OBTAINED BY ROCKET- AND SATELLITE-BORNE SPECTROGRAPHS. INVESTIGATIONS OF THE VARIOUS PROCESSES OCCURRING IN SOLAR FLARES WILL BE STUDIED BY USING A PLASMA FOCUS TO SIMULATE THE PARTICLE ACCELERATION AND OTHER PHENOMENA OCCURRING IN SOLAR FLARES. STUDIES ARE MADE OF MAGNETIC-FIELD ANNIHILATION AND RECONNECTION AND OF THE PARTICLE ACCELERATION IN THE ELECTRIC FIELDS DEVELOPED NEAR MAGNETIC NEUTRAL POINTS. DETAILED COMPARISON OF THE X-RAY AND OTHER RADIATION FROM SOLAR FLARES WITH LABORATORY SIMULATION OF FLARES WILL BE MADE. DATA OBTAINED IN MIAHUATLAN, MEXICO DURING THE MARCH 7, 1970, TOTAL ECLIPSE OF THE SUN WILL BE EVALUATED. THESE DATA WILL DETERMINE FOR THE FIRST TIME SIMULTANEOUS MULTICOLOR INTENSITY, AND DEGREE AND ANGLE OF POLARIZATION PROFILES FROM PHOTOMETRIC MEASUREMENTS. COMPARISON WITH MEASUREMENTS DURING THE 1973 ECLIPSE WILL BE MADE. THE LONG DURATION AND THE HIGH ZENITH ANGLE OF THE LATTER WILL INCREASE THE QUALITY OF THE MEASUREMENTS.

RTOP NO. 188-38-52 TITLE: GROUND BASED OBSERVATIONS OF THE SUN
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BRANDT, J. C. TEL. 301-982-4701
TECHNICAL SUMMARY

THE DEVELOPMENT OF AN OBSERVATORY TO DETERMINE SOLAR WIND PROPERTIES AT REMOTE LOCATIONS IN THE SOLAR SYSTEM BY RECORDING AND ANALYZING THE PROPERTIES OF IONIC COMET TAILS IS CONTINUING. THE ZEISS FILTERGRAPH, USED TO OBTAIN SUPPORTING OBSERVATIONS FOR THE GSFC OSO-5 WHEEL EXPERIMENT, HAS BEEN ADAPTED FOR A VIDICON DETECTOR SYSTEM, TO SUPPORT THE GSFC OSO-H POINTED EXPERIMENT. POLARIZATION MAPS WILL BE MADE OF SOLAR ACTIVE REGIONS AT MM WAVELENGTHS. A CORONAL PHOTOMETRY SYSTEM, INTENDED TO OBTAIN BRIGHTNESS MAPS OF THE SOLAR CORONA DURING TOTAL ECLIPSES WITH A HIGH ACCURACY IN RELATIVE POINT-TO-POINT PHOTOMETRY IS BEING DESIGNED.

RTOP NO. 188-38-53 TITLE: LABORATORY AND THEORETICAL SOLAR PHYSICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OERTEL, G. K. TEL. 202-962-0157
TECHNICAL SUMMARY

LABORATORY AND THEORETICAL STUDIES ARE CARRIED OUT ON CURRENT PROBLEMS IN SOLAR ASTRONOMY AND SOLAR PHYSICS, AND ON IMPORTANT AREAS OF ATOMIC AND MOLECULAR PHYSICS WHICH ARE CONTRIBUTING BASIC INFORMATION AS REQUIRED FOR THE ANALYSIS OR UNDERSTANDING OF SOLAR DATA FROM THE GROUND AND FROM SPACE. THEORETICAL STUDIES OF THE SUN INCLUDE THE FOLLOWING TYPES OF ACTIVITY: THE ANALYSIS OF GROUND-BASED AND SPACE DATA IN TERMS OF MODELS OF THE SOLAR ATMOSPHERE ACTIVITY, OR STRUCTURES SCIENTIFIC INTERPRETATION IN TERMS OF PHYSICAL CONDITIONS AND MECHANISMS PREDICTION OF FUTURE

EVENTS ON THE SUN, SUCH AS PREDICTIONS OF CORONAL STRUCTURES FROM FEATURES OBSERVABLE ON THE DISK; OF THE DEVELOPMENT OF FUTURE ACTIVE REGIONS FROM MAGNETIC AND H-ALPHA FEATURES; THE OCCURRENCE OF FLARES FROM MAGNETIC FIELD COMPLEXITY AND CONFIGURATION. THEORETICAL AND LABORATORY STUDIES IN ATOMIC AND MOLECULAR PHYSICS INCLUDE THESE ACTIVITIES: THE MEASUREMENT OR COMPUTATION OF ATOMIC OR MOLECULAR QUANTITIES SUCH AS WAVELENGTHS, ENERGY LEVELS, F-VALUES, LINE BROADENING PARAMETERS, IONIZATION AND EXCITATION FUNCTIONS, ETC.

RTOP NO. 188-38-53 TITLE: SOLAR PHYSICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO CONDUCT EXPERIMENTS AND ANALYSES INTENDED TO EXPLAIN THE PHYSICAL PROCESSES THAT GOVERN THE STRUCTURE AND DYNAMICS OF THE SOLAR CORONA. SPECIFICALLY, THE WORK WILL BE CONCERNED WITH (1) ECLIPSE OBSERVATIONS OF THE SOLAR CORONA WITH AN AIRBORNE SCANNING INTERFEROMETER TO SEARCH FOR INFRARED EMISSION LINES FROM HIGH LEVELS OF FE XV, (2) CORRELATION OF FINE-SCALE BRIGHTNESS DISTRIBUTION OF THE INNER CORONA, OBTAINED FROM WHITE LIGHT ECLIPSE PHOTOGRAPHS, WITH THE LOCATION OF STRONG MAGNETIC FIELDS, (3) A SOLAR FLARE X-RAY EXPERIMENT TO STUDY THE K ALPHA EMISSION FROM HIGHLY IONIZED IRON, (4) A STUDY TO IDENTIFY THE NON-THERMAL IMPULSIVE BURST PHASE IN A SOLAR FLARE AND ITS RELATION TO MAGNETIC FIELD DYNAMICS, AND PHOTOSPHERIC AND CHROMOSPHERIC KINETICS, (5) LABORATORY STUDIES OF THE VUV AND X-RAY EMISSION SPECTRA OF HIGHLY IONIZED SPECIES BELIEVED TO EXIST IN THE SUN AND, (6) SUPPORT OF AIRBORNE OBSERVATIONS OF HIGH-RESOLUTION INFRARED SOLAR SPECTRA IN THE RANGE 3 UM TO 7 UM AND BEYOND. THE RESULTS OF THESE STUDIES WILL HAVE ASTROPHYSICAL VALUE BY CONTRIBUTING TO AN UNDERSTANDING OF THE PHYSICAL PROCESSES NEAR THE SURFACE AND IN THE ATMOSPHERE OF THE SUN, AND WILL CONTRIBUTE TO THE PRACTICAL PROBLEM OF PREDICTING THE OCCURRENCE AND INTENSITY OF PARTICLE STREAMS AND RADIATION FROM SOLAR FLARES THAT ARE DANGEROUS TO MANNED OR UNMANNED SPACECRAFT.

RTOP NO. 188-38-53 TITLE: LABORATORY AND THEORETICAL SOLAR PHYSICS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BRANDT, J. C. TEL. 301-982-4701
TECHNICAL SUMMARY

RESEARCH TOWARD IMPROVED SYSTEMS FOR SOLAR OBSERVATIONS IN THE EUV, X-RAY & GAMMA RAY REGIONS THROUGH THE DEVELOPMENT OF PROTOTYPE TELESCOPES & COLLIMATOR SYSTEMS & DETECTORS FOR THESE WAVELENGTHS. A FEASIBLE GOAL IS 5 ARC SEC SPATIAL RESOLUTION AT EUV WAVELENGTHS USING TWO-ELEMENT GLANCING INCIDENCE TELESCOPES. DEVELOPMENT OF MECHANICAL SYSTEMS FOR STABLE ALIGNMENT OF THE TWO ELEMENTS IN WOLTER TYPE II SYSTEMS. THE X-RAY & EUV SCATTERING PROPERTIES OF SURFACES PRODUCED BY VARIOUS POLISHING TECHNIQUES IS BEING STUDIED. RESEARCH INTO IMPROVED HARD X-RAY DETECTORS EMPHASIZES THE OBJECTIVE OF EXTENDING THE ENERGY RANGE OF OBSERVATION TO 20 MEV. USE OF A

PASSIVE LI IMPREGNATED BISMUTH SHIELD OFFERS A SUBSTANTIAL IMPROVEMENT OVER EXISTING METHODS. ELECTRONICS ARE BEING DEVELOPED, WHICH TOGETHER WITH EXISTING CRYSTAL & MECHANICAL FIXTURES, WILL PRODUCE A DETECTOR ABLE TO RECORD THE SPECTRUM OF A SOLAR X-RAY BURST WITH 100 MILLISECONDS RESOLUTION. DETECTOR WORK BEGINS ON A MULTIPLE CHAMBER COUNTER CAPABLE OF SIMULTANEOUSLY RECORDING SOFT, MEDIUM & HARD X-RAYS. DESIGN OF A HIGH RESOLUTION CORONAL SPECTROGRAPH FOR THE 300A REGION CONTINUES & BENCH TESTING WILL BEGIN. COS/MOS TYPE INTEGRATED CIRCUITS WHICH MAY HAVE REDUCED POWER NEEDS, VOLUME & WEIGHT WILL BE ENVIRONMENTALLY TESTED IN TYPICAL SPACE SOLAR EXPERIMENT ELECTRONIC UNITS. DESIGN WORK FORGROUND-BASED WORK IN THE MM & INFRARED REGIONS CONTINUES & IS DONE ON RADIOMETER FRONT-ENDS FOR OPERATION AT 9.5MM & 6MM WAVELENGTHS. RADIOMETER BACK-END FOR USE WITH BOTH FRONT-ENDS HAS BEEN DESIGNED & WORK ON THE JOSEPHSON EFFECT DETECTOR HAS IMPROVED THE SENSITIVITY TO 10 TO THE 13TH----

RTOP NO. 188-39-56 TITLE: MAGNETOSPHERIC PHYSICS - PARTICLES AND PARTICLE/PHOTON INTERACTIONS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: AIKIN, A. C. TEL. 301-982-4913
TECHNICAL SUMMARY

DEVELOPMENT OF MEASUREMENT TECHNIQUES FOR DETERMINING PROPERTIES OF LOWER PLANETARY IONOSPHERES. THE LONG RANGE OBJECTIVE IS THE DETERMINATION OF THE ELECTRICAL PROPERTIES FOR THE FIRST 100 KM OF THE ATMOSPHERES OF THE TERRESTRIAL PLANETS. THIS NECESSITATES THE DETERMINATION OF THE DEGREE OF SPATIAL AND TEMPORAL VARIATION OF THE IONIZATION OF AN ATMOSPHERE AND THE SPECIES OF POSITIVE AND NEGATIVE IONS. THIS OBJECTIVE IS BEING MET BY: 1) DEVELOPMENT OF TECHNIQUES FOR ION MASS IDENTIFICATION AT ATMOSPHERIC PRESSURES GREATERTHAN .0001 MM HG. THESE INCLUDE STUDYING THE EFFECTS OF SHOCK WAVES ON THE OPERATION OF A QUADRUPOLE ION SPECTROMETER TRAVELING AT LARGEMACH NUMBERS AND CONSTRUCTION OF ION SPECTROMETERS OPERATING ON THE PRINCIPLE OF MOBILITY IDENTIFICATION. 2) FORMULATING MODELS OF THE LOWER IONOSPHERES OF EARTH, MARS AND VENUS. 3) DETERMINATION OF REACTION RATES FOR PERTINENT ION-MOLECULE REACTIONS. THE RESEARCH HAS APPLICATION TO THE MANNED AND UNMANNED EXPLORATION OF THE MARTIAN SURFACE, SINCE IT DEFINES THE ELECTRICAL ENVIRONMENT IN WHICH SYSTEMS OPERATE.

RTOP NO. 188-41-01 TITLE: ASTRONOMY - GAMMA RAY OBSERVATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: OLIVIER, J. R. TEL. 205-453-3427
TECHNICAL SUMMARY

A PROGRAM OF BALLOON-FLIGHTS FOR GAMMA RAY EXPERIMENTS IS PROPOSED WITH OAK RIDGE NATIONAL LABORATORY (ORNL) PROVIDING THE SCIENTIFIC TECHNIQUES AND WITH MSFC SUPPORTING THE PROJECT BY ASSUMING ALL RESPONSIBILITY FOR TELEMETRY AND REAL-TIME DATA RECOVERY. BALLOON EXPERIMENTATION TO DATE HAS SHOWN THAT GE(LI) DETECTORS ARE RUGGED ENOUGH TO UNDERGO BALLOON FLIGHTS, AND CONSEQUENTLY SPACE FLIGHTS, AND RETURN VALUABLE DATA SO LONG AS THE

CRYOGENIC SYSTEM REMAINS IN GOOD CONDITION. THE DESIGN FOR THE SPECTROMETER SHIELD, THE STABILIZED PLATFORM, AND THE BASIC ELECTRONIC REQUIREMENTS FOR THE SPECTROMETER AND GONDOLA CONTROL HAVE ALL BEEN ESSENTIALLY COMPLETED IN A SERIES OF FLIGHTS. IT IS PROPOSED THAT THE KNOWLEDGE GAINED AND THE TECHNIQUES DEVELOPED BE RAPIDLY UTILIZED FOR SCIENTIFIC OBSERVATIONS BY ADAPTING THE ORNL/MSFC GE(LI) SPACE GAMMA RAY SPECTROMETER FOR BALLOON EXPERIMENTATION. THIS ADAPTATION WOULD PROVIDE ONE-FOURTH THE DETECTOR AREA AS THE SPACE MODEL. THE APPROACH TO OBTAINING THIS CAPABILITY INCLUDES: (1) COMPLETION OF A STABILIZED PLATFORM AND ASSOCIATED ELECTRONICS BASED ON THE FINDINGS OF THE JULY 1969 TEST FLIGHT; (2) ADAPT THE GE(LI) SPECTROMETER DESIGN FOR A BALLOON INSTRUMENT AND REQUEST QUOTES FROM INDUSTRY FOR BUILDING THE INSTRUMENT; (3) DESIGN AND BUILD A MULTIMODE SPECTROMETER TO EXTEND THE EFFECTIVE ENERGY RANGE TO ABOUT 18 MEV; AND (4) ACCOMPLISH BALLOON FLIGHTS FOR THE PURPOSE OF OBSERVING VARIOUS REGIONS OF THE GALAXY TO SEARCH FOR THE PRESENCE OF GAMMA _RAY LINES BELOW 1.5 MEV WHICH ARE EXPECTED AS A RESULT OF NUCLEAR REACTION.

RTOP NO. 188-41-51 TITLE: GROUND BASED ASTRONOMY - OPTICAL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: OLIVER, J. R. TEL. 205-453-3427
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO PERFORM GROUND BASED VISIBLE AND NEAR IR FILTER PHOTOMETRY OF BINARY STARS, LONG PERIOD MIRA VARIABLES, SEYFERT GALAXIES AND MAGNETIC VARIABLE STARS; AND TO PERFORM MULTISPECTRAL PHOTOELECTRIC POLARIMETRY TO STUDY PROPERTIES OF ZODIACAL LIGHT. THE ABOVE DATA WILL BE USED IN SUPPORT OF SEVERAL FLIGHT EXPERIMENTS NOW UNDER DEVELOPMENT AT MSFC. MULTISPECTRAL PHOTOMETRY WILL BE PERFORMED USING EQUIPMENT WHICH IS MOSTLY ALREADY DEVELOPED AND ON HAND. THE 30 AND 49 CM TELESCOPES AT MSFC, AND THE 150 CM TELESCOPE AT TUCSON, ARIZONA WILL BE USED.

RTOP NO. 188-41-51 TITLE: GROUND BASED ASTRONOMY - OPTICAL
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BOGGESS, A., III TEL. 301-982-5103
TECHNICAL SUMMARY

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 AND ROCKET TELESCOPES IN ORDER TO ANALYZE THE PROPERTIES OF STELLAR ATMOSPHERES AND THE INTERSTELLAR MEDIUM. MODEL ATMOSPHERES ARE BEING DEVELOPED TO COMPARE WITH OBSERVATION, PARTICULAR ATTENTION BEING PAID TO NONEQUILIBRIUM PHENOMENA. ADDITIONAL TASKS INCLUDE CALCULATIONS OF FUNDAMENTAL PHYSICAL PARAMETERS OF ASTROPHYSICAL INTEREST, N-BODY ORBIT ANALYSIS, AND INVESTIGATIONS OF SECULAR EFFECTS IN THE MOTIONS OF PLANETARY SYSTEMS.

RTOP NO. 188-41-52 TITLE: RADIO ASTRONOMY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: OLIVER, J. R. TEL. 205-453-3427
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS STUDY IS TO OBSERVE AND INVESTIGATE MILLIMETER EMISSIONS FROM THE SUN AT THE SHORTEST PRACTICAL RADIO WAVELENGTH (I.E. THREE MILLIMETERS) BEFORE, DURING, AND AFTER SOLAR EVENTS AND DURING THE QUIET SUN AND TO CORRELATE THE RESULTS WITH SOLAR MAGNETOGRAPH, H-ALPHA RECORDS AND SOLAR FLARE INFORMATION. THE RESULTS WILL BE USED TO DETERMINE THE CORRELATION BETWEEN MILLIMETER EMISSIONS AND SOLAR ACTIVITY FOR POSSIBLE FLARE PREDICTION AND AS A BASIS FOR A MORE COMPLETE UNDERSTANDING OF THE PHYSICAL PROCESSES IN THE SOLAR CHROMOSPHERE THROUGH THE COMPARISON OF OBSERVED DATA WITH THAT PREDICTED BY CURRENT SOLAR MODELS. THE THREE MILLIMETER DATA WILL BE OBTAINED FROM THE MILLIMETER WAVELENGTH RADIO TELESCOPE NOW IN OPERATION AT MSFC. INITIALLY, REGIONS OF THE SUN WHICH EXHIBIT ACTIVITY (AS INDICATED BY H-ALPHA) WILL BE MONITORED CONTINUOUSLY DURING PERIODS OF ADEQUATE VISIBILITY. THE SECOND PHASE WILL BE THE INCLUSION OF A SCANNING MODE OF OPERATION AND ACTIVE REGIONS WILL BE IDENTIFIED INDEPENDENTLY. EVENTUALLY, RESOLUTION OF THE TELESCOPE SYSTEM WILL BE IMPROVED AND CONSIDERATION WILL BE GIVEN TO OTHER PROPERTIES OF THE EMISSIONS (POLARIZATION, ETC) WHICH ARE LIKELY TO PROVIDE ADDITIONAL INFORMATION OF THE PROCESSES PRODUCING THE RADIATION.

RTOP NO. 188-41-52 TITLE: RADIO ASTRONOMY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: STONE, R. G. TEL. 301-982-4631
TECHNICAL SUMMARY

THE OBJECTIVE OF THE GROUND BASED RADIO ASTRONOMY PROGRAM IS TO PROVIDE A BETTER UNDERSTANDING OF THE DYNAMICS AND COMPOSITION OF ASTROPHYSICAL PLASMAS IN OBJECTS SUCH AS RADIO GALAXIES, SUPERNOVAE, QUASARS, AND SOLAR SYSTEM SOURCES SUCH AS THE SUN AND JUPITER THROUGH THE HIGH ANGULAR AND TIME RESOLUTION OBSERVATIONS OF RADIO EMISSION FROM THESE OBJECTS. RADIO ASTRONOMY HAS PROVIDED NEW INSIGHT INTO SUCH PROBLEMS WHICH COULD NOT HAVE BEEN GAINED FROM OBSERVATIONS IN OTHER PARTS OF THE SPECTRUM SUCH AS THE VISIBLE OR UV REGION. THE INTERPRETATION OF SOURCE SPECTRAL AND SPATIAL DISTRIBUTION IN TERMS OF OUR KNOWLEDGE OF PLASMAS AND HIGH ENERGY PROCESSES LEADS TO KNOWLEDGE OF THE EVOLUTION OF THE SOURCE AND OF THE MAGNETIC FIELD, ENERGETIC PARTICLE COMPOSITION AND DYNAMIC PROCESSES WITHIN THE SOURCE. THE APPROACH TAKEN INVOLVES THE USE AND DEVELOPMENT OF HIGH RESOLUTION RADIO TELESCOPES.

RTOP NO. 188-41-52 TITLE: INTERSTELLAR MICROWAVE SPECTROSCOPY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THIS RTOP USES THE UNIQUE FACILITIES OF NASA'S DEEP SPACE INSTRUMENTATION FACILITY (DSIF) TO FIND MICROWAVE SPECTRAL LINES OF

INTERSTELLAR ATOMS AND MOLECULES AT X-BAND (8 GHZ) AND K-BAND (15 GHZ), REGIONS IN WHICH NASA'S RECEIVING CAPABILITIES ARE THE BEST IN THE WORLD. CONCURRENTLY, A LABORATORY MICROWAVE SPECTROSCOPY PROGRAM IS CARRIED OUT IN ORDER TO INTERPRET THE RESULTS OF THE OBSERVATION PROGRAM AS TO THE MOLECULAR SPECIES, ABUNDANCES WITHIN THE SOURCE, AND THE DOPPLER SHIFT OF THE SOURCE ITSELF. DSIF EQUIPMENT TO BE USED INCLUDES THE 64M GOLDSTONE ANTENNA; K-BAND AND X-BAND WIDEBAND LOW NOISE FEEDS, MASERS, AND RECEIVERS; A WIDEBAND DIGITAL CORRELATOR SPECTRUM ANALYZER; CALIBRATED NOISE SOURCES; AND PROGRAMMABLE LOCAL OSCILLATORS. THIS DSIF EQUIPMENT EITHER ALREADY EXISTS OR IS BEING DEVELOPED FOR PROGRAMS SUPPORTED BY THE OFFICE OF TRACKING AND DATA ACQUISITION (OTDA); THUS, THIS RTOP DOES NOT PAY FOR SUCH EQUIPMENT. THE SPECTROMETER SYSTEM TO BE USED IN THE LABORATORY INVESTIGATIONS INCLUDES A STARK MODULATION SPECTROMETER AND ASSOCIATED PROGRAMMABLE DIGITAL DATA HANDLING AND CONTROL EQUIPMENT. THE LABORATORY EQUIPMENT IS TO BE FUNDED OUT OF DISCRETIONARY FUNDS, NOT OUT OF THIS RTOP. FUNDAMENTAL QUESTIONS IN STELLAR AND GALACTIC EVOLUTION TO BE ANSWERED BY INTERSTELLAR MICROWAVE SPECTROSCOPY INCLUDE THE GALACTIC MOLECULAR AND ISOTOPE DISTRIBUTION AND THE ISOTOPIC ABUNDANCE RATIOS; THE VELOCITY DISTRIBUTION OF INTERSTELLAR MATERIAL; AND THE CAUSES OF ANOMALOUS INTERSTELLAR MOLECULAR SPECTRAL LINE INTENSITIES. OF PARTICULAR INTEREST IS THE LOCATION AND ABUNDANCE OF COMPLEX INTERSTELLAR MOLECULES, BECAUSE THE MECHANISMTHAT ALLOWS THE CREATION AND RETENTION OF SUCH----

RTOP NO. 188-41-53 TITLE: COMPUTATIONAL PHYSICS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

WITH THE AVAILABILITY OF LARGER AND FASTER COMPUTERS AND WITH THE DEVELOPMENT OF EFFICIENT NUMERICAL METHODS IT IS BECOMING POSSIBLE TO OBTAIN REALISTIC COMPUTER SIMULATIONS OF THE EVOLUTION OF COMPLEX PHYSICAL SYSTEMS. VARIOUS PROBLEMS RELATED TO THE GEOMAGNETIC ENVIRONMENT, TO STELLAR AND GALACTIC DYNAMICS, TO PLASMA PHYSICS, AND TO FLUID DYNAMICS WILL BE STUDIED. THE INTERACTION OF AN ARTIFICIAL SATELLITE OR SPACE STATION WITH THE EARTH'S IONIZED ATMOSPHERE, IN PARTICULAR THE EXTENDED WAKE REGION, WILL BE INVESTIGATED. THIS WILL INCLUDE AN ASSESSMENT OF THE EFFECT OF ENVIRONMENTAL CONTAMINATION BY THE SPACE STATION ON OBSERVATIONS OF FAINT ASTRONOMICAL SOURCES. NEW AND IMPROVED NUMERICAL METHODS AND COMPUTER MODELS ARE NEEDED TO PERFORM THE COMPUTER SIMULATIONS. AREAS OF PARTICULAR INTEREST FOR SIMULATIONS THAT ARE PRESENTLY IN PROGRESS ARE CONCERNED WITH THE DYNAMICS OF SPIRAL GALAXIES AND THE EXPANSION OF ARTIFICIAL BARIUM CLOUDS IN THE EARTH'S MAGNETOSPHERE. THE EFFECTS OF COMPANION GALAXIES ON THE SPIRAL STRUCTURE WILL BE STUDIED. FOR THE BARIUM CLOUD EXPERIMENT THE RATE OF EXPANSION OF THE CLOUD AND THE DIFFUSION OF THE MAGNETIC FIELD IS BEING NUMERICALLY SIMULATED.

RTOP NO. 188-41-53 TITLE: THEORETICAL ASTROPHYSICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. G. TEL. 202-962-2989
TECHNICAL SUMMARY

OBJECTIVE IS TO INVESTIGATE VARIOUS AREAS OF ASTROPHYSICS TO UNDERSTAND: STELLAR SPECTRA; WAVE FUNCTIONS; STELLAR EVOLUTION; STELLAR INTERIORS; COSMOLOGY; STELLAR ATMOSPHERES; STELLAR SYSTEMS (E.G., BINARY STARS); AND POLARIZATION. THEORETICAL STUDIES ARE NECESSARY TO UNDERSTAND DATA COLLECTED FROM ORBITAL AND GROUNDBASED OBSERVATIONS. A TOTAL UNDERSTANDING OF THE ASTRONOMICAL NATURE OF OUR UNIVERSE IS THE PRIME GOAL OF THE ASTRONOMY PROGRAM. THE THEORETICAL WORK DESCRIBED HERE IS THE FIRST STEP TOWARD THAT GOAL. IN SHORT, THE OBJECTIVE IS TO PLACE ASTRONOMY ON A SOLID THEORETICAL BASE FROM WHICH OUR KNOWLEDGE MAY BE EXPANDED. THE APPROACH USED IS TO DEVELOP MATHEMATICAL AND PHYSICAL MODELS, TO USE FUNDAMENTAL ATOMIC, NUCLEAR, AND CHEMICAL DATA TO DETERMINE THE UNDERLYING PHYSICS OF THE SITUATION; TO USE COMPUTER TECHNIQUES TO DEVELOP SOPHISTICATED MODELS WHICH DESCRIBE AND PREDICT BEHAVIOUR; AND TO USE LABORATORY AND FLIGHT DATA TO DEVELOP NEW THEORIES AND TO CHECK EXISTING ONES.

RTOP NO. 188-41-53 TITLE: THEORETICAL ASTROPHYSICS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

TO CONDUCT THEORETICAL STUDIES ON IMPORTANT FUNDAMENTAL PROBLEMS OF ASTRONOMY AND ASTROPHYSICS. MAJOR AREAS OF STUDY INCLUDE: 1. LINE FORMATION IN EXPANDING GASEOUS ENVELOPES WITH SPECIFIC APPLICATION TO THE QUASI-STELLAR OBJECTS PHL-5200 AND RS-23. POSSIBLE EXTENSIONS ARE BEING CONSIDERED TO INCLUDE OTHER QSO'S AND A WIDE CLASS OF HOT YOUNG STARS WHICH ARE UNDERGOING CONTINUOUS OR SUDDEN MASS LOSS. 2. COSMOLOGICAL PROBLEMS WITH PARTICULAR EMPHASIS ON THE EFFECT OF COSMOLOGICAL EXPANSION UPON THE STABILITY OF CLUSTERS OF GALAXIES. 3.INFRA-RED ASTRONOMY. PARTICULAR ATTENTION HAS BEEN GIVEN TO THE PROBLEM OF THE SUB-MILLIMETER BACKGROUND RADIATION AND THEORETICAL SUPPORT IS BEING SUPPLIED TO THE AMES OBSERVATIONAL PROGRAM IN INFRA-RED ASTRONOMY. 4. STELLAR STUDIES. STELLAR WIND PROCESSES ARE UNDER STUDY AND THE PROBLEM OF THE PRE-MAIN SEQUENCE EVOLUTION OF A ONE SOLAR MASS OBJECT WITH ROTATION IS BEING INVESTIGATED. 5. A MODEL FOR THE TRANSFER OF ENERGY WITHIN THE CRAB NEBULA INVOLVING THE COLLISIONLESS DAMPING OF HYDROMAGNETIC WAVES IS BEING DEVELOPED.

RTOP NO. 188-41-54 TITLE: RELATIVITY & CELESTIAL MECHANICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

WHEREAS CLASSICAL OPTICAL ASTRONOMY YIELDED TWO SIGNIFICANT TESTS OF RELATIVISITIC GRAVITY TO MODERATE PRECISION (LIGHT DEFLECTION PLUS OR MINUS 20 PERCENT; PERIHELION SHIFT, PLUS OR MINUS

SEVERAL PER CENT), IN THE NEXT FIFTEEN YEARS SPACE-PROBE RANGING, LASER RANGING, RADAR RANGING, LONG-BASELINE INTERFEROMETRY AND SUPERCONDUCTING GYROSCOPES SHOULD YIELD A NUMBER OF TESTS WITH PRECISIONS OF .001 TO .0001. THE IMPORTANCE OF CARRYING OUT SUCH EXPERIMENTS WAS EMPHASIZED EARLY LAST YEAR IN A REPORT OF THE NATIONAL SCIENCE BOARD TO CONGRESS: "IF MAN IS TO ACHIEVE A FUNDAMENTAL UNDERSTANDING OF GRAVITY, SUCH EXPERIMENTS MUST BE DONE:" WITH THE NEW TECHNOLOGY THAT HAS GROWN UP IN THE SPACE AGE, MAN SHOULD BE ABLE TO MEASURE A NUMBER OF RELATIVISTIC GRAVITATIONAL EFFECTS, SOME OF WHICH DIFFER MARKEDLY IN NATURE AND ORIGIN FROM THE CLASSIC PERIHELION SHIFT AND LIGHT DEFLECTION. NOW IS THE TIME, WE BELIEVE, TO DELINEATE THE NEWLY ACCESSIBLE EFFECTS, AND TO EVALUATE THE FEASIBILITY OF PERFORMING EXPERIMENTS TO MEASURE THEM. THIS IS THE GOAL OF THIS RESEARCH. WE PROPOSE A TWO-PRONGED ATTACK ON THE PROBLEM OF PLANNING EXPERIMENTAL HIGH PRECISION TESTS OF GENERAL RELATIVITY. THE FIRST PHASE IS TO DEVELOP A NEW THEORETICAL FRAMEWORK WITHIN WHICH TO COMPARE THE VARIOUS POSSIBLE THEORIES OF GRAVITY, AND TO USE THAT FRAMEWORK TO DELINEATE SOLAR-SYSTEM EXPERIMENTS WHICH MIGHT BE PERFORMED. THE SECOND PHASE WILL EVALUATE CONCURRENTLY THE TECHNICAL FEASIBILITY OF THE PROPOSED EXPERIMENTS USING EXISTING JPL COMPUTER PROGRAMS.

RTOP NO. 188-41-54 TITLE: RELATIVITY AND GRAVITATION
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. G. TEL. 202-962-2989
TECHNICAL SUMMARY

THE PRIME OBJECTIVE IS TO MAKE EXPERIMENTAL TESTS OF THE THEORY OF RELATIVITY. THE TESTS WOULD BE MADE BY INSTRUMENTS SUCH AS THE HYDROGEN MASER AND PRECISION GYROSCOPES. THE TESTS ARE BOTH GROUND-BASED AND ORBITAL. IN ADDITION TO THE SCIENTIFIC GOALS, IMPROVEMENTS IN CRYOGENICS, HIGH PRECISION GYROSCOPE DESIGN AND MANUFACTURE, AND PRECISE TIME MEASUREMENT MAY BE REALIZED. ANOTHER OBJECTIVE IS AN INCREASE IN UNDERSTANDING OF THE UNDERLYING THEORIES. THE ORBITAL TEST OF THE EINSTEIN GENERAL THEORY OF RELATIVITY IS THE PRIME OBJECTIVE. THE THEORY OF RELATIVITY IS OF HIGH SCIENTIFIC INTEREST AND IS MOST FUNDAMENTAL. EXPERIMENTAL TESTS ARE RARE. THE ABILITY TO ORBIT LARGE, COMPLEX, AND PRECISE APPARATUS WELL SHIELDED FROM UNWANTED FORCES OFFERS A UNIQUE OPPORTUNITY WHICH SHOULD NOT BE WASTED. 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 WHICH WOULD BENEFIT IR DETECTION. THE SPECIFIC OBJECTIVES INCLUDE IMPROVEMENT IN OPERATION OF THE HYDROGEN MASER; STUDIES OF THE FLIGHT WORTHINESS; LABORATORY OPERATION OF CRYOGENIC GYROSCOPE; COMPLETE GYROSCOPE SYSTEM ERROR ANALYSIS; DETECTION OF GRAVITY WAVES; AND CONSIDERATION OF POSSIBLE NEW TESTS.

RTOP NO. 188-41-55 TITLE: EXPERIMENTAL AND OBSERVATIONAL RESEARCH IN INFRARED ASTRONOMY AND INTERSTELLAR MEDIUM
ORGANIZATION: GODDARD INSTITUTE FOR SPACE STUDIES
MONITOR: THADDEUS, P. TEL. 212-866-3210
TECHNICAL SUMMARY

GISS IS CARRYING OUT SEVERAL PROJECTS IN EXPERIMENTAL AND OBSERVATIONAL ASTROPHYSICS AND ASTRONOMY FOR THE PURPOSE OF STUDY OF INTERSTELLAR MOLECULES, INFRARED SOURCES AND THE COSMIC MICROWAVE RADIATION. SPECIFIC ASPECTS OF THESE PROJECTS PLANNED FOR FY72 ARE: 1. CONDUCT OF EXPERIMENTS USING BALLOONS, AIRCRAFT, SOUNDING ROCKETS AND GROUND-BASED TELESCOPES FOR STUDY OF INFRARED SOURCES AND FOR IMPROVEMENT OF TECHNIQUES FOR INFRARED OBSERVATION. 2. TO OBTAIN PRECISE LABORATORY FREQUENCIES OF A NUMBER OF MOLECULAR TRANSITIONS RECENTLY DISCOVERED IN SPACE WITH RADIO TELESCOPES; AND, ALSO TO MEASURE THE FREQUENCY OF LINES WHICH ARE GOOD CANDIDATES FOR DETECTION. 3. TO CONTINUE ANALYSIS WITH THE GISS MICRODENSITOMETER SYSTEM OF HIGH RESOLUTION STELLAR AND INTERSTELLAR SPECTRA OBTAINED AT LICK AND MCDONALD OBSERVATORIES. 4. TO OBTAIN OBSERVATIONS OF INTERSTELLAR MOLECULES IN COLLABORATION WITH BELL TELEPHONE LABORATORIES IN THE REGION OF MILLIMETER WAVELENGTHS.

RTOP NO. 188-41-55 TITLE: INFRARED ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BOGGESS, N. W. TEL. 202-963-5997
TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY OBJECTS IN THE INFRARED BY MEANS OF GROUND-BASED TELESCOPES, AIRPLANES, ROCKETS, AND BALLOONS. ANOTHER OBJECTIVE IS TO DEVELOP ADVANCED DETECTORS, AND CRYOGENICS SYSTEMS SUITABLE FOR USE ON SATELLITES DEVOTED TO INFRARED RESEARCH. THE INFRARED PORTION OF THE ELECTROMAGNETIC SPECTRUM IS IMPORTANT FOR AN UNDERSTANDING OF THE FORMATION OF STARS, INSTELLAR MATTER, THE CENTER OF OUR GALAXY, OTHER GALAXIES, QUASISTELLAR OBJECTS, AND THE ENERGY MECHANISMS ASSOCIATED WITH THEM. THE INFRARED ALSO IS IMPORTANT FOR UNDERSTANDING THE RESIDUAL RADIATION OF THE UNIVERSE. THE FUTURE DEVELOPMENT OR MORE SENSITIVE INFRARED DETECTORS, APART FROM THEIR SCIENTIFIC BENEFITS, WOULD INCLUDE PRACTICAL BENEFITS DERIVED FROM THEIR USE FOR EARTH RESOURCES. THE SPECIFIC OBJECTIVES INCLUDE DEVELOPMENT OF INFRARED TELESCOPES AND INTERFEROMETERS THAT CAN BE USED BY THE DIFFERENT VEHICLES SUCH AS BALLOONS, THE LEAR JET, THE CONVAIR 990, AND THE C-141, AS WELL AS ON GROUND-BASED INSTRUMENTS. ALSO INCLUDED ARE SKY MAPS AND DETAILED STUDIES OF INDIVIDUAL SOURCES.

RTOP NO. 188-41-55 TITLE: INFRARED ASTRONOMY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE BROAD OBJECTIVES OF THIS PROGRAM ARE (1) TO OBTAIN AND INTERPRET ASTRONOMICAL DATA IN THE FAR INFRARED REGION OF THE SPECTRUM AND (2) TO DEVELOP AND EVALUATE IMPROVED PLATFORMS AND

INSTRUMENTATION FOR INFRARED ASTRONOMY. A MICHELSON INTERFEROMETER (ALREADY BUILT) WILL BE USED WITH AN EXISTING 12" TELESCOPE MOUNTED ON A LEAR JET TO DETERMINE THE SPECTRA OF THE GALACTIC CENTER, THE ORION NEBULA AND THE BRIGHT PLANETS IN THE RANGE 30 TO 300 MICRONS. A 28" BALLOON BORNE TELESCOPE WILL BE MODIFIED TO MAKE IT SUITABLE FOR OBSERVATIONS IN THE FAR INFRARED. ENGINEERING TEST FLIGHTS (PROBABLY 2) WILL BE LAUNCHED TO CHECK OUT GUIDANCE AND CONTROL AND TO COMPARE THE PERFORMANCE OF THE DETECTOR AND THE INTERFEROMETER ABOARD THE BALLOON SYSTEM WITH THAT ABOARD THE LEAR JET. EFFORTS WILL BE MADE TO OBTAIN A SPECTRUM OF ATMOSPHERIC EMISSION FROM BOTH PLATFORMS. A SMALL APERTURE (8 CM) LIQUID HELIUM COOLED TELESCOPE-INTERFEROMETER AND ASSOCIATED REMOTE GUIDANCE, CONTROL AND INFORMATION HANDLING SYSTEMS WILL BE DEVELOPED FOR USE ON HIGH ALTITUDE AIRCRAFT.

RTOP NO. 188-41-55 TITLE: HIGH-RESOLUTION INFRARED STELLAR SPECTROSCOPY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO OBTAIN AND ANALYZE HIGH RESOLUTION SPECTRA OF SELECTED COOL STARS IN THE 1.2 TO 6 MICRON REGION WITH THE JPL MK III CONNES'-TYPE FOURIER SPECTROMETER AT THE COUDE FOCUS OF THE 107" TELESCOPE MCDONALD OBSERVATORY. A MORE DETAILED OBJECTIVE AND A LIST OF SPECIFIC STARS IS APPENDED.

RTOP NO. 188-41-55 TITLE: INFRARED ASTRONOMY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: OLIVER, J. R. TEL. 205-453-3427
TECHNICAL SUMMARY

THIS SURVEY WILL BE PERFORMED WITH EARTH-BASED TELESCOPES USING LIQUID HELIUM-COOLED GALLIUM-DOPED GERMANIUM AND COPPER-DOPED GERMANIUM DETECTORS. BANDPASS SPECTRAL FILTERS WILL BE USED TO MAKE USE OF THE EARTH'S ATMOSPHERIC WINDOWS AND ALSO TO GIVE THE SPECTRAL DISTRIBUTION OF THE EMITTED ENERGY. THE MEASUREMENT WILL BE MADE USING A 1.5 METER INFRARED TELESCOPE AT TUCSON, ARIZONA. THERE ARE MANY STARS AND STELLAR SOURCES WHICH EMIT A SIZEABLE PORTION OF THEIR ENERGY IN THE INFRARED PART OF THE SPECTRUM. SURVEYS HAVE BEEN MADE IN THE NEAR INFRARED BUT MUCH REMAINS TO BE DONE IN DETERMINING WHICH OF THE OBJECTS ARE DETECTABLE IN THE MIDDLE AND FAR INFRARED. THE RESULTS FROM THESE MEASUREMENTS WILL BE MADE AVAILABLE TO INFRARED ASTRONOMERS SO THAT CLOSER STUDY CAN BE MADE ON THOSE FINDINGS THAT ARE OF PRIME INTEREST IN UNDERSTANDING STELLAR EVOLUTION AND PROCESSES.

RTOP NO. 188-41-55 TITLE: ASTRONOMY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: KONDO, Y. TEL. 713-483-6468
TECHNICAL SUMMARY

TASK 1 - INFRARED ASTRONOMY. INFRARED SPECTRA OF PLANETARY NEBULAE AND COOL STARS ARE MEASURED WITH A MICHELSON INTERFEROMETER USING INFRARED DETECTORS AND THE 107-INCH MCDONALD OBSERVATORY TELESCOPE. ANALYSIS OF THE SPECTRA YIELDS INFORMATION ON THE COMPOSITION AND STRUCTURE OF THE NEBULAR GASES AND THE STELLAR ATMOSPHERES. PRINCIPAL OBJECTIVES OF THE WORK ARE TO CLARIFY THE ORIGIN AND NATURE OF COOL CARBON-RICH AND OXYGEN-RICH STARS AND TO EXPLORE THE NATURE OF INFRARED EMISSIONS FROM PLANETARY NEBULAE. IN A PARALLEL EFFORT, ANALYTICAL PERFORMANCE STUDIES OF INFRARED TELESCOPES FOR OPERATION ON MANNED SPACE OBSERVATORIES ARE BEING DONE TO SUPPORT PLANNING ACTIVITIES FOR SPACE STATION EXPERIMENT DEFINITION. TASK 2 - BALLOON-BORNE ULTRAVIOLET STELLAR SPECTROMETER. TO OBSERVE MG II. DOUBLET EMISSION AT 2795 A AND 2802 A IN VARIOUS SPECTRAL TYPE STARS. PARTICULAR EMPHASIS WILL BE PLACED IN THE INTERMEDIATE TO EARLY TYPE STARS. (IN THIS SPECTRAL REGION, THE CA II. DOUBLET EMISSIONS AT 3933 A AND 3928 A BECOME UNOBSERVABLE.) THE BALLOON-BORNE ULTRAVIOLET STELLAR SPECTROMETER WILL BE DESIGNED, FABRICATED, AND FLOWN TWICE IN 1971. FURTHER FLIGHTS WILL BE REQUIRED TO EXTRACT THE FULL USEFULNESS OF THIS INSTRUMENTATATION.

RTOP NO. 188-41-57 TITLE: LABORATORY ASTROPHYSICS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. G. TEL. 202-962-2989
TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY ATOMIC RADIATION AS EMITTED BY STELLAR OR LABORATORY PLASMA AND OPTICAL AND PHOTOELECTRIC PROPERTIES OF MATERIALS OF ASTRONOMICAL INTEREST. LABORATORY MEASUREMENTS ARE NECESSARY FOR THE IDENTIFICATION AND INTERPRETATION OF SPECTRA OF CELESTIAL OBJECTS OBTAINED EITHER FROM THE GROUND OR FROM SPACE. IN ADDITION, PROPERTIES OF CERTAIN MATERIALS ARE NEEDED TO IDENTIFY THOSE WHICH PROMISE TO HAVE USE FOR SPACE ASTRONOMY RESEARCH. SPECIFIC OBJECTIVES INCLUDE: THE ANALYSIS OF ATOMIC EMISSION SPECTRA AND DEVELOPMENT OF COMPUTER METHODS OF DATA ANALYSIS; OBTAINING QUANTITATIVE INTENSITY AND WAVELENGTH MEASUREMENTS OF MOLECULES OF INTEREST IN STELLAR ATMOSPHERES RESEARCH; THEORETICAL STUDIES OF LINE BROADENING; CALCULATIONS OF CROSS-SECTIONS AND OSCILLATOR STRENGTH; AND OPTICAL AND PHOTOELECTRIC PROPERTIES OF CERTAIN INORGANIC SEMI-CONDUCTORS AND INSULATORS.

RTOP NO. 188-41-58 TITLE: SUPPORTING TASKS FOR ASTRONOMY PROGRAM
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. G. TEL. 202-962-2989
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE MEANS FOR CONCLUDING, IN A TIMELY MANNER, SPECIAL PROJECTS OF PARTICULARLY HIGH INTEREST TO THE NASA ASTRONOMY PROGRAM. THE TASKS ARE GREATLY VARIED. THE ASTRONOMY

PROGRAM HAS SEVERAL TASKS WHICH ARE VERY BROAD AND WHICH ARE A BASE FOR THE TOTAL PROGRAM. THIS, NATURALLY, MAKES THEM ESSENTIAL TO THE EFFICIENT OPERATION OF THAT PROGRAM. A PARTICULARLY IMPORTANT FEATURE IS THAT THROUGH SUCH TASKS WE ARE ABLE TO FOSTER CLOSE COOPERATION BETWEEN ENGINEERING DEVELOPMENT TEAMS AND ASTRONOMY RESEARCH TEAMS WITH THE RESULT THAT EACH BENEFITS. TO INVESTIGATE BROAD AND SPECIFIC AREAS OF ASTRONOMY; TO INVESTIGATE WAYS OFCOLLECTING, SORTING, AND ANALYZING LARGE AMOUNTS OF DATA MORE EFFICIENTLY; TO CONDUCT RESEARCH IN SOLID STATE PHYSICS PARTICULARLY FOR APPLICATION IN ADVANCED DETECTOR WORK--THESE ARE THE BROAD OBJECTIVES OF THESE SUPPORTING TASKS. SPECIALISTS IN EACH OF THE BROAD AREAS NOTED ABOVE ARE SUPPORTED AS APPROPRIATE. BECAUSE OF THE DIVERSE NATURE OF THE TASKS, THE EFFORT RANGES FROM THEORETICAL STUDIES TO HARDWARE FABRICATION.

RTOP NO. 188-41-59 TITLE: X-RAY ASTRONOMY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: BOLDT, E. A. TEL. 301-982-5853
TECHNICAL SUMMARY

X-RAY PRODUCTION IS A NECESSARY CONSEQUENCE OF ENERGETIC CHARGED PARTICLES IN SPACE. ULTRA-RELATIVISTIC ELECTRONS RADIATE X-RAYS VIA THEIR INTERACTIONS WITH THE AMBIENT ELECTROMAGNETIC ENVIRONMENT (E.G., MAGNETIC FIELDS, STARLIGHT, MICROWAVE RADIO). SUBRELATIVISTIC ENERGETIC PARTICLES RADIATE X-RAYS VIA COLLISIONS WITH MATTER; HIGHLY IONIZED ATOMS RADIATE CHARACTERISTIC X-RAY LINES AFTER RECOMBINING WITH AMBIENT ELECTRONS. HENCE, BY STUDYING THE X-RAY EMISSION FROM STELLAR OBJECTS, NEBULAE, AND INTERSTELLAR SPACE WE GET DIRECT INFORMATION ON ENERGETIC PROCESSES OVER A BROAD RANGE OF PHYSICAL CONDITIONS AND ASTRONOMICAL SCALES. OBSERVATIONS OF HARD X-RAYS ARE MADE WITH MECHANICALLY COLLIMATED PROPORTIONAL COUNTERS OF ADVANCED DESIGN. THE TECHNICAL GOALS ARE LARGE EFFECTIVE AREA, BROAD SPECTRAL COVERAGE, OPTIMUM RESOLUTION, AND EFFICIENT REJECTION OF EXTRANEOUS EVENTS (E.G., CAUSED BY GAMMA RAYS, ELECTRONS, RADIOACTIVITY). THESE GOALS, COUPLED WITH A DETAILED KNOWLEDGE OF DETECTOR RESPONSE, ARE BEING ACHIEVED VIA LABORATORY TESTS, BALLOON AND ROCKET FLIGHTS. OBSERVATIONS OF SOFT X-RAYS MAY BE MADE WITH THE USE OF GRAZING INCIDENCE OPTICS. SMALL DETECTORS OF HIGHER RESOLUTION ARE THEN PRACTICAL, AND WE ARE DEVELOPING A COOLED SI(LI) DETECTOR FOR USE AT THE FOCUS OF AN X-RAY TELESCOPE.

RTOP NO. 188-41-59 TITLE: X-RAY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: HIBBARD, R. T. TEL. 202-963-6975
TECHNICAL SUMMARY

THE OBJECTIVE IS TO UNDERSTAND: THE CONDITIONS EXISTING IN POINT SOURCES OF X-RAY MISSION; THE COSMIC BACKGROUND RADIATION; AND THE EMISSION MECHANISM. X-RAY ASTRONOMY RESEARCH HAS BEEN VERY PRODUCTIVE IN THE RECENT PAST. ABOUT 60 SOURCES OF X-RAY EMISSION HAVE BEEN DISCOVERED. REFINED EXPERIMENTS HAVE LOCATED POINT SOURCES WITH SUFFICIENT ACCURACY SO THAT OPTICALLY IDENTIFIABLE OBJECTS,

HITHERTO UNKNOWN, HAVE BEEN LOCATED. IN ADDITION TO THE POINT SOURCES THE GENERAL COSMIC BACKGROUND NEEDS TO BE STUDIED FURTHER BOTH TO UNDERSTAND THE EMISSION MECHANISM AND TO RELATE THESE SOURCES TO FUNDAMENTAL COSMOLOGICAL THEORIES. THE SPECIFIC OBJECTIVES ARE THE DETECTION OF ADDITIONAL SOURCES OF X-RAY EMISSION; MEASUREMENT OF THE BACKGROUND; PRECISE LOCATION OF KNOWN POINT SOURCES; CORRELATION OF OPTICALLY IDENTIFIABLE OBJECTS WITH KNOWN X-RAY EMITTERS; AND CLEAR UNDERSTANDING OF THE EMISSION MECHANISM. THE OBJECTIVES ARE MET BY LABORATORY, FLIGHT (ROCKETS, BALLOONS, AND SPACECRAFT), AND THEORETICAL INVESTIGATIONS. RESEARCH AND DEVELOPMENT OF ADVANCED DETECTORS INCLUDING PROPORTIONAL DETECTORS, SOLID STATE DETECTORS, THOSE WITH LARGE CROSS-SECTIONAL AREA, SHIELDING SYSTEMS, AND FOCUSSING SYSTEMS ARE BEING CONDUCTED. DATA PROCESSING METHODS ARE BEING REFINED.

RTOP NO. 188-41-60 TITLE: STRATOSCOPE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GARDINER, D. TEL. 205-453-3410
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN HIGH RESOLUTION PHOTOGRAPHS OF CELESTIAL OBJECTS FROM ABOVE THE TURBULENCE AND SCATTERING OF THE TERRESTIAL ATMOSPHERE. STRATOSCOPE II HAS THE GOAL OF OBTAINING DIFFRACTION LIMITED PHOTOGRAPHS OF THE PLANETS, GALAXIES AND NEBULAE. THE PROJECT HAS DEVELOPED A COMPLEX, BALLOON-BORNE TELESCOPE; AND AN INTENSIVE ENGINEERING STUDY OF THE BALLOON SYSTEM WAS CONDUCTED. THE INSTRUMENT IS BEING PREPARED FOR A FLIGHT FROM HUNTSVILLE IN AUGUST 1971. AFTER THIS FLIGHT THE INSTRUMENT WILL BE RE-EXAMINED AND THE DAMAGE ASSESSED. PLANS FOR THE NEXT FLIGHT WILL BE BASED ON THE AMOUNT OF REPAIR NECESSARY. THESE PLANS WILL ALSO BE GUIDED BY THE POSSIBILITIES OF MAKING THE PRESENT STRATOSCOPE PROGRAM MORE ECONOMICAL AND THE POSSIBILITIES OF TAILORING THE PROJECT TO A MORE DIRECT RELATION TO THE SHUTTLE PROGRAM AND THE LST.

RTOP NO. 188-41-60 TITLE: STRATOSCOPE
ORGANIZATION: NASA HEADQUARTERS
MONITOR: ROMAN, N. C. TEL. 202-962-2989
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN HIGH RESOLUTION PHOTOGRAPHS OF CELESTIAL OBJECTS FROM ABOVE THE TURBULENCE AND SCATTERING OF THE TERRESTIAL ATMOSPHERE. STRATOSCOPE II HAS THE GOAL OF OBTAINING DIFFRACTION LIMITED PHOTOGRAPHS OF THE PLANETS, GALAXIES AND NEBULAE. THE PROJECT HAS DEVELOPED A COMPLEX, BALLOON-BORNE TELESCOPE; AND AN INTENSIVE ENGINEERING STUDY OF THE BALLOON SYSTEM WAS CONDUCTED. A 36-INCH BALLOON-BORNE TELESCOPE HAS BEEN DESIGNED AND BUILT. THE MIRROR WAS SHOWN TO BE ACCURATE TO BETTER THAN 100 A (0.02 WAVELENGTHS). A PRELIMINARY MODEL WAS DEVOTED TO INFRARED SPECTROSCOPY. THIS FLIGHT PRODUCED SIGNIFICANT RESULTS ON THE STARS AND JUPITER. THE PROJECT WAS CAREFULLY REVIEWED BY DR. J. BOEHM AND A MSFC TEAM IN 1967-1968. THEIR RECOMMENDATIONS LED TO A SUCCESSFUL FLIGHT IN THE SPRING OF 1969. IN PARTICULAR, AN UPPER LIMIT OF FOUR

PARSECS WAS PLACED ON THE NUCLEUS OF A SEYFERT GALAXY. IN A FLIGHT IN MARCH 1970, URANUS WAS SHOWN TO BE ESSENTIALLY FEATURELESS; EXCEEDINGLY HIGH RESOLUTION PHOTOGRAPHS OF JUPITER WERE OBTAINED; IO, A SATELLITE OF JUPITER WAS PHOTOGRAPHED IN A SERIES OF PICTURES AS IT MOVED INTO THE SHADOW OF ITS PLANET. THE INSTRUMENT IS BEING PREPARED AT MSFC FOR ANOTHER FLIGHT IN LATE SUMMER OF 1971.

RTOP NO. 188-45-51 TITLE: COMETS AND ASTEROIDS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: DONN, B. D. TEL. 301-982-5014
TECHNICAL SUMMARY

THE PROGRAMS INCLUDED IN THE RTOP FORM A THREEFOLD STUDY OF INTERPLANETARY AND INTERSTELLAR MATTER. THE PRIMARY OBJECTIVE IS TO PERFORM LABORATORY EXPERIMENTS RELEVANT TO THE BEHAVIOR OF MATTER IN SPACE. A SECOND CLOSELY ASSOCIATED AIM IS THEORETICAL ANALYSES COMBINING EXPERIMENTAL DATA AND ASTRONOMICAL OBSERVATION. THE LAST ASPECT INVOLVES OBSERVATIONS UNIQUE TO THIS PROGRAM AND A STUDY OF TECHNIQUES OF PHOTOGRAPHY AT LOW LIGHT LEVELS. USING MOLECULAR BEAM TECHNIQUES, CROSS SECTIONS FOR PRODUCTION FROM COMETARY MOLECULES OF IONS, RADICALS AND METASTABLE MOLECULES WILL BE DETERMINED. DISSOCIATION MECHANISMS INVOLVING PHOTON, PROTON AND ELECTRON IMPACT WILL BE STUDIED. THE OPTICS, SPECTROSCOPY AND CHEMISTRY OF SPECIES APPROPRIATE TO THE STUDY OF INTERSTELLAR MOLECULES AND GRAINS WILL BE INVESTIGATED. PART OF THE RESEARCH WILL EXAMINE THE POSSIBLE RELATIONSHIP OF COMETARY AND INTERSTELLAR MOLECULES TO CHEMICAL EVOLUTION AND THE ORIGIN OF LIFE. IN SUPPORT OF THE OTHER RESEARCH, USES OF IMAGE-INTENSIFIERS TO STUDY COMETS AND INTERPLANETARY DUST, WILL BE INVESTIGATED.

RTOP NO. 188-45-51 TITLE: COMETS AND ASTEROIDS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

INVESTIGATE THE ORIGIN, STRUCTURE AND PHYSICAL NATURE OF COMETS, ASTEROIDS, THE ZODIACAL LIGHT AND GEGENSCHEIN. THE OBJECTIVES INCLUDE: STUDY OF THE COMETS, ASTEROIDS, ZODIACAL LIGHT, AND THE GEGENSCHEIN, IN RELATION TO THE ORIGIN AND EVOLUTION OF THE SOLAR SYSTEM, DETERMINATION OF THE PHYSICAL AND CHEMICAL PROPERTIES OF THE ENSEMBLES OF GASES AND PLASMAS AND MICRO-PARTICLES IN SPACE, DETERMINATION OF DYNAMICAL PROPERTIES OF INTERPLANETARY BODIES IN THE SOLAR ENVIRONMENT, ESPECIALLY THE EVOLUTIONARY PROPERTIES OF COMAS AND TAILS OF COMETS, INVESTIGATIONS OF THE COMPONENT OF THE INTERPLANETARY DUST OF INTERSTELLAR ORIGIN AND ITS PROPERTIES, AND APPLICATION OF THESE INVESTIGATIONS TO INTERPLANETARY MISSIONS INVOLVING COMET AND ASTEROID INTERCEPTS, RENDEZVOUS AND SIMPLE RETURN. ASTRONOMICAL OBSERVATIONS OF THE COMETS, ASTEROIDS, ZODIACAL LIGHT AND GEGENSCHEIN TO DETERMINE THE MORPHOLOGY, SPECTRAL CHARACTERISTICS, POLARIZATION AND EVOLUTIONARY PROPERTIES. THE OBSERVATIONS INVOLVE BOTH GROUND BASED OBSERVATIONS AND OBSERVATIONS FROM AIRCRAFT AND BALLOONS. THE CHEMICAL AND PHYSICAL NATURE OF

ENSEMBLES OF GASES, PLASMAS AND MICRO-PARTICLES IS STUDIED IN THE LABORATORY AND IN SPACE, AND BY RELEASES IN SPACE OF CLOUDS OF GASES, PLASMAS, AND SMALL DUST PARTICLES.

RTOP NO. 188-45-52 TITLE: METEOR PHYSICS - SPECTRAL PATROL
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE: 1. TO MEASURE THE COMPOSITION AND MASS OF METEOROIDS IN THE .0001 TO 1 GRAM MASS RANGE; 2. TO ANALYZE METEOR RADIATION PROCESSES; AND, 3. TO MEASURE FLUXATIONS IN THE METEORID "FLOW FIELD." DETERMINATIONS OF A "TYPICAL METEOROID COMPOSITION" AND OF THE DISTRIBUTION OF DIFFERENT METEOROID COMPOSITIONS WILL BE MADE.

RTOP NO. 188-45-52 TITLE: METEOR ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

THE OBJECTIVES OF THE METEOR ASTRONOMY RESEARCH INCLUDE: DETERMINATION OF THE CHARACTERISTICS, COMPOSITION, POPULATION DISTRIBUTION OF METEOROIDS, STUDY OF THE PHYSICAL REACTIONS OF METEOROIDS IN THE ATMOSPHERE, CONTRIBUTIONS TO THE STRUCTURE OF THE ATMOSPHERE, AND THE ENTRY BALLISTICS OF A BODY INTO A PLANETARY ATMOSPHERE. METEOR ASTRONOMY IS THE OBSERVATIONAL STUDY OF SOLID BODIES AND METEOROIDS IN THE SOLAR SYSTEM FROM THE ACTION DURING THE ENTRY INTO THE EARTH'S ATMOSPHERE. FROM THESE OBSERVATIONS THE METEORS' TRACK, THE VELOCITY, THE SPECTROSCOPIC CHARACTERISTICS, THE ORBITS, THE POPULATION DISTRIBUTION, MASS DISTRIBUTION, STRUCTURE AND COMPOSITION MAY BE DETERMINED. THE OBSERVATIONAL METHODS INCLUDE PHOTOGRAPHIC AND IMAGE INTENSIFIER OBSERVATIONS OF METEORS, INCLUDING USE OF SPECTROGRAPHIC EQUIPMENT AND OBSERVATIONS WITH RADAR AND LASERS. THE RESEARCH ON METEORS IS CONCENTRATED ON THE EXTREMES OF A METEOR MAGNITUDE SCALE, THE VERY BRIGHT METEORS WITH MASSES OF A FEW KILOGRAMS TO TONS, AND THE MINUTE PARTICLES OBSERVED WITH RADAR AND LASER BEAMS. THE OBSERVATIONS OF THE INTERACTIONS OF THE BRIGHT METEORS WITH THE ATMOSPHERE GIVE STRUCTURAL INFORMATION AND COMPOSITION FROM SPECTROSCOPIC OBSERVATION. IN SOME CASES THE BRIGHT METEORS ARE THE SOURCE OF THE RECOVERY OF COSMIC DUST PARTICLES BY SEARCHING THE IMPACT REGION OR BY CAPTURE, USING AIRCRAFT COLLECTION SYSTEMS, SHORTLY AFTER A FIREBALL PASSAGE.

RTOP NO. 188-45-53 TITLE: COSMIC DUST RESEARCH
ORGANIZATION: NASA HEADQUARTERS
MONITOR: DUBIN, M. TEL. 202-962-2847
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS THE UNDERSTANDING OF THE NATURE AND ORIGIN OF CONDENSED MATTER IN THE SOLAR SYSTEM. THIS

COSMIC DUST RESEARCH AREA INVOLVES: DETECTION AND COLLECTION OF MATERIAL OF COSMOLOGICAL SIGNIFICANCE, ANALYSIS OF COSMIC DUST MATERIAL FOR STRUCTURE, COMPOSITION AND ISOTOPE, DISTRIBUTION, AND DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES FOR COLLECTIONS AND ANALYSIS, THE DESIGN OF INSTRUMENTS FOR FLIGHT ON PROBES AND SATELLITES, AND THE DESIGN OF COLLECTION SYSTEMS IS INCLUDED IN THIS RESEARCH. THESE COLLECTION SYSTEMS ARE OFTEN CARRIED ON BALLOON AND AIRCRAFT, WITH AIRCRAFT BEING OF SPECIAL USE IN COLLECTIONS FOLLOWING THE PASSAGE OF A FIREBALL. THE DETAILED ANALYSIS OF THE COMPOSITION IS RELATED TO OBSERVATIONS OF COMETS, ASTEROIDS, METEORS, AND THE COMPOSITION OF SOLAR NEBULA. THE IDENTIFICATION OF THE VOLATILE COMPONENT, THE EXISTENCE OF COMPLEX ORGANIC MOLECULES, AN INTERSTELLAR SIGNATURE, AND ANY CONNECTION TO BIOGENIC EVOLUTION ARE IMPORTANT ELEMENTS OF THE ANALYSIS. THE ANALYSIS INCLUDES THE USE OF ELECTRON AND STEREOSCAN MICROSCOPY X-RAY DIFFRACTION, ISOTOPIC ANALYSIS, AND MINERALOGICAL-PETROGRAPHIC MICROPROBES.

RTOP NO. 188-45-53 TITLE: COSMIC DUST RESEARCH
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: WALTER, L. S. TEL. 301-982-2282
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH WILL BE TO UNDERSTAND THE NATURE AND ORIGIN OF THE CONDENSED MATTER OF THE SOLAR SYSTEM. IN THIS EFFORT, A MULTI-DISCIPLINARY APPROACH WILL BE APPLIED WHICH WILL INVOLVE: A. DETECTION AND COLLECTION OF MATERIAL OF COSMOLOGICAL SIGNIFICANCE 1. ANALYSIS OF MICROMETEOROID FLUX DATA FROM EXPERIMENTS/SUCH AS THAT FLOWN ON THE PIONEER SATELLITE 2. PARTICIPATION IN SEARCHES FOR FRESHLY FALLEN METEORITES DETECTED BY THE PRARIE NETWORK SYSTEM WHICH IS OPERATED BY SAO. B. ANALYSIS OF MATERIAL OF COSMOLOGICAL SIGNIFICANCE WHEN IT IS RETURNED TO THE LABORATORY. 1. MINERALOGICAL/PETROGRAPHIC (INCLUDING MICROPROBE) ANALYSIS. 2. CHEMICAL ANALYSIS (BOTH "WET" AND TRACE ELEMENT ANALYSIS). 3. ISOTOPIC ANALYSIS:

RTOP NO. 188-45-53 TITLE: COSMIC DUST MEASUREMENTS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

TO PERFORM CHEMICAL ANALYSES OF EXTRATERRESTRIAL MATERIAL (INVOLVING MAJOR ELEMENT, TRACE ELEMENT AND ISOTOPIC DETERMINATIONS) ENABLING INTERPRETATION OF THE NATURE AND ORIGIN OF COSMIC DUST AND METEORITES. A LASER MICROPROBE WILL BE USED IN THIS WORK TO EXCITE SPECTRAL EMISSION FROM COSMIC DUST GRAINS AND METEORITE MINERALS AS A MEANS OF STUDYING MAJOR AND TRACE ELEMENT CONTENT. ION MICROPROBE AND ELECTRONPROBE TECHNIQUES WILL ALSO BE APPLIED TO DETERMINE ISOTOPE RATIOS IN AND MAJOR ELEMENT CONTENTS OF EXTRATERRESTRIAL MATERIALS. A DIRECT-READING PROBE (ONE USING PHOTOMULTIPLIER TUBES) HAS NOW BEEN DESIGNED AND BUILT AND HAS PROVEN TO BE A MUCH MORE SENSITIVE AND PRECISE METHOD THAN FILM RECORDING OF ELEMENTAL LINE INTENSITIES. PRE-AMPS, AMPLIFIERS, ANALOG-TO-DIGITAL CONVERTERS AND

SCALERS ARE CURRENTLY BEING PURCHASED AND INTEGRATED, AND A COMPLETED SYSTEM, CAPABLE OF REGISTERING AND PRINTING OUT INTENSITIES OF TEN OR MORE ELEMENTS SIMULTANEOUSLY, IS EXPECTED TO BE IN ROUTINE OPERATION BY DECEMBER 1971.

RTOP NO. 188-46-51 TITLE: LOW ENERGY COSMIC RAYS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO STUDY THE COMPOSITION AND PROPAGATION OF SOLAR AND GALACTIC COSMIC RAYS WITH ENERGIES LESS THAN 10 BEV. 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 ON THE STELLAR PROCESSES WHICH CREATED THE COSMIC RADIATION AND INFORMATION ON THE INTERSTELLAR MATERIAL, THROUGH WHICH THE COSMIC RADIATION HAS PASSED. THE TOTAL ENERGY CONTENT OF THE GALACTIC COSMIC RAY GAS IS HIGH, AND IT IS BELIEVED TO BE A MAJOR FACTOR IN THE STABILITY OF A GALAXY. THE OBSERVATION OF SOLAR COSMIC RAYS PROVIDES INFORMATION ON THE ABUNDANCES OF DIFFERENT ELEMENTS IN THE SUN AND INFORMATION ON THE SOLAR PROCESSES WHICH ACCELERATE THE COSMIC RAY PARTICLES TO THEIR OBSERVED ENERGIES. SIMILARLY, THE MEASUREMENT OF SOLAR NEUTRONS WILL GIVE INFORMATION ON THERMONUCLEAR REACTIONS IN THE SUN AND MECHANISMS RESPONSIBLE FOR ACCELERATING CHARGED PARTICLES IN SOLAR FLARES. IT IS ALSO NECESSARY TO BE ABLE TO ASSESS THE HAZARD OF SOLAR FLARE PARTICLE BURSTS ON ASTRONAUT OPERATIONS AND ON THE OPERATION OF RADIATION-SENSITIVE SPACECRAFT COMPONENTS. THE COSMIC RAY PARTICLES CONSIDERED HERE CAN BE OBSERVED BY SOLID-STATE DETECTORS, SCINTILLATORS, NUCLEAR EMULSIONS AND SIMILAR NUCLEAR DETECTORS. FUNDS PROVIDED HERE ARE UTILIZED TO CONDUCT LABORATORY AND BALLOON TESTS OF NEW INSTRUMENT CONCEPTS AS WELL AS FOR THEORETICAL STUDIES OF COSMIC RAY PHENOMENA.

RTOP NO. 188-46-51 TITLE: LOW ENERGY COSMIC RAYS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MCDONALD, F. B. TEL. 301-982-4801
TECHNICAL SUMMARY

THE TECHNICAL OBJECTIVE OF THIS TASK IS THE DEVELOPMENT OF NEW DETECTOR SYSTEMS TO DETERMINE THE PROPERTIES OF SOLAR AND GALACTIC COSMIC RAYS AND THE ASSOCIATED DEVELOPMENT OF THEORETICAL STUDIES RELATED TO THESE EXPERIMENTS. SPECIFIC GOALS ARE ENUMERATED AS FOLLOWS: (I) THE DEVELOPMENT OF A HIGH RESOLUTION DETECTOR SYSTEM COMBINING SUPERCONDUCTING MAGNETS AND NUCLEAR EMULSIONS TO CONDUCT EXPERIMENTS WHICH WOULD MEASURE THE SEPARATE ABUNDANCE OF THE ISOTOPES OF THE ELEMENTS FROM LI THROUGH C IN COSMIC RADIATION IN THE ENERGY REGION FROM ABOUT 100 TO 400 MEV/NUCLEON. (II) THE DEVELOPMENT OF A LARGE AREA DETECTOR TO OBTAIN THE FIRST MEASUREMENTS OF THE SPECTRA OF HEAVY (Z IS GREATER THAN OR EQUAL TO 3) GALACTIC COSMIC RAYS AT LOW ENERGIES 2 IS LESS THAN OR EQUAL TO EWHICH IS LESS THAN OR EQUAL TO 30 MEV/ NUCLEON. (III) THE DEVELOPMENT OF DETECTORS

TO MEASURE THE TRUE INTENSITY OF COSMIC RAYS IN INTERSTELLAR SPACE ON DEEP SPACE MISSIONS. (IV) IMPROVED MEASUREMENTS OF THE DIFFERENTIAL INTENSITIES OF _POSITIVE AND NEGATIVE COSMIC RAY ELECTRONS WITH ENERGIES FROM 20 MEV TO 20 GEV. DETECTORS WILL BE DESIGNED, CONSTRUCTED, AND TESTED IN OUR LABORATORIES. DETECTOR BEHAVIOR WILL BE EXPLORED USING PARTICLE ACCELERATOR BEAMS AND OTHER DEVICES. BALLOON FLIGHTS WILL BE CARRIED _OUT BOTH FOR THE PURPOSE OF DETECTOR DEVELOPMENT AND OBTAINING NEW SCIENTIFIC INFORMATION.

RTOP NO. 188-46-51 TITLE: COSMIC RAY PHYSICS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: KURZ, R. J. TEL. 713-483-5171
TECHNICAL SUMMARY

EXPERIMENTAL RESEARCH ON THE GALACTIC COSMIC RADIATION. OBJECTIVES ARE THE MEASUREMENT OF THE COMPOSITION AND ENERGY DISTRIBUTION OF THE COSMIC RADIATION IN ORDER TO PROVIDE INFORMATION OF ASTROPHYSICAL SIGNIFICANCE WHERE LITTLE EXISTS AT PRESENT. TWO MAJOR SUBPROGRAMS PURSUING DIFFERENT TECHNICAL APPROACHES ARE: THE COSMIC RAY EMULSION-PLASTIC EXPERIMENT (CREPE), AND THE SUPERCONDUCTING MAGNET EMULSICN SPECTROMETER SYSTEM (MESS). MESS IS A HIGH-RESOLUTION STUDY OF THE RIGIDITY _RANGE OF 10 TO THE 10TH POWER TO 10 TO THE 12TH POWER V, AND CREPE IS AN INVESTIGATION OF THE VERY HIGH ATOMIC NUMBER (Z IS GREATER THAN 75) COMPOSITION AT RIGIDITIES ABOVE 2 X 10 TO THE 9TH POWER V. PRESENT EXPERIMENTS ARE PERFORMED ON HIGH-ALTITUDE BALLOON. SPACE FLIGHT EXPERIMENTS WILL BE PROPOSED WHEN SUITABLE FLIGHT OPPORTUNITIES BECOME AVAILABLE.

RTOP NO. 188-46-51 TITLE: LOW ENERGY GALACTIC COSMIC RAYS
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

TO STUDY THE SPACE RADIATION ENVIRONMENT AND INVESTIGATE THE METHODS OF ITS PRODUCTION AND PROPAGATION. THE STUDY WILL INCLUDE THE MEASUREMENT OF THE ABUNDANCE AND ENERGY DISTRIBUTION OF THE INTERMEDIATE MASS COMPONENTS OF GALACTIC COSMIC RAYS WITH ENERGIES LESS THAN ABOUT 150 MEV/NUCLEON, ANALYSIS OF DATA OBTAINED THROUGH SIMILAR MEASUREMENTS, AND EVALUATION OF VARIOUS MODELS THAT TRY TO EXPLAIN THE DATA. TO MEASURE THE LOW ENERGY GALACTIC COMPONENT A CHARGED PARTICLE IDENTIFICATION/ENERGY SPECTROMETER SYSTEM WILL BE DEVELOPED. THE SYSTEM WILL HAVE A HIGH RESOLVING POWER IN MASS AND ENERGY FOR NUCLEI OF INTERMEDIATE MASS. IT WILL EMPLOY A DE/DX COUNTER TELESCOPE AND A TIME-OF-FLIGHT CIRCUITRY. IT WILL BE DESIGNED FOR USE ON SATELLITES OR _SPACE PROBES. GROUND BASED ALPHA AND HEAVIER ION ACCELERATOR FACILITIES WILL BE USED THROUGHOUT THE DEVELOPMENT STAGE. THE SAME FACILITIES WILL BE USED TO CALIBRATE THE INSTRUMENT PRIOR TO FLIGHT EXPERIMENTS.

RTOP NO. 188-46-52 TITLE: HIGH ENERGY COSMIC RADIATION
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: MCDONALD, F. B. TEL. 301-982-4801
TECHNICAL SUMMARY

THE TECHNICAL OBJECTIVE IS TO MEASURE THE ENERGY DISTRIBUTION AND THE CHARGE AND MASS COMPOSITION OF THE SEVERAL COMPONENTS OF THE PRIMARY COSMIC RADIATION HIGH ALTITUDE FROM BALLOONS. THESE COMPONENTS INCLUDE BOTH ELECTRONS AND NUCLEI FROM HYDROGEN TO IRON, LEAD, URANIUM, AND BEYOND. THE RESULTS WILL BE USED IN ASTROPHYSICAL CONSIDERATIONS CONCERNING THE ORIGIN, ACCELERATION, AND PROPAGATION OF COSMIC RADIATION. THE PROPERTIES OF CHARGE MEASURING DEVICES, DIRECTION AND DETECTING DEVICES AND TOTAL IONIZATION SPECTROMETERS WILL BE CALIBRATED ON THE GROUND AND STUDIED AT BALLOON ALTITUDES.

RTOP NO. 188-46-52 TITLE: HIGH ENERGY COSMIC RAYS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO STUDY THE COMPOSITION AND PROPAGATION OF PRIMARY COSMIC RADIATION GREATER THAN 10 BEV IN ENERGY. COSMIC RAYS IN THE ENERGY RANGE PROVIDE INFORMATION ON VERY HIGH ENERGY PROCESSES OCCURRING IN STELLAR REACTIONS. THE ENERGY OF SOME COSMIC RAY PARTICLES PRESENTLY EXCEEDS THE ENERGIES AVAILABLE FROM GROUND-BASED ACCELERATORS. VERY HIGH ENERGY NUCLEAR PARTICLE INTERACTIONS, WHICH CANNOT BE STUDIED IN TERRESTRIAL LABORATORIES, CAN BE STUDIED IN SPACE. THE HIGH ENERGY OF THESE PARTICLES REQUIRES LARGE SOPHISTICATED INSTRUMENTATION TO DEFINE THE CHARACTERISTICS OF THE COSMIC RAY PARTICLE AND TO ANALYZE THE RESULTING INTERACTION. THESE EFFECTS ARE STUDIED WITH INSTRUMENTS SUCH AS IONIZATION SPECTROMETERS, TOTAL ABSORPTION CASCADE DETECTORS AND TRANSITION RADIATION DETECTORS. THE SIZE AND COMPLEXITY OF THESE INSTRUMENTS REQUIRES EXTENSIVE DEVELOPMENT AND BALLOON TESTING PRIOR TO FLIGHT ON A SPACECRAFT.

RTOP NO. 188-46-53 TITLE: HIGH ENERGY ASTROPHYSICS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THIS DESCRIBES THE JPL PART OF A COOPERATIVE PROGRAM WITH UCSD IN X- AND GAMMA-RAY ASTRONOMY. THE OBJECTIVE IS TO OBSERVE LINE SPECTRA IN EXTRA-TERRESTRIAL X-RAY AND GAMMA RAY SOURCES IN THE 0.05 TO 10 MEV ENERGY RANGE. OBSERVATION OF SUCH SOURCES WOULD PROVIDE IMPORTANT INFORMATION ON NUCLEOSYNTHESIS, GALACTIC HISTORY, AND THE NATURE OF COSMIC X-RAY SOURCES. UNDER THIS PROGRAM, GAMMA RAY SENSORS WHICH HAVE BEEN DEVELOPED FOR LUNAR MISSIONS WILL BE ADAPTED TO BALLOON FLIGHT SYSTEMS FOR CARRYING OUT ASTRONOMICAL OBSERVATIONS WHILE SIMULTANEOUSLY STUDYING THEIR PROPERTIES AND PERFORMANCE IN A SPACE-LIKE RADIATION ENVIRONMENT. THE SPECIFIC OBJECTIVE FOR THIS PROGRAM FOR FY'72 IS TO INTEGRATE AN ADVANCED SOLID STATE DETECTOR ARRAY, ITS CESIUM IODIDE SHIELD, PULSE-HEIGHT ANALYZER, AND DATA

HANDLING ELECTRONICS INTO A BALLOON-FLIGHT SYSTEM AND PERFORM A BALLOON FLIGHT IN THE LAST PART OF FY'72, OR FY'73.

RTOP NO. 188-46-53 TITLE: GREATER THAN 10 KEV X-RAY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

SEVERAL X-RAY SOURCES HAVE BEEN IDENTIFIED, WHICH HAVE SPECTRA EXTENDING INTO THE TENS OF KEV ENERGY RANGE. IN ADDITION, A DIFFUSE X-RAY BACKGROUND HAS BEEN IDENTIFIED. THE BACKGROUND IS PREDICTED TO ORIGINATE FROM A COMBINATION OF CONTRIBUTION FROM DISCREET SOURCES AND A CONTRIBUTION FROM THE INTERACTION OF HIGH ENERGY COSMIC RAY ELECTRONS WITH THE 2.7 DEGREES K BACKGROUND RADIATION. THE SPECTRA OF THE _DISCREET SOURCES AND THE SPECTRA AND CELESTIAL DISTRIBUTION OF THE X-RAY BACKGROUND WILL PROVIDE INFORMATION ON STELLAR PROCESSES AS WELL AS ON PHYSICAL PROCESSES IN GALACTIC AND EXTRAGALACTIC SPACE. SOLID-STATE DETECTORS AND LARGE INORGANIC SCINTILLATORS HAVE BEEN USED FOR MEASUREMENTS IN THIS ENERGY REGION. SOLID-STATE DETECTORS GENERALLY MUST BE COOLED AND LARGE SCINTILLATORS ARE RELATIVELY FRAGILE IN THE SPACE AND LAUNCH ENVIRONMENTS. TECHNICAL DEVELOPMENT IS REQUIRED TO PERFECT THESE SENSORS FOR SPACE USE.

RTOP NO. 188-46-54 TITLE: GAMMA RAY ASTRONOMY
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: FICHTEL, C. E. TEL. 301-982-6281
TECHNICAL SUMMARY

THE TECHNICAL OBJECTIVE IS TO DEVELOP THE MOST APPROPRIATE DETECTOR SYSTEMS FOR THE OBSERVATION OF THE ASTROPHYSICAL SOURCES OF VERY ENERGETIC PHOTONS. THE APPROACH HAS BEEN DIVIDED INTO SEVERAL DIFFERENT PARTS. THE FIRST APPROACH TO THE GENERAL PROBLEM OF GAMMA-RAY ASTRONOMY WAS THE DEVELOPMENT OF A LARGE TELESCOPE USING DIGITIZED SPARK CHAMBERS TO BE TESTED ON HIGH ALTITUDE BALLOONS AND THEN FLOWN ON SATELLITES. OTHER APPROACHES TO DETECTOR SYSTEMS ARE NOW BEING PURSUED _BOTH FOR THE HIGH ENERGY GAMMA RAYS AND INTERMEDIATE GAMMA RAY STUDIES. A MEDIUM ENERGY GAMMA RAY DETECTOR IS BEING DESIGNED AND BUILT. _ A UNIQUE FEATURE OF THIS SYSTEM IS ITS HIGH TIME RESOLUTION WHICH WILL PERMIT THE TAGGING OF SEVERAL GAMMA RAYS DURING A SHORT (MICROSECONDS) PULSE AS MIGHT BE EXPECTED FROM A SUPERNOVA OUTBURST. IN ADDITION, A CLOSELY-SPACED MULTI-WIRE PROPORTIONAL COUNTER IS BEING DEVELOPED. ALSO IMPROVEMENTS IN THE SPARK CHAMBER SYSTEMS ARE CONTINUING, _AND METHODS FOR ACCURATE TIMING ARE BEING DEVELOPED FOR A SEARCH FOR DISCRETE SOURCE EMISSION OF GAMMA RAYS AT PULSAR PERIODICITIES. IN ADDITION, A COMPLEMENTARY GROUND-BASED DETECTOR SYSTEM IS BEING CONSTRUCTED AND OPERATED TO SEARCH FOR ATMOSPHERIC FLUORESCENCE WHICH WOULD BE GENERATED BY PHOTON PULSES. THESE PULSES ARE EXPECTED TO RESULT FROM EXTRA-GALACTIC SUPERNOVA, AND THEIR DETECTION WOULD STRONGLY SUGGEST THAT SUPERNOVA ARE THE PRINCIPAL SOURCES OF COSMIC RAY PARTICLES.

RTOP NO. 188-46-54 TITLE: GAMMA-RAY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: OPP, A. G. TEL. 202-962-1987
TECHNICAL SUMMARY

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 CONDENSATION AND INTERACTION OF INTERSTELLAR MATERIAL WITH RADIATION, 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 GIVES INFORMATION ON THE LOCATION OF THE GAMMA-RAY SOURCES. THE HIGH GAMMA-RAY BACKGROUND OF THE EARTH AND THE HIGH ENERGY OF SEVERAL OF THE GAMMA RAYS OF INTEREST REQUIRES SOPHISTICATED INSTRUMENTATION CAPABLE OF ABSORBING HIGH ENERGY PHOTONS WITH SATISFACTORY DIRECTIONALITY AND SHIELDING TO PROTECT AGAINST BACKGROUND AND TO DETERMINE THE DIRECTION OF ARRIVAL OF THE PHOTON. INSTRUMENTATION USED FOR THESE INVESTIGATIONS ARE SPARK CHAMBERS, LARGE INORGANIC SCINTILLATORS AND CERENKOV COUNTERS. THE PRIMARY OBJECTIVE OF THIS TASK IS TO DEVELOP THESE DETECTORS, SUCH THAT UNAMBIGUOUS MEASUREMENTS OF HIGH ENERGY PHOTONS CAN BE MADE IN SPACE.

RTOP NO. 188-78-51 TITLE: ADVANCED TECHNOLOGICAL DEVELOPMENT GENERAL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

IN ORDER TO CARRY OUT MORE SOPHISTICATED SPACEBORNE ASTRONOMICAL AND PHYSICAL OBSERVATIONS IT IS NECESSARY TO IDENTIFY TECHNOLOGICAL REQUIREMENTS AND ESTABLISH SUITABLE RESEARCH AND DEVELOPMENT PROGRAMS TO OVERCOME THESE DEFICIENCIES. ALBEIT NO ONE SPECIFIC TECHNOLOGY IS CONSIDERED, THEY RANGE FROM SPACE PHYSICS TECHNOLOGY TO THERMAL STUDIES ON THE PRIMARY MIRROR OF SOLAR TELESCOPES, TO X-RAY IMAGING AND DETECTION SYSTEMS, TO DIGITIZED ELECTRONIC IMAGING SYSTEMS OF STELLAR PHENOMENA.

RTOP NO. 188-78-57 TITLE: LARGE SPACE TELESCOPE/ATD
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

DEVELOPMENT OF THE LARGE SPACE TELESCOPE IS FUNDAMENTAL TO THE OBJECTIVES OF THE ASTRONOMY RESEARCH PROGRAM. IT IS ESSENTIAL THAT NORMAL INCIDENCE IMAGE FORMING SYSTEMS OPERATING WITH MAXIMUM SPATIAL AND SPECTRAL RESOLUTION IN THE IR, VISIBLE, AND ULTRA VIOLET REGIONS BE EVOLVED. THESE INSTRUMENTS WILL BE REQUIRED TO DETECT AND PRESENT ASTRONOMICAL DATA IN EXTREME FIDELITY. IN ORDER TO ACCOMPLISH THIS IT WILL BE NECESSARY TO DEVELOP A SERIES OF INSTRUMENTS THAT BOTH ACCOMPLISH THEIR SCIENTIFIC OBJECTIVE AND AT THE SAME TIME PROVIDE TECHNOLOGICAL DATA TO PERMIT A BURGEONING CAPABILITY. IN ORDER TO FULLY UTILIZE SUCH ADVANCED TELESCOPES IT WILL BE NECESSARY TO

CONCURRENTLY DEVELOP SUITABLE ELECTRONIC IMAGE SENSING SYSTEMS.

RTOP NO. 188-78-58 TITLE: LARGE SPACE TELESCOPE SYSTEMS STUDIES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

THE LARGE SPACE TELESCOPE (LST) WILL BE A GENERAL PURPOSE, MULTIPLE OBSERVING ASTRONOMICAL INSTRUMENT HAVING BETWEEN A TWO AND THREE-METER PRIMARY MIRROR. A LAUNCH IS PLANNED FOR THE 1977-8 TIME PERIOD WHICH WILL LEAD TO THE ULTIMATE THREE-METER CLASS DIFFRACTION LIMITED TELESCOPE BY THE EARLY 1980'S. THIS MULTIPLE PURPOSE OBSERVING INSTRUMENT WILL MAKE POSSIBLE THE CONTINUOUS COVERAGE OF THE SPECTRUM FROM ABOUT 900 ANGSTROM TO 10 MICRONS IN WHICH IT WILL PROVIDE NOT ONLY IMAGERY BUT SPECTROPHOTOMETRY, AND POLARIZATION MEASUREMENTS. THE LST WILL BE IN EARTH ORBIT AND OPERATED AS A NATIONAL FACILITY. APPROPRIATE COMBINATION OF REDUNDANCY AND MANNED MAINTENANCE THROUGH SPACE STATION AND SHUTTLE OPERATIONS WILL KEEP THE LST IN USE NEARLY CONTINUOUSLY FOR A MINIMUM OF A DECADE. ESTABLISHMENT OF THE LST REPRESENTS A MAJOR STEP FORWARD BOTH IN SCIENTIFIC INVESTIGATIONS AND TECHNOLOGICAL DEVELOPMENT. ITS MULTIPLE SCIENTIFIC CAPABILITIES, HIGHLIGHTING ITS POSSIBLE UNIQUE CONTRIBUTIONS TO COSMOLOGY HAVE BEEN DOCUMENTED BY THE NATIONAL ACADEMY OF SCIENCES, SPACE SCIENCE BOARD COMMITTEE ON THE LARGE SPACE TELESCOPE. THE ASTRONOMY MISSIONS BOARD HAS RECOMMENDED THIS PROJECT AS THE NEXT MAJOR STEP IN SPACEBORNE OPTICAL ASTRONOMY WHICH SHOULD BE TAKEN TO BUILD ON THE INFORMATION AND TECHNOLOGY TO BE ACHIEVED BY THE CURRENTLY APPROVED FLIGHT PROGRAM.

RTOP NO. 188-78-59 TITLE: SORTIE/SKYLAB SYSTEMS & ATD
ORGANIZATION: NASA HEADQUARTERS
MONITOR: AUCREMANNE, M. J. TEL. 202-962-1983
TECHNICAL SUMMARY

THERE WILL BE A GROUP OF FOUR INSTRUMENTS AND THE ASSOCIATED STABILIZED PLATFORM TO CONDUCT SOLAR AND STELLAR OBSERVATIONS FROM THE SPACE SHUTTLE. THESE DEVICES WILL BE ADAPTIONS OF OTHERS BUILT FOR THE ATM, STRATOSCOPE BALLOON, OAO, SAS, ETC. CONSIDERATION IS BEING GIVEN TO A 65 CM PHOTOHELIOGRAPH, A ONE-METER ULTRAVIOLET MANNED ASTRONOMY TELESCOPE (MAST) OR (GEP), A ONE METER IMAGER OF THE STRATOSCOPE TYPE, AND AN IMAGING X-RAY INSTRUMENT. THESE INSTRUMENTS WILL PERMIT MEASUREMENTS OF DYNAMIC PHENOMENA OVER A WIDE SPECTRAL RANGE. THE SORTIE CONCEPT IS PARTICULARLY ADAPTED TO THE SPACE SHUTTLE WITH ITS HIGH RATE OF LAUNCH ALLOWING INVESTIGATIONS OF TARGETS OF OPPORTUNITY, E.G., SOLAR FLARES. PRIMARY EMPHASIS IN FY 1972 WILL BE PLACED UPON THE PLATFORM DESIGN REQUIREMENTS AND SHUTTLE INTERFACES.

RTOP NO. 192-55-61 TITLE: PLANETARY BIOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: YOUNG, R. S. TEL. 202-962-5178
TECHNICAL SUMMARY

CHEMICAL EVOLUTION IS THE LABORATORY STUDY OF THE NON-BIOLOGICAL SYNTHESIS OF BIOLOGICALLY SIGNIFICANT ORGANIC MOLECULES UNDER CONDITIONS PRESUMED TO HAVE EXISTED ON THE PRIMITIVE EARTH OR ANY PRIMITIVE PLANET BEFORE THE EVENT OF LIFE. THE STUDY IS RELEVANT TO UNDERSTANDING THE ORIGIN AND EVOLUTION OF LIFE. EXPERIMENTS RELEVANT TO PREBIOLOGICAL ORGANIC CHEMISTRY CAN IN PRINCIPAL EXPLAIN THE PROCESSES BY WHICH PRIMITIVE CELLS COULD HAVE ORIGINATED ON THEOF EVOLUTIONARY PUZZLES, THE ORIGIN OF LIFE, TAKES ORIGIN OF LIFE, TAKES ON A NEW IMMEDIACY IN LIGHT OF RECENT LABORATORY ADVANCES AND EXPERIMENTS WHICH HAVE A DIFFERENT APPROACH BUT HAVE THE SAME COMMON DENOMINATOR, I.E., PATHWAYS BY WHICH BIOLOGICALLY SIGNIFICANT MOLECULES AROSE PRIOR TO LIFE.

RTOP NO. 192-55-62 TITLE: PLANETARY BIOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: YOUNG, R. S. TEL. 202-962-5178
TECHNICAL SUMMARY

ORGANIC GEOCHEMISTRY IS THE STUDY OF ANCIENT TERRESTRIAL ROCKS FOR ORGANIC MOLECULES AND INCLUSIONS OF BIOLOGICAL ORIGIN. THE DEVELOPMENT OF TECHNIQUES FOR THE ISOLATION OF ORGANIC MATTER AND DISTINGUISHING ORGANIC MATTER OF BIOLOGICAL ORIGIN FROM THAT OF NON-BIOLOGICAL ORIGIN. THE APPLICATIONS OF SUCH TECHNOLOGY TO RETURNED EXTRATERRESTRIAL SAMPLES.

RTOP NO. 192-55-63 TITLE: PLANETARY BIOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: YOUNG, R. S. TEL. 202-962-5178
TECHNICAL SUMMARY

THE DEVELOPMENT TECHNIQUES FOR THE DETECTION OF EXTRATERRESTRIAL LIFE AND LIFE RELATED MOLECULES, INCLUDING EVIDENCE OF LIFE, PAST, PRESENT OR FUTURE THROUGH THE SEARCH FOR ORGANIC MOLECULES OF BIOLOGICAL OR NON-BIOLOGICAL ORIGIN, METABOLIC ACTIVITY, GROWTH AND REPRODUCTION, AND VISUAL IDENTIFICATION.

RTOP NO. 192-55-64 TITLE: PLANETARY BIOLOGY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: YOUNG, R. S. TEL. 202-962-5178
TECHNICAL SUMMARY

THE STUDY OF THE ABILITY OF MICROORGANISMS TO SURVIVE AND/OR GROW IN ENVIRONMENTAL EXTREMES APPROACHING THOSE OF THE PLANETARY ENVIRONMENTS, PARTICULARLY IN TERMS OF TEMPERATURE AND PH EXTREMES, WATER AVAILABILITY, AND SALT CONCENTRATIONS. THIS IS RELEVANT TO AN UNDERSTANDING OF BIOLOGICAL PROCESSES IN ENVIRONMENTS VERY DIFFERENT FROM THOSE USUALLY CONSIDERED AS BEING TYPICAL OF THE EARTH.

RTOP NO. 192-55-68 TITLE: SUPPORT ACTIVITIES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: YOUNG, R. S. TEL. 202-962-5178
TECHNICAL SUMMARY

ESTABLISHMENT OF AIBS ADVISORY PANELS FOR OSSA TO PERFORM THE FOLLOWING FUNCTIONS: 1. TO EVALUATE THE SCIENTIFIC MERITS OF RESEARCH PROPOSALS SUBMITTED BY PROGRAM CHIEF (S) OSSA AND ADVISE PROGRAM CHIEF (S) ON THE SCIENTIFIC MERITS OF SAID PROPOSALS. 2. TO PLAN, CONDUCT AND COORDINATE MEETINGS OF THE PANELS, PROVIDING NECESSARY SECRETARIAL SERVICE, INCLUDING MINUTES OF THE MEETING.

RTOP NO. 193-58-61 TITLE: STERILIZATION TECHNIQUES
ORGANIZATION: NASA HEADQUARTERS
MONITOR: HALL, L. B. TEL. 202-962-8925
TECHNICAL SUMMARY

IT IS NASA'S POLICY TO AVOID CONTAMINATING THE PLANETS WITH VIABLE TERRESTRIAL LIFE AND TO AVOID NEGATION OF LIFE DETECTION EXPERIMENTS BY CONTAMINATION WITH TERRESTRIAL LIFE. THIS CAN BE ACCOMPLISHED BY (1) AVOIDING CONTACT WITH THE PLANET, OR (2) LANDING ONLY SPACE FLIGHT HARDWARE THAT CARRIES NO LIFE ON BOARD. THE RESEARCH WILL RESULT IN STERILIZATION METHODS SPECIFICALLY TAILORED TO THE SPACECRAFT.THE TECHNOLOGY THAT IS BEING DEVELOPED IN THE USE OF DRY-HEAT MAY HAVE LIMITED APPLICATION TO OTHER FIELDS, BUT ALTERNATIVE METHODS BEING DEVELOPED TO SUPPLEMENT DRY-HEAT MAY HAVE WIDESPREAD AND ECONOMICALLY IMPORTANT USES IN THE STERILIZATION OF FOODS, PHARMACEUTICALS, SURGICAL SUPPLIES AND OTHER FIELDS IN WHICH BIOLOGICAL CONTAMINATION CANNOT BE TOLERATED. THE MAJOR APPROACH TO THE STERILIZATION OF SPACECRAFT HAS CENTERED ON DRY-HEAT. OTHER METHODS HAVE BEEN EXAMINED AND FOUND WANTING ON THE BASIS OF RELIABILITY, COST, SAFETY, AND OTHER FACTORS. IN DRY-HEAT HEAVY EMPHASIS HAS BEEN AND WILL CONTINUE TO BE PLACED ON THE DEFINITION OF THE AMOUNT NEEDED TO ACCOMPLISH THE PURPOSE. CONCURRENTLY, A SEARCH IS BEING MADE FOR ACCEPTABLE ALTERNATIVE METHODS OF STERILIZATION THAT MAY BE USED FOR SPECIFIC APPLICATIONS IN WHICH DRY-HEAT IS NOT ACCEPTABLE BECAUSE OF MATERIALS DEGRADATION. INCLUDED IN THIS APPROACH ARE STUDIES OF THE LETHAL EFFECT OF THE SPACE ENVIRONMENT ENCOUNTERED DURING THE PERIOD OF INTERPLANETARY CRUISE.

RTOP NO. 193-58-62 TITLE: MICROBIAL ANALYSIS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: HALL, L. B. TEL. 202-962-8925
TECHNICAL SUMMARY

THE RESEARCH PROGRAM ON MICROBIAL ANALYSIS STEMS PRIMARILY FROM THE NEED TO STERILIZE SPACE FLIGHT HARDWARE BY THE APPLICATION OF SOME FORM OF STRESS TO THE ORGANISMS. SO STRESSED THE ORGANISMS DIE, NOT ALL AT THE SAME TIME, BUT PROGRESSIVELY IN WHAT IS TERMED THE "LOGRITHMIC ORDER OF DEATH". THUS, THE MORE ORGANISMS THAT ARE

PRESENT THE MORE STRESS (USUALLY DRY-HEAT) MUST BE APPLIED. ACTING IN THE OPPOSITE DIRECTION, HOWEVER, IS THE NEED TO KEEP THE STRESS TO THE ESSENTIAL MINIMUM SO THAT HARDWARE RELIABILITY WILL NOT BE DEGRADED. FOR THESE REASONS THE NUMBER AND TYPES OF MICROORGANISMS MUST BE KNOWN IN ORDER THAT THE OPTIMUM STERILIZATION CYCLE MAY BE APPLIED. THE APPLICATIONS OF THIS TECHNOLOGY ARE BEING ANDWILL BE APPLIED LARGELY TO SPACECRAFT BUT THE METHODS WILL ALSO SPILL OVER INTO THE HOSPITAL, FOOD PREPARATION, PHARMACEUTICAL AND SURGICAL SUPPLY FIELDS. THE APPROACH BEING TAKEN INCLUDES THE DEVELOPMENT OF PRECISE METHODS FOR THEREMOVAL, ENUMERATION AND IDENTIFICATION OF ALL THE BACTERIA FROM A REPRESENTATIVE SURFACE, THE RECOVERY OF A REPRESENTATIVE SAMPLE OF THE ORGANISMS THAT ARE BURIED IN SOLIDS, THE PROPAGATION OF BACTERIA IN AEROSOLS AND THE ESTIMATION BY MATHEMATICAL AND COMPUTER TECHNIQUES OF THE TOTAL BIOLOAD ON AND IN A SPACECRAFT. CONCURRENTLY FIELD APPLICATIONS ARE BEING CARRIED OUT TO PROVIDE EXPERIENCE WITH THE TECHNOLOGY AND THE BASE LINE DATA ON MISSIONS THAT HAVE BEEN OR WILL BE LANDED.

RTOP NO. 193-58-62 TITLE: MICROBIAL ANALYSIS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVES OF THE TECHNICAL WORK PACKAGE ARE TO PERFORM ANALYTICAL AND EXPERIMENTAL STUDIES IN THE AREA OF PLANETARY QUARANTINE TO DEVELOP PROBABILITY NUMBERS FOR POTENTIAL CONTAMINATION EVENTS FOR FUTURE MISSIONS. SPECIFICALLY, THESE STUDIES WILL INCLUDE: (1) AN ANALYSIS OF PLANETARY QUARANTINE CONSTRAINTS FOR OUTER MULTIPLANET, JUPITER ORBITER, JUPITER PROBE AND PLANETARY SAMPLE RETURN MISSIONS; (2) STUDIES TO DETERMINE THE AMOUNT OF MICROBIAL BURDEN REDISTRIBUTION ON SPACECRAFT SURFACES FOLLOWING LAUNCH; AND (3) THE EFFECT OF THE NATURAL SPACE ENVIRONMENT ON THE SURVIVAL OF MICROORGANISMS. THESE STUDIES ARE BEING CONDUCTED TO IDENTIFY PLANETARY QUARANTINE CONSTRAINTS FOR FUTURE MISSIONS TO BETTER UNDERSTAND THE REQUIREMENTS AND TO DEVELOP THE PROCEDURES AND METHODOLOGY BY WHICH JPL AND OTHER FLIGHT PROGRAMS CAN RELIABLY SATISFY THESE REQUIREMENTS. EXISTING JPL FACILITIES WILL BE USED TO CONDUCT THESE STUDIES AND A MULTIDISCIPLINED TEAM WILL BE ESTABLISHED TO PERFORM ANALYSIS FOR ADVANCED MISSIONS. THIS TEAM WILL INCLUDE SUPPORT FOR THE DEFINITION OF THE NATURAL SPACE ENVIRONMENTAL PARAMETERS, SPACECRAFT FLIGHT ENVIRONMENTS, MISSION ANALYSIS AND MICROBIOLOGY.

RTOP NO. 193-58-63 TITLE: CONTAMINATION CONTROL
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TECHNICAL WORK PACKAGE IS TO DEVELOP METHODOLOGY AND PROCEDURES FOR THE REDUCTION, ESTIMATION AND PREDICTION OF MICROBIAL BURDEN ON AN ASSEMBLED SPACECRAFT AT THE TIME OF ENCAPSULATION OR TERMINAL STERILIZATION. THIS TECHNOLOGY IS

REQUIRED FOR: 1) DETERMINATION OF THE STERILIZATION PROCESS FOR A PLANETARY LANDER OR PROBE; 2) ESTIMATION OF MICROBIAL BURDEN TO DETERMINE THE PROBABILITY OF CONTAMINATION ASSOCIATED WITH CONTAMINATING EVENTS IDENTIFIED IN THE MISSION PRELAUNCH ANALYSIS; 3) THE REDUCTION OF EXCESSIVE MICROBIAL BURDEN ON SPACECRAFT COMPONENTS FOR THE PURPOSES OF EITHER DECREASING PLANETARY CONTAMINATION PROBABILITIES FOR AN ORBITER OR MINIMIZING THE DURATION OF THE STERILIZATION PROCESS FOR A LANDER. THE WORK WILL PROVIDE MATHEMATICAL TOOLS FOR THE STORAGE, RETRIEVAL, ANALYSIS, ESTIMATION AND PREDICTION OF MICROBIAL BURDEN ON SPACECRAFT AND NEEDED INFORMATION CONCERNING CLEANING TECHNIQUES THAT COULD SIGNIFICANTLY REDUCE MICROBIAL BURDEN ON SPACECRAFT HARDWARE. THIS TECHNICAL WORK PACKAGE CONTAINS A WORK UNIT WHICH PROVIDES DIRECT SUPPORT TO THE NASA HEADQUARTERS PLANETARY QUARANTINE OFFICER UPON HIS REQUEST.

RTOP NO. 193-58-63 TITLE: CONTAMINATION CONTROL
ORGANIZATION: NASA HEADQUARTERS
MONITOR: HALL, L. B. TEL. 202-962-8925
TECHNICAL SUMMARY

THE PROBABILITY OF CONTAMINATING A PLANET BY A FLYBY OR ORBITER SPACECRAFT AND THE DIFFICULTY OF ACHIEVING STERILITY OF A LANDING SPACECRAFT IS RELATED DIRECTLY TO THE AMOUNT OF BIOLOGICAL CONTAMINATION ON THE SPACECRAFT. THEREFORE, THE PROBABILITY OF CONTAMINATING THE PLANET AND THE DIFFICULTY OF STERILIZING A LANDING VEHICLE CAN BE REDUCED BY CONTROLLING THE AMOUNT OF VIABLE CONTAMINATION THAT GETS ON AND IN THE SPACECRAFT DURING MANUFACTURE, CHECK OUT AND LAUNCH. THE CONCEPTS AND PROCEDURES RESULTING FROM THIS EFFORT PROVIDE THE MEASURES USED TO KEEP A SPACECRAFT BIOLOGICALLY CLEAN. THE DISSEMINATION OF THESE BIOLOGICAL CLEANLINESS PROCEDURES IS OF MAJOR IMPORTANCE TO INDUSTRY, PARTICULARLY PHARMACEUTICAL AND SURGICAL SUPPLY INDUSTRIES. IN THE FORMER THE PROCEDURES DEVELOPED FOR CONTAMINATION CONTROL ARE SAVING MILLIONS OF DOLLARS A YEAR BY PREVENTING THE CONTAMINATION OF PRODUCTS. THE TECHNOLOGY IS PARTICULARLY USEFUL IN PREVENTING CONTAMINATION OF TESTS THUS PREVENTING FALSE POSITIVES THAT RESULT IN THE NEEDLESS DESTRUCTION OF LARGE BATCHES OF PRODUCT. THE APPROACH TO THIS PROBLEM CENTERS LARGELY IN THE EVALUATION, DISSEMINATION AND APPLICATION OF ULTRACLEAN TECHNIQUES. BETTER METHODS OF AIR CLEANING AND HANDLING OF SPACE FLIGHT HARDWARE FROM THE PIECE PART LEVEL TO THE COMPLETED SPACECRAFT RESULT IN REDUCED LEVELS OF BIOLOGICAL CONTAMINATION.

RTOP NO. 196-41-51 TITLE: RADIO AND RADAR PLANETARY STUDIES
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: ALEXANDER, J. K. TEL. 301-982-5461
TECHNICAL SUMMARY

THE OBJECTIVE OF THE JUPITER MONITOR PROGRAM IS TO OBTAIN

CONTINUOUS SYNOPTIC OBSERVATIONS OF THE DECAMETER-WAVE RADIO EMISSIONS FROM JUPITER IN ORDER TO FACILITATE RELIABLE STUDIES OF THE MORPHOLOGY OF THE EMISSION PHENOMENON AND ITS RELATION TO DYNAMICAL PROCESSES IN THE JOVIAN MAGNETOSPHERE. TO MEET THIS NEED A WORLD-WIDE NETWORK OF FIVE OBSERVING SITES HAS BEEN ESTABLISHED IN ORDER TO MONITOR JUPITER WITH IDENTICAL INSTRUMENTS AT EACH SITE AND THUS OBTAIN A HOMOGENEOUS BODY OF DATA FOR ANALYSIS. EACH SITE CONSISTS OF A TWO-ELEMENT INTERFEROMETER OPERATING AT 16.7 AND 22.2 MHZ. THESE ARE LOCATED AT GODDARD SPACE FLIGHT CENTER, AT CLARK LAKE OBSERVATORY IN BORREGO SPRINGS, CALIF., AND AT MSFN STATIONS IN KAUAI, HAWAII; CARNARVON, AUSTRALIA; AND GRAND CANARY IS., SPAIN. THE NETWORK IS PROVIDING IMPORTANT DATA ON THE JOVIAN RADIO EMISSIONS THAT CAN NOT BE OBTAINED FROM A SINGLE, ISOLATED OBSERVATORY OR FROM COMBINATION OF DATA FROM VARIOUS DISSIMILAR OBSERVATORIES.

RTOP NO. 196-41-66 TITLE: AIRBORNE PLANETARY ASTRONOMYGROUND-BASED INFRARED ASTRONOMY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS RTOP IS TO PROVIDE HIGH-ALTITUDE PLATFORMS FOR INFRARED OBSERVATIONS OF THE PLANETS. THE EXPERIMENTS WILL BE FLOWN AT ALTITUDES WHICH PUT THEM ABOVE MOST OF THE ATMOSPHERIC WATER VAPOR, WHICH IS THE CHIEF ABSORBER OF INFRARED AND THERMAL STRUCTURE OF THE ATMOSPHERES. THIS GOAL WILL BE ACCOMPLISHED BY THE USE OF A DOUBLE THE EXTENT AND COMPOSITION OF PLANETARY ATMOSPHERES AND THE COMPOSITION OF PLANETARY 0.2 WAVE NUMBERS BETWEEN 7 AND 25 MICRONS. THE INSTRUMENT WILL BE ATTACHED TO THE COUDE FOCUS OF SURFACES. THIS INFORMATION WILL BE OF ASSISTANCE A LARGE GROUND-BASED TELESCOPE. IN THE DESIGN OF MANNED AND UNMANNED SYSTEMS FOR MISSIONS TO THE PLANETS.

RTOP NO. 196-41-67 TITLE: PLANETARY ASTRONOMY AND SUPPORTING LABORATORY STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE ABUNDANCE, TEMPERATURE, AND PRESSURE OF CERTAIN CONSTITUENTS OF PLANETARY ATMOSPHERES CAN BE DETERMINED BY SPECTROSCOPIC OBSERVATIONS FROM GROUND-BASED AND FROM AIRBORNE OBSERVATORIES. SUCH DATA IS NECESSARY FOR THE PREPARATION OF MODEL ATMOSPHERES THAT ARE NEEDED TO EVALUATE THE POSSIBILITIES OF LIFE ON THE PLANETS AND TO DESIGN SYSTEMS FOR EXPLORATORY MISSIONS. THE OBJECTIVE OF THIS WORK IS TO MAKE AIRBORNE AND GROUND BASED OBSERVATIONS OF PLANETARY SPECTRA, TO OBTAIN IN THE LABORATORY THE SPECTROSCOPIC PARAMETERS NEEDED TO ANALYZE THE OBSERVATORY SPECTRA, AND TO DEVELOP THE ANALYTICAL AND COMPUTATIONAL TECHNIQUES NEEDED TO INTERPRET THE SPECTRA IN TERMS OF REAL PLANETARY ATMOSPHERES. THE SPECTROSCOPIC PARAMETERS SUCH AS ABSORPTION AND LINE WIDTHS AND THEIR TEMPERATURE AND PRESSURE DEPENDENCES WILL BE OBTAINED USING LONG PATH GAS CELLS, COOLED GAS CELLS AND HIGH RESOLUTION SPECTROMETERS AND

INTERFEROMETERS OPERATING PRIMARILY IN THE INFRARED.

RTOP NO. 196-41-71 TITLE: GROUND BASED OPTICAL ASTRONOMY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS THE COMPREHENSIVE STUDY OF THE ATMOSPHERES AND SURFACES OF SOLAR SYSTEM BODIES THROUGH GROUND-BASED TELESCOPIC OBSERVATIONS. PRINCIPAL EMPHASIS IN THIS PROGRAM IS DEVOTED TO SPECTROSCOPIC OBSERVATIONS OF MARS, VENUS, JUPITER AND SATURN. ALL AVAILABLE EARTH-BASED TECHNIQUES SHOULD BE USED TO LEARN AS MUCH AS POSSIBLE ABOUT A PLANETARY ATMOSPHERE BEFORE A SPACE MISSION AND ITS COMPLEMENT OF SCIENTIFIC INSTRUMENTS IS PLANNED. DATA ACQUIRED FROM THE EARTH COMPLEMENTS THE TYPE OF INFORMATION NORMALLY ACQUIRED FROM SPACECRAFT. THE PRINCIPAL INSTRUMENT USED IN THIS TASK IS THE HIGH-DISPERSION COUDE FOCUS OF THE TABLE MOUNTAIN OBSERVATORY 24-INCH TELESCOPE. SPECIFIC OBJECTIVES FOR FY 72 INCLUDE REDUCTION AND ANALYSIS OF THE SPECTRA OF SATURN OBTAINED BY NEWBURN IN FY 71 WHICH SHOW LINES OF AMMONIA, REDUCTION AND ANALYSIS OF THE SPECTRA OF VENUS CO2 BANDS OBTAINED BY SCHORN, YOUNG AND YOUNG IN FY 71, CONTINUATION OF THE VENUS CO2 BAND PHASE EFFECT PROGRAM, COMMENCEMENT OF A SPECTROSCOPIC PATROL OF THE AMOUNT AND SEASONAL VARIATION OF WATER VAPOR IN THE MARTIAN ATMOSPHERE, AND OBSERVATION AND ANALYSIS OF THE 6800 A METHANE BAND IN THE SPECTRUM OF JUPITER.

RTOP NO. 196-41-72 TITLE: GROUND-BASED INFRARED ASTRONOMY
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO OBTAIN AND ANALYZE HIGH RESOLUTION SPECTRA OF THE PLANETS AT INFRARED WAVELENGTHS. THE PRINCIPAL INSTRUMENTATION EMPLOYED IS THE MK III CONNES'-TYPE FOURIER SPECTROMETER AT THE 107 INCH TELESCOPE, MCDONALD OBSERVATORY. A FABRY-PEROT INTERFEROMETER SYSTEM FOR USE WITH THE COUDE SPECTROGRAPH AT TABLE MOUNTAIN OBSERVATORY IS ALSO UNDER CONSTRUCTION. DURING FY 72 WE PLAN TO CONTINUE OUR OBSERVING PROGRAMS ON MARS AND VENUS AND COMMENCE A PROGRAM OF OUTER PLANET SPECTROSCOPY, PRIMARILY JUPITER AND SATURN. AS A VITAL ADJUNCT TO THE PLANETARY OBSERVATIONS, WE HAVE ALSO UNDERTAKEN AN INVESTIGATION OF THE SOLAR-TELLURIC SPECTRUM WITH THE SAME SYSTEM CONFIGURATION AS FOR THE PLANETARY SPECTRUM, THE OBJECTIVE BEING THE PUBLICATION OF A NEW ATLAS OF THE INFRARED SOLAR-TELLURIC SPECTRUM AT MUCH HIGHER RESOLUTION THAN HERETOFORE AVAILABLE.

RTOP NO. 196-41-73 TITLE: RADIO AND RADAR PLANETARY STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO CONDUCT A COMPREHENSIVE PROGRAM IN GROUND BASED PLANETARY RADIO ASTRONOMY. SOME SPECIFIC RADAR ASTRONOMY PROGRAMS AND A SYSTEMATIC SURVEY OF RADIO, PHOTOGRAPHIC AND VISUAL OBSERVATIONS OF JUPITER WILL ALSO BE CARRIED OUT UNDER THIS TASK. RADIO ASTRONOMY PROVIDES DATA ON THE PROPERTIES OF THE ATMOSPHERES, SURFACES, AND MAGNETOSPHERES OF THE PLANETS. RADAR ASTRONOMY PROVIDES DATA ON THE PROPERTIES OF THE ATMOSPHERE, SURFACES, AND MECHANICS OF THE BODIES OF THE SOLAR SYSTEM. A MICROWAVE RADIOMETER DEVELOPMENT PROGRAM IS CONDUCTED TO PROVIDE BASIC SUPPORT FOR THE OBSERVATIONAL RADIO ASTRONOMY PROGRAM. THE SUPPORT OBJECTIVES ARE TO DESIGN, CONSTRUCT, TEST AND MAINTAIN ADVANCED MICROWAVE RADIOMETER SYSTEMS FOR USE AT THE TABLE MOUNTAIN, GOLDSTONE, OWENS VALLEY AND OTHER RADIOTELESCOPE FACILITIES. EQUIPMENT USED IN THE COURSE OF THIS TASK INCLUDES THE FACILITIES AND TEST EQUIPMENT OF THE TABLE MOUNTAIN OBSERVATORY AND THE DEEP SPACE NETWORK. THE FACILITIES INCLUDE THE 18-FOOT MILLIMETER WAVE ANTENNA AT TABLE MOUNTAIN, AND THE 30-FOOT, 85-FOOT, AND 210-FOOT ANTENNAS AT THE GOLDSTONE TRACKING STATION. OBSERVATIONS AT OTHER OBSERVATORIES ARE CARRIED OUT AS REQUIRED BY THE SPECIFIC NEEDS OF THE PROGRAM.

RTOP NO. 196-41-74 TITLE: PLANETARY ASTRONOMY--SUPPORTING LABORATORY STUDIES
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: BURCHAM, D. P. TEL. 213-354-3028
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS TO SUPPORT ASTRONOMICAL AND SPACE FLIGHT STUDIES OF PLANETARY ATMOSPHERES BY OBTAINING SPECTRA OF GASES UNDER SUITABLE CONDITIONS. THERE ARE TWO MAIN FUNCTIONS, NAMELY: (1) TO FURNISH QUANTITATIVE BAND OR LINE DATA CHIEFLY AT INFRARED WAVELENGTHS, AND (2) TO PROVIDE DIRECT AID IN VERIFYING IDENTIFICATIONS OF FEATURES OBSERVED IN PLANETARY SPECTRA. THE PRIMARY FACILITY EMPLOYED IN THIS TASK IS THE SPECTROSCOPY LABORATORY WHICH CONTAINS SPECTROMETERS COVERING THE VISIBLE, NEAR AND MIDDLE INFRARED SPECTRAL REGIONS AND ABSORPTION TUBES CAPABLE OF PROVIDING PATH LENGTHS OF UP TO 1 KILOMETER AT PRESSURES UP TO 20 ATMOSPHERES. A FACILITY FOR THE STUDY OF LINE FORMATION IN SCATTERING ATMOSPHERE HAS ALSO BEEN CONSTRUCTED.

RTOP NO. 196-41-80 TITLE: GROUND-BASED OPTICAL PLANETARY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

TO INCREASE OUR KNOWLEDGE OF THE PLANETS AND THEIR SATELLITES THROUGH THE USE OF ASTRONOMICAL OBSERVATIONS MADE WITH TELESCOPES AND OTHER OPTICAL INSTRUMENTS LOCATED AT GROUND-BASED OBSERVATORIES. THE OBSERVATIONS WILL BE MADE THROUGHOUT THE VISIBLE AND INFRARED

PORTIONS OF THE SPECTRUM. REDUCTION, INTERPRETATION, ANALYSIS, AND PUBLICATION OF THE DATA THUS OBTAINED ARE INCLUDED AS PART OF THE OBJECTIVE. THE EXISTING TECHNIQUES OF GROUND-BASED OPTICAL ASTRONOMY INCLUDING, BUT NOT LIMITED TO, DIRECT PHOTOGRAPHY, PHOTOMETRY, SPECTROMETRY, INTERFEROMETRY, AND POLARIMETRY WILL BE APPLIED TO THE DETAILED STUDY OF THE PLANETS AND THEIR SATELLITES. THE OBSERVATIONAL DATA WILL BE REDUCED, ANALYZED AND INTERPRETED IN TERMS OF PLANETARY PROPERTIES USING THE BEST AVAILABLE THEORETICAL AND LABORATORY SUPPORTING DATA OBTAINED UNDER RELATED RTOP'S AND FROM THE PUBLISHED LITERATURE. THE OBSERVATIONS WILL BE CARRIED OUT BY ASTRONOMERS AND ASSOCIATED SCIENTISTS AT UNIVERSITIES, NON-PROFIT ORGANIZATIONS, AND, IN SOME CASES, INDUSTRIALORGANIZATIONS. THEY WILL USE OBSERVATIONAL FACILITIES AT THEIR OWN ORGANIZATIONS AS WELL AS OTHER AVAILABLE FACILITIES WHERE THEY PARTICIPATE AS GUEST OBSERVERS. THE RESEARCH PROGRAM UNDER THIS RTOP COMPLEMENTS SIMILAR PROGRAMS CARRIED OUT AT NASA CENTERS.

RTOP NO. 196-41-81 TITLE: ASTRONOMICAL OPTICAL INSTRUMENT DEVELOPMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DESIGN, DEVELOP, AND CONSTRUCT OPTICAL TELESCOPES AND AUXILIARY INSTRUMENTATION TO BE USED FOR GROUND-BASED ASTRONOMICAL OBSERVATIONS. THE AUXILIARY INSTRUMENTATION INCLUDES SUCH ITEMS AS CAMERAS, PHOTOMETERS, SPECTROMETERS, INTERFEROMETERS. REQUIREMENTS FOR NEW OR ADDITIONAL OPTICAL INSTRUMENTS ARISE FROM SEVERAL SOURCES. UNDER THIS RTOP, OPTICAL INSTRUMENTS WILL BE DESIGNED AND CONSTRUCTED TO FILL THE REQUIREMENTS OF: 1. PROVIDING ADDITIONAL OBSERVING TIME FOR CRITICAL ASTRONOMICAL OBSERVATIONS. 2. PROVIDING AUXILIARY INSTRUMENTATION FOR NEW TELESCOPES. 3. UPGRADING OR MODERNIZING EXISTING FACILITIES AND INSTRUMENTS TO INCREASE THEIR EFFICIENCY.4. MODIFYING AUXILIARY INSTRUMENTS TO INCORPORATE IDEAS FOR MAKING MORE SIGNIFICANT OBSERVATIONS WITH EXISTING TELESCOPES. 5. MAKING MAXIMUM USE FOR ASTRONOMICAL PURPOSES OF INSTRUMENTATION DEVELOPMENTS FROM OTHER SOURCES SUCH AS THE SPACE PROGRAM. THE TELESCOPES AND OTHER INSTRUMENTS WILL BE CONSTRUCTED AT THE UNIVERSITIES OR OTHER NON-NASA ORGANIZATIONS WHO WILL BE THE PRIME USERS. THIS PROGRAM IS CLOSELY COORDINATED WITH SIMILAR PROGRAMS AT NASA CENTERS.

RTOP NO. 196-41-82 TITLE: GROUND-BASED RADIO AND RADAR PLANETARY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

TO DETERMINE PLANETARY PROPERTIES BY OBSERVATIONS FROM GROUND-BASED OBSERVATORIES AT RADIO WAVELENGTHS. BOTH PASSIVE (RADIO) AND ACTIVE (RADAR) OBSERVATIONS WILL BE PERFORMED. THE PROGRAM WILL INCLUDE THE REDUCTION, ANALYSIS, AND INTERPRETATION OF

THE OBSERVATIONS. THE PLANETS WILL BE OBSERVED WITH RADIO TELESCOPES TO STUDY THEIR THERMAL AND NON-THERMAL ENERGY DISTRIBUTIONS AT RADIO WAVELENGTHS. OBSERVATIONS WILL BE MADE AT MANY WAVELENGTHS FROM ONE MILLIMETER TO THE LONG WAVELENGTH ATMOSPHERIC CUTOFF. THE OBSERVATIONS WILL BE CARRIED OUT ON RADIO TELESCOPES LOCATED THROUGHOUT THE COUNTRY BY ASTRONOMERS FROM UNIVERSITIES AND OTHER NON-NASA ORGANIZATIONS. SIMILARLY, PROPERTIES OF PLANETARY SURFACES AND ATMOSPHERES WILL BE STUDIED USING THE TECHNIQUES OF RADAR ASTRONOMY FROM RADAR TELESCOPES INCLUDING THE HAYSTACK AND ARECIBO OBSERVATORIES. THESE PROGRAMS, BOTH RADIO AND RADAR, ARE CLOSELY COORDINATED WITHSIMILAR PROGRAMS AT THE NASA CENTERS AND, IN PARTICULAR, AT THE JET PROPULSION LABORATORY.

RTOP NO. 196-41-83 TITLE: RADIO AND RADAR ASTRONOMY INSTRUMENT DEVELOPMENT
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DESIGN, DEVELOP, AND CONSTRUCT INSTRUMENTS TO BE USED FOR RADIO AND RADAR ASTRONOMY AT UNIVERSITIES AND OTHER NON-NASA ORGANIZATIONS, WITH EMPHASIS ON OBSERVATIONS OF THE PLANETS. THE PROGRAM INCLUDES THE DEVELOPMENT OF AUXILIARY INSTRUMENTATION SUCH AS RADIOMETERS FOR EXISTING RADIO AND RADAR FACILITIES AS WELL AS THE CONSTRUCTION OR MODIFICATION OF MAJOR FACILITIES WHEN REQUIRED. LIMITATIONS ON THE INFORMATION THAT CAN BE OBTAINED ABOUT THE PLANETS AND THEIR SATELLITES IN THE RADIO WAVELENGTH PORTION OF THE SPECTRUM ARE DUE PRIMARILY TO THE LACK OF ADEQUATE INSTRUMENTATION. INSTRUMENTATION SUCH AS RADIOMETERS IS NORMALLY USABLE ONLY OVER A NARROW BAND OF FREQUENCIES SO THAT DIFFERENT INSTRUMENTATION IS REQUIRED FOR EACH DIFFERENT PROGRAM IF OBSERVATIONS ARE TO BE MADE OVER A LARGE RANGE OF FREQUENCIES. THIS REQUIRES A CONTINUING PROGRAM OF INSTRUMENT DEVELOPMENT. ALSO, MANY PROGRAMS OF RADIO AND RADAR ASTRONOMY ARE SEVERELY LIMITED BY THE SIZES AND TYPES OF ANTENNAS PRESENTLY AVAILABLE. PLANETARY RADAR ASTRONOMY SHOWS PROMISE OF GREAT RETURN, BUT IS PRESENTLY LIMITED BY TRANSMITTER POWER AND ANTENNA SIZE. THE MAJOR PROGRAM UNDER THE PRESENT RTOP IS, THEREFORE, THE ADDITION OF A HIGH POWER RADAR CAPABILITY FOR THE ARECIBO OBSERVATORY AT S-BAND. THIS TOTAL PROGRAM, INVOLVING UNIVERSITIES AND OTHER NON-NASA ORGANIZATIONS, IS CLOSELY COORDINATED WITH A SIMILAR PROGRAM INVOLVING NASA CENTERS AND THE JET PROPULSION LABORATORY.

RTOP NO. 196-41-84 TITLE: LABORATORY SUPPORTING STUDIES (ASTRONOMY)
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN LABORATORY DATA REQUIRED FOR THE ANALYSIS AND INTERPRETATION OF PLANETARY OBSERVATIONS MADE FROM THE VICINITY OF THE EARTH. THE DATA OBTAINED WILL BE OF TWO TYPES, FIRST, DETAILED STUDY OF GASES AND OTHER MATERIALS KNOWN TO EXIST ON

A PLANET AND, SECOND, STUDY OF THE PROPERTIES OF MANY POSSIBLE MATERIALS TO TRY TO EXPLAIN UNIDENTIFIED FEATURES DETECTED IN PLANETARY OBSERVATIONS. THE DATA OBTAINED UNDER THIS PROGRAM WILL BE PUBLISHED AS WELL AS BEING USED DIRECTLY IN THE INTERPRETATION OF NEW OBSERVATIONS. THE TECHNICAL PLAN IS TO DETERMINE LABORATORY VALUES OF THE PROPERTIES OF MATERIALS KNOWN OR SUSPECTED TO BE OBSERVED ON THE PLANETS. EXISTING LABORATORY FACILITIES WILL BE USED AS MUCH AS POSSIBLE BUT NEW FACILITIES WILL BE CONSTRUCTED OR EXISTING FACILITIES MODIFIED IF REQUIRED TO CARRY OUT THE PROGRAM. THE MAJOR EMPHASIS OF THE PROGRAM IS, AT PRESENT, IN THE AREA OF SPECTROSCOPY OF GASES KNOWN OR SUSPECTED TO BE CONSTITUENTS OF PLANETARY ATMOSPHERES. SPECTRAL PROPERTIES OF THE GASES AS A FUNCTION OF TEMPERATURE AND PRESSURE ARE STUDIED IN THE VISIBLE AND INFRARED REGIONS OF THE SPECTRUM WITH THE GREATEST EFFORT GOING INTO STUDYING THOSE REGIONS OF THE SPECTRA WHERE PLANETARY OBSERVATIONS ARE FEASIBLE. THIS PROGRAM, BEING CARRIED OUT AT UNIVERSITIES AND OTHER NON-NASA ORGANIZATIONS, IS BEING CLOSELY COORDINATED WITH SIMILAR PROGRAM UNDERWAY AT NASA CENTERS AND THE JET PROPULSION LABORATORY.

RTOP NO. 196-41-85 TITLE: THEORETICAL PLANETARY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

TO PROVIDE THEORETICAL SUPPORT FOR THE PLANETARY ASTRONOMY PROGRAM BY PREDICTING WHAT DATA SHOULD BE OBSERVED AND BY EXPLAINING THE OBSERVATIONAL RESULTS, BOTH PREDICTED AND UNEXPECTED. THE PROGRAM ALSO INVOLVES THE INTEGRATION OF OBSERVATIONAL AND LABORATORY RESULTS FROM MANY SOURCES TO PROVIDE AN EXPLANATION OF PLANETARY PHENOMENA. THUS, THIS PROGRAM PROVIDES AN IMPORTANT LINK BETWEEN THE OBSERVATIONAL AND LABORATORY PROGRAMS AND AN UNDERSTANDING OF THE PLANETS. BASED ON PRIOR KNOWLEDGE OF THE PLANETS AND EXISTING PHYSICAL LAWS, PROGRAMS ARE UNDERTAKEN TO PREDICT THE OBSERVATIONAL DATA ON THE PLANETS. AS AN EXAMPLE, THEORETICAL ATMOSPHERIC SPECTRA ARE GENERATED USING ASSUMED KNOWLEDGE OF THE PLANETARY ATMOSPHERIC CONSTITUENTS, THE SPECTRAL EFFECTS PRODUCED BY A SCATTERING ATMOSPHERE CONTAINING AEROSOLS, AND THE DISPERSION OF THE OBSERVABLE SPECTRA. COMPARISON OF THE OBSERVED SPECTRA WITH THE THEORETICALLY CALCULATED SPECTRA TESTS THE ASSUMPTIONS USED IN THE THEORETICAL CALCULATIONS. ON THE OTHER HAND, THEORETICAL PROGRAMS ARE ALSO UNDERTAKEN IN AN ATTEMPT TO UNDERSTAND UNPREDICTED OBSERVATIONAL RESULTS SUCH AS THE RADIO NOISE STORMS OBSERVED AT LONG RADIO WAVELENGTHS FROM JUPITER. THIS WORK IS BEING CARRIED OUT AT UNIVERSITIES AND OTHER NON-NASA ORGANIZATIONS. IT IS, HOWEVER, CLOSELY COORDINATED WITH SIMILAR PROGRAMS AT NASA CENTERS AND THE JET PROPULSION LABORATORY.

RTOP NO. 196-41-86 TITLE: AIRCRAFT-BASED PLANETARY ASTRONOMY
ORGANIZATION: NASA HEADQUARTERS
MONITOR: BRUNK, W. E. TEL. 202-962-1861
TECHNICAL SUMMARY

TO OBSERVE THE PLANETS AND THEIR SATELLITES USING TELESCOPES AND ASSOCIATED EQUIPMENT MOUNTED ABOARD HIGH ALTITUDE AIRCRAFT. OBSERVATIONS WILL BE MADE PRIMARILY IN THE INFRARED FROM ALTITUDES ABOVE THE TROPOPAUSE WHERE THE INTEGRATED WATER VAPOR CONTENT OF THE REMAINING ATMOSPHERE IS BELOW APPROXIMATELY 10 MICRONS. UNDER THESE CONDITIONS IT IS POSSIBLE TO OBSERVE THROUGHOUT ALMOST THE ENTIRE INFRARED PORTION OF THE SPECTRUM. THIS PROGRAM HAS TWO MAJOR ASPECTS. THE FIRST IS PROVIDING FOR THE OPERATION OF HIGH ALTITUDE AIRCRAFT PROPERLY INSTRUMENTED FOR ASTRONOMICAL OBSERVATIONS. THIS ASPECT OF THE PROGRAM IS PRESENTLY HANDLED UNDER A SEPARATE RTOP THROUGH THE AMES RESEARCH CENTER. THE SECOND ASPECT IS THE DEVELOPMENT AND CARRYING OUT OF SPECIFIC RESEARCH PROGRAMS BY INVESTIGATORS BOTH INSIDE AND OUTSIDE NASA. THIS RTOP COVERS THE SUPPORT OF NON-NASA INVESTIGATORS IN PLANNING AND EXECUTING THE HIGH ALTITUDE OBSERVATIONAL PROGRAM AS WELL AS THE REDUCTION, ANALYSIS, AND INTERPRETATION OF THE OBSERVATIONAL DATA.EMPHASIS DURING THE COMING YEAR WILL BE ON SPECTRAL OBSERVATIONS OF MARS AND FAR INFRARED PHOTOMETRY OF THE OTHER PLANETS. THE PROGRAM CARRIED OUT UNDER THIS RTOP IS CLOSELY COORDINATED WITH THE NASA CENTER RELATED AIRCRAFT FLIGHT PROGRAMS.

OFFICE OF MANNED SPACE FLIGHT

RTOP NO. 908-41-02 TITLE: SPACE STATION - THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GUY, W. W. TEL. 713-483-2351
TECHNICAL SUMMARY

THE OBJECTIVE OF THE PROPOSED EFFORT IS TO DEVELOP AN ADVANCED SPACE RADIATOR CONFIGURATION WHICH IS APPLICABLE FOR A VARIETY OF SPACECRAFTS AND MISSIONS, PROVIDES INCREASED SYSTEM RELIABILITY, MINIMIZES METEOROID PROTECTION REQUIREMENTS, AND IMPROVES HEAT LOAD RANGE CAPABILITY. THE APPROACH WILL INCLUDE AN ANALYTICAL INVESTIGATION AND EXPERIMENTAL VERIFICATION OF CANDIDATE MODULAR HEAT-PIPE RADIATOR PANEL DESIGN CONCEPTS. CANDIDATE PANEL CONCEPTS WILL BE IDENTIFIED FOR BOTH INTEGRAL SKIN AND FLEXIBLE OR RIGID DEPLOYABLE CONFIGURATIONS. WORK INITIATED IN FY 1971 WILL SERVE AS THE TECHNOLOGY BASE FOR THIS EXTENSION ACTIVITY.

RTOP NO. 908-41-07 TITLE: SPACE STATION COMMUNICATIONS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: CHICOINE, E. L. TEL. 713-483-2128
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO PROVIDE THE RF SUBSYSTEMS TECHNICAL GUIDELINES FOR AN INTEGRATED ANTENNA SYSTEM APPROACH AND FUNCTIONAL REQUIREMENTS FOR COMMUNICATIONS DEVELOPMENT AND TECHNOLOGY PROGRAMS BEING UNDERTAKEN FOR SPACE STATION. SPECIFICALLY, THE FOLLOWING OBJECTIVE WILL BE MET: PROVIDE THE OVERALL TECHNICAL GUIDELINES FOR AN INTEGRATED RF AND ANTENNA SUBSYSTEM TO MEET SPACE STATION REQUIREMENTS, MAKING MAXIMUM UTILIZATION OF STATE-OF-THE-ART TECHNOLOGY IN THE COMMUNICATIONS AREA AND CONTINUING DEVELOPMENTS ALREADY IN PROGRESS. THIS WILL RESULT IN RF SUBSYSTEMS PARAMETRIC DATA THAT WILL AID IN ATTAINING BROADER OBJECTIVES AS FOLLOWS: (1) ESTABLISH THE OVERALL COMMUNICATION FUNCTIONAL REQUIREMENTS AND SUBSYSTEM CRITERIA NECESSARY FOR A VIABLE ONBOARD COMMUNICATION SYSTEM FOR AUTONOMOUS OPERATION AND LONG LIFE, (2) PROVIDE CRITERIA FOR ANTENNA DESIGN AND COMMUNICATION LINK PERFORMANCE, (3) OUTLINE TECHNICAL REQUIREMENTS FOR THE SPACE STATION COMMUNICATION SYSTEM TEST BED, COMMUNICATION SUBSYSTEM INTEGRATION, AND AN OVERALL TEST AND EVALUATION PROGRAM (SPACE-GROUND), (4) ESTABLISH ENGINEERING INTERFACE AND COMPATIBILITY CRITERIA FOR THE VARIOUS SPACE STATION COMMUNICATION LINKS WITH: OTHER SPACE VEHICLES; VIA RELAY SATELLITE; OR DIRECT TO GROUND AND (5) PROVIDE CRITERIA FOR INTERFACING COMMUNICATION SUBSYSTEMS WITH OTHER SUBSYSTEMS. PROVIDE COMMUNICATION SYSTEM ANALYSIS AND EVALUATION OF DIGITAL COMMUNICATIONS SYSTEMS DESIGN CONFIGURATION AND FUNCTIONAL REQUIREMENTS OF THE SPACE STATION. MAXIMIZE THE EFFECTIVENESS OF EXISTING SYSTEMS AND APPLY NEW TECHNOLOGY FOR SOLUTIONS TO SPECIFIC----

RTOP NO. 908-41-10 TITLE: SPACE STATION - GUIDANCE AND NAVIGATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: KENNEDY, R. C. TEL. 713-483-4384
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A TECHNICAL FOUNDATION FOR THE SELECTION AND DEVELOPMENT OF AN ORBITAL NAVIGATION SYSTEM FOR THE SPACE STATION. THE NAVIGATION SYSTEM MUST HAVE PERFORMANCE CAPABILITIES APPROACHING THAT OF THE MSFN GROUND TRACKING NETWORK IN ORDER TO PROPERLY SUPPORT THE SPACE STATION PLANNED SCIENTIFIC EXPERIMENTS PROGRAM. FURTHER, A HIGH DEGREE OF AUTONOMY WILL BE REQUIRED TO REDUCE, OR ELIMINATE, THE NEED FOR GROUND SUPPORT THEREBY PROVIDING A COST EFFECTIVE NAVIGATION CAPABILITY. TO ACHIEVE THIS END THIS TASK WILL EXAMINE THE VARIETY OF POSSIBLE TECHNIQUES WHICH CAN POTENTIALLY MEET THE PERFORMANCE REQUIREMENTS. ERROR ANALYSES WILL BE CONDUCTED AS REQUIRED TO FORM A BASIS FOR PERFORMANCE COMPARISON. SYSTEM MECHANIZATION ANALYSES WILL BE CONDUCTED TO DEVELOP THE HARDWARE AND SOFTWARE ASPECTS OF THE CANDIDATE SYSTEMS INCLUDING LEVELS OF REDUNDANCY AND OPERATING PROCEDURES. COST DATA WILL BE COMPILED AND, TOGETHER WITH THE TECHNICAL TRADE FACTORS DEVELOPED IN THE PERFORMANCE AND SYSTEM ANALYSIS WORK, WILL BE EVALUATED TO SELECT A BEST SYSTEM APPROACH FOR CONTINUING ANALYSIS.

RTOP NO. 908-41-18 TITLE: CHECKOUT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: WELDON, J. W. TEL. 713-483-4065
TECHNICAL SUMMARY

THE PRESENT CONCEPT OF A SPACE STATION/BASE AS A PERMANENT FACILITY (10 YEAR LIFE) IMPLIES SELF-CONTAINED AUTONOMOUS OPERATION. THIS REQUIRES PERFORMING ONBOARD DATA MANAGEMENT AND CHECKOUT FUNCTIONS WHICH ON PRESENT SPACECRAFTS ARE PERFORMED ON THE GROUND. THE DESIGN AND DEVELOPMENT OF THE HARDWARE AND SOFTWARE TO PERFORM THE ONBOARD COMPUTATION, PROCESS CONTROL AND SYSTEM CHECKOUT IS RECOGNIZED AS A CRITICAL TECHNOLOGY AREA. TO ASSURE THE AVAILABILITY OF THIS CRITICAL TECHNOLOGY, AN ONBOARD DATA MANAGEMENT/CHECKOUT SYSTEM WILL BE INTERFACED WITH THE ENVIRONMENTAL THERMAL CONTROL/LIFE SUPPORT SYSTEM. THE OBJECTIVE OF THIS TASK IS THE DEVELOPMENT OF ONBOARD CHECKOUT HARDWARE DEVICES AND SOFTWARE PROGRAMS REQUIRED TO INTERFACE THE SPACE STATION DATA MANAGEMENT SYSTEM BREADBOARD WITH THE ENVIRONMENTAL THERMAL CONTROL/LIFE SUPPORT SYSTEM (ETC/LSS) (RTOP 975-11-06). EMPHASIS WILL BE GIVEN TO PROVIDING AUTOMATED STATUS MONITORING, DIAGNOSTICS, CONTROL AND CHECKOUT OF THE ETC/LSS DURING THE IN-HOUSE OPERATION AND EVALUATION OF THE ETC/LSS. THIS TASK WILL PROVIDE VALIDATION OF THE TECHNIQUES AND CONCEPTS DEVELOPED BY RTOP 125-23-14 AND 125-23-15.

RTOP NO. 908-41-33 TITLE: INFORMATION MANAGEMENT SYSTEM DESIGN FOR FUTURE MISSIONS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: LYON, J. C. TEL. 713-483-2051
TECHNICAL SUMMARY

THE OBJECTIVE OF THE STUDY IN PROGRESS IS TO PROVIDE THE NASA A TOOL FOR EVALUATION OF VARIOUS DESIGN ALTERNATIVES FOR THE EOSS ONBOARD COMPUTER SYSTEM, THE INFORMATION MANAGEMENT SYSTEM (IMS). THE TOOL IS A SIMULATION PROGRAM FOR WHICH DESIGN HAS BEEN COMPLETED (1-71) AND DEVELOPMENT WILL BE COMPLETED UNDER CURRENT FUNDING IN JULY 1971. THE PROGRAM WILL BE EMPLOYED FOR BASIC SPECIFICATIONS OF EQUIPMENT AND SOFTWARE NECESSARY TO PERFORM ALL IMS FUNCTIONS. EXTENSION OF FUNDING INCLUDES THE FOLLOWING TASKS: MAINTENANCE OF THE SIMULATION PROGRAM, MODIFICATIONS NECESSARY TO MAINTAIN COMPATIBILITY WITH MSC REMOTE TERMINAL SYSTEMS, PROGRAM IMPROVEMENTS, AND ANALYSIS BY THE CONTRACTOR OF PROPOSED IMS DESIGN CONFIGURATIONS USING THE SIMULATION PROGRAM.

RTOP NO. 908-41-33 TITLE: ADVANCING THE HAL LANGUAGE TO AN OPERATIONAL STATUS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GARMAN, J. TEL. 713-483-2308
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO PROVIDE A COMPILER LEVEL LANGUAGE THAT WILL AID IN OPERATIONAL SOFTWARE DEVELOPMENT AND SOFTWARE MANAGEMENT FOR NASA SPACE FLIGHT AND GROUND SUPPORT COMPUTER SYSTEMS (E.G. THE SPACE SHUTTLE AVIONICS SYSTEM). TO MEET THIS OBJECTIVE THREE TASKS WILL BE PERFORMED USING THE HAL LANGUAGE (DELIVERED TO NASA UNDER CONTRACT 9-10542) WHICH WILL: 1. MAINTAIN THE HAL COMPILER AND TRAIN USER S IN THE HAL LANGUAGE. 2. EXTEND THE LANGUAGE AND COMPILER CAPABILITIES. 3. DEVELOP A CODE GENERATOR FOR A FLIGHT COMPUTER. MORE SPECIFICALLY, UNDER TASK 2, THE HAL LANGUAGE WILL BE MADE EASILY TRANSFERRABLE FROM ONE COMPUTER TO ANOTHER; CAPABILITY TO INTERFACE WITH OTHER HIGHER ORDER LANGUAGES AND CAPABILITY FOR CODEOPTIMAZATION WILL BE ADDED; MACHINE INDEPENDENT REAL TIME CONTROLS FEATURES WILL BE INCORPORATED AND ADVANCED FEATURES IN STORAGE MANAGEMENT AND I/O METHODOLOGY WILL BE DEVELOPED AND ADDED. IN ADDITION TO THE CONTRACTED EFFORT DESCRIBED ABOVE AN MSC-MANNED EFFORT WILL BE PERFORMED IN ORDER TO DETERMINE THE EFFECTIVENESS OF THE HAL LANGUAGE AS AN OPERATIONAL PROGRAMMING TECHNIQUE IN COMPARISON WITH A CURRENTLY USED ASSEMBLY LANGUAGE.

RTOP NO. 908-42-01 TITLE: STRUCTURES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: ST. LEGER, L. G. TEL. 713-483-2626
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO EXPLORE TWO PROMISING NEW TOOLS OF NONDESTRUCTIVE EVALUATION (NDE), LASER HOLOGRAPHIC INTERFEROMETRY (LHI) AND ACOUSTIC EMISSION (AE), AND TO DEVELOP UNDERSTANDING IN ALL OF THE IMPORTANT ADVANCED TECHNIQUES OF NDE TO

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SUPPORT MSC'S ROLE OF MANAGING THE DEVELOPMENT OF THE SPACE SHUTTLE. HIGH-TEMPERATURE ADHESIVES WILL BE SURVEYED FOR THEIR SUITABILITY AS A BONDING AGENT FOR THE SPACE SHUTTLE EXTERNAL INSULATION SYSTEM. MECHANICAL AND THERMOELASTIC PROPERTIES OF CANDIDATE ADHESIVES WILL BE DETERMINED THROUGHOUT THE RANGE OF DESIGN TEMPERATURES AS WELL AS PROCESSING EFFECTS, THERMAL CYCLING EFFECTS, AND THICKNESS EFFECTS. A SEPARATE PROCUREMENT WILL BE MADE OF AN ANALYTICAL TOOL FOR THE ACCURATE PREDICTION OF BONDLINE STRESSES. PROVIDE STRUCTURAL DESIGN DATA TO ASSESS THE POTENTIAL USE OF BERYLLIUM FOR HOT STRUCTURE ON THE SPACE SHUTTLE. THE APPROACH IS FIRST TO DESIGN TYPICAL OPTIMUM WEIGHT PANELS REPRESENTATIVE OF THE ABOVE-MENTIONED APPLICATIONS FOR THE SPACE SHUTTLE. THE SECOND STEP INVOLVES THE MANUFACTURE AND TESTING OF A FEW OF THESE REPRESENTATIVE PANELS. THE TECHNICAL OBJECTIVE IS TO DEVELOP REUSABLE MECHANICAL FASTENERS FOR USE IN AN ENVIRONMENT OF 1800 DEGREES F, 2000 DEGREES F, 2500 DEGREES F. THE MATERIALS CORRESPONDING TO THESE CUT-OFF TEMPERATURES ARE HAYNES 188, TD-NICR, AND CB, RESPECTIVELY.

RTOP NO. 908-42-02 TITLE: SPACE SHUTTLE THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: SMITH, J. A. TEL. 713-483-3676
TECHNICAL SUMMARY

THE OVERALL VEHICLE THERMAL MANAGEMENT SYSTEMS FOR THE SHUTTLE MUST BE FLEXIBLE AND ADAPTABLE ENOUGH TO ACCOMMODATE CHANGES IN MISSIONS AND CONFIGURATIONS AND MUST EFFICIENTLY UTILIZE AVAILABLE HEAT SOURCES AND SINKS. THE MULTI-MISSION REQUIREMENT FOR THE SHUTTLE PRESENTS PARTICULAR DESIGN PROBLEMS IN THERMAL CONTROL DUE TO: (1) LIFE-CYCLE CONSIDERATIONS, AND (2) THE WIDE RANGE OF REQUIRED OPERATING CONDITIONS VARYING FROM THOSE SIMILAR TO CONVENTIONAL AIRCRAFT, TO SPACECRAFTS SUBJECTED TO BOOST, ORBITAL AND REENTRY THERMAL CONDITIONS. THE OBJECTIVE OF THIS RTOP IS TO DEVELOP CANDIDATE THERMAL CONTROL CONCEPTS WHICH OFFER POTENTIAL SOLUTIONS FOR SHUTTLE DESIGN PROBLEMS AND DEVELOP IMPROVED ANALYTICAL TECHNIQUES FOR MORE EFFECTIVE DESIGN AND EVALUATION. HEAT PIPE THERMAL CONTROL SYSTEMS OFFER THE POTENTIAL FOR LONG LIFE AND TROUBLE FREE HEAT TRANSPORT AND REJECTION AT LOW WEIGHTS FOR SPACE SHUTTLE EQUIPMENT COOLING APPLICATIONS. DESIGN AND TESTING OF PROTOTYPE THERMAL CONTROL SYSTEMS APPLICABLE TO THE UNIQUE SPACE SHUTTLE ENVIRONMENT AND REUSE APPLICATIONS WILL BE PURSUED TO PROVIDE THERMAL CONTROL DESIGN OPTIONS FOR THE SHUTTLE VEHICLE. VEHICLE COMPLEXITY AND USE OF ADVANCED COMPONENTS REQUIRES IMPROVED ANALYTICAL METHODS AND EXTENSIVE VEHICLE LEVEL ANALYSIS FOR DESIGN SUPPORT AND MISSION PLANNING. THE ANALYTICAL TECHNIQUES DEVELOPMENT PROGRAM IS DIRECTED TOWARDS DEVELOPING COMPUTER PROGRAMS FOR USE AS ANALYTICAL TOOLS FOR THE SHUTTLE PROGRAM.

RTOP NO. 908-42-03 TITLE: SPACE SHUTTLE - PROPULSION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: BUCHANAN, M. C. TEL. 713-483-5189
TECHNICAL SUMMARY

MANUFACTURE VARIOUS SEALS FROM MATERIALS WHICH HAVE BEEN SELECTED FROM PREVIOUS DEVELOPMENT CONTRACTS, ALSO FROM PROMISING NEW MATERIALS. IT ALSO SHOULD BE CONSIDERED TO SYNETHESIS ADDITIONAL NEW MATERIAL FOR SEAL TESTING. THESE SEALS WILL BE USED IN STATIC AND DYNAMIC APPLICATIONS IN BOTH LIQUID OXYGEN AND LIQUID HYDROGEN. A SELECTION WILL BE MADE FROM PROMISING NEW MATERIALS FOR USE IN FURTHER TESTING. THESE MATERIALS WILL BE FABRICATED INTO DIFFERENT DESIGNS AND TESTED TO DETERMINE THEIR FUNCTIONAL CHARACTERISTICS.

RTOP NO. 908-42-05 TITLE: SPACE POWER DEVICES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EASTMAN, F. E. TEL. 713-483-3171
TECHNICAL SUMMARY

THE SPACE ELECTRICAL POWER SYSTEM MUST PERFORM IMPORTANT FUNCTIONS, SUCH AS: (1) ACCEPT POWER FROM THE PRIMARY POWER SOURCE AND PROVIDE POWER PROCESSING; (2) DISTRIBUTE THIS POWER FROM THE SOURCE TO THE VARIOUS LOADS THROUGH BUSES, LOAD CENTERS, AND FEEDER CIRCUITS; AND (3) PROVIDE THE REQUIRED CIRCUIT PROTECTION AND CONTROL. THREE CLASSES OF HARDWARE NEEDED FOR PERFORMING THESE FUNCTIONS ARE: (1) POWER PROCESSING EQUIPMENT (CONVERTERS, INVERTERS, VOLTAGE REGULATORS, ETC.); (2) WIRING, CONNECTORS, AND ASSOCIATED EQUIPMENT; AND (3) CIRCUIT CONTROL AND PROTECTION DEVICES (CIRCUIT BREAKERS, FUSES, POWER DISCONNECT, SWITCHES, ETC.). AS DETERMINED FROM AN EVALUATION OF THE SHUTTLE CONSTRAINTS, GUIDELINES, AND REQUIREMENTS, THIS EFFORT INVOLVES TWO SUBTASKS WHICH WILL SUPPORT THE ABOVE SYSTEM FUNCTIONS. THESE TASKS ARE AS FOLLOWS: 01 DYNAMIC LOAD SIMULATOR - THIS DEVELOPMENT WILL ENABLE ELECTRICAL POWER SYSTEM LOADS TO BE SIMULATED TO ALLOW EVALUATION OF REALISTIC TRANSIENT CONDITIONS. THE SYSTEM IS DIVIDED INTO TWO AREAS: (1) DYNAMIC LOAD INTERROGATOR AND (2) DYNAMIC LOAD SIMULATOR. MSC CAN PROVIDE SOME LOAD INTERROGATION AND FUNCTIONAL SUPPORT EQUIPMENT AS AN APPROACH TO REDUCE COST. THE DYNAMIC LOAD SIMULATOR APPROACH INCLUDES A STUDY PHASE, ENGINEERING MODEL PHASE, AND PROTOTYPE/PRODUCTION PHASE. 02 SWITCHING DEVICES (SOLID STATE REMOTE POWER CONTROLLERS) - DEVELOPMENT OF SOLID STATE REMOTE POWER CONTROLLERS IS NEEDED TO MEET THE OPERATIONAL AND UNIQUE ENVIRONMENTAL REQUIREMENTS OF THE SHUTTLE. THE APPROACH INCLUDES A DESIGN STUDY, EVALUATION OF SELECTED COMPONENT DESIGN, AND THE DEVELOPMENT, FABRICATION, AND TESTING OF AN ENGINEERING MODEL.

RTOP NO. 908-42-10 TITLE: SPACE SHUTTLE - GUIDANCE AND NAVIGATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: CHEVERS, E. TEL. 713-483-2851
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO PROVIDE FEASIBLE GN&C SYSTEM DESIGNS AND FUNCTIONAL SOFTWARE ROUTINES (EQUATIONS AND ALGORITHMS)

IN THE AREAS OF SHUTTLE ENTRY NAVIGATION, ENTRY GUIDANCE AND CONTROL, AND IN-ORBIT DELTA-V GUIDANCE. THIS PROGRAM WILL BE A CONTINUATION OF SIMILAR ANALYTICAL ACTIVITIES FUNDED UNDER FY71 PROGRAMS 908-42-08 AND 908-41-10. THE VEHICLE CONFIGURATIONS AS DEVELOPED UNDER THE PHASE B PROGRAM STUDIES WILL BE ANALYZED TO DETERMINE THE GN&C SYSTEM REQUIREMENTS FOR THE ABOVE STATED FLIGHT MODES. THE REQUIREMENTS WILL BE TRANSLATED INTO SYSTEM CONCEPTS AND EQUATION DESIGNS WHICH WILL SATISFY THE MISSION AND VEHICLE REQUIREMENTS FOR THESE FLIGHT MODES. THE OBJECTIVE OF THIS TASK IS TO PROCEED WITH THE FABRICATION OF LABORATORY PROTOTYPES OF A VOTER COMPARATOR SWITCH (VCS) DEVICE. THIS DEVICE, CONCEIVED AND DESIGNED UNDER FY70 908-41-10 AND FY71 908-41-08 PROGRAMS, IS AN ADAPTIVE VOTER ELEMENT WHICH CAN INTERFACE UP TO FOUR COMPUTERS IN A REDUNDANT RECONFIGURABLE SYSTEM. IT IS INTENDED THAT THE FABRICATION USE STATE-OF-THE-ART LARGE SCALE INTEGRATION. THE PROTOTYPE DEVICES WILL BE DELIVERED TO MSC AND INTERFACED WITH CANDIDATE FLIGHT-TYPE COMPUTERS FOR LABORATORY EVALUATION OF VOTING AND RECONFIGURATION OF REDUNDANT SYSTEMS.

RTOP NO. 908-42-18 TITLE: SPACE SHUTTLE - CHECKOUT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MARLOWE, G. D. TEL. 713-483-6196
TECHNICAL SUMMARY

THE INTERDEPENDENCE OF HARDWARE, COMPUTER SYSTEMS AND FUNCTIONAL APPLICATIONS MUST BE RECOGNIZED AS A SIGNIFICANT AREA SINCE ANY ONE MAY INFLUENCE THE DESIGN OF THE OTHER DURING THE DEVELOPMENT PHASES. THIS EFFORT WILL ASSURE EMPHASIS ON CRITICAL COMPUTER SYSTEM CONSIDERATIONS OF CHECKOUT, REDUNDANCY CONTROL, ERROR RECOVERY, VERIFICATION TECHNIQUES, AND DESIGN OF A BASIC DATA MANAGEMENT OPERATING SYSTEM FOR THE SPACE SHUTTLE. THIS EFFORT BUILDS UPON AND INTEGRATES THE FY-70 AND FY-71 TECHNOLOGY ACTIVITIES. THE STUDIES AND RECOMMENDATIONS OF THE FY-70 STUDIES WILL BE UTILIZED IN THE FY-71 TECHNOLOGY DEVELOPMENT OF THE DETAILED EXECUTIVE DESIGN AND PROCEDURES. THE DETAILED SPECIFICATIONS AND PROCEDURES DELIVERED UNDER THE FY-71 EFFORT WILL BE UTILIZED TO SPECIFY, DELIVER AND DOCUMENT A DATA MANAGEMENT OPERATING SYSTEM WHICH WILL BE UTILIZED WITH AN MSC SUBSYSTEM BREADBOARD SYSTEM. THIS SYSTEM WILL INCLUDE A FLIGHT COMPUTER (4 PI), DATA BUS, REDUNDANT POWER DISTRIBUTION SYSTEM, SIMULATED ENVIRONMENTAL CONTROL SYSTEM AND A GENERAL PURPOSE SIMULATION COMPUTER (360/44). THE DEVELOPMENT AND TESTING OF REAL APPLICATIONS BASED UPON PAST TECHNOLOGY EFFORTS IS EXPECTED TO DRIVE CRITICAL PROBLEM AREAS WHICH WOULD NOT OTHERWISE BE UNCOVERED UNTIL LATE IN THE SHUTTLE PROGRAM.

RTOP NO. 908-42-37 TITLE: SPACE SHUTTLE - CRYOGENIC STORAGE SYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: ALLGEIER, R. K. TEL. 713-483-4771
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO CONTINUE A CURRENT EFFORT WHICH WILL COMPARE VARIOUS THERMAL PROTECTION SYSTEMS UTILIZING A 225

FEET CUBED LIQUID OXYGEN TANK AS A TEST BED. THIS VESSEL IS DESIGNED TO OPERATE AT 160 PSI AND EMPLOYS A GLASS-FACED COMPOSITE, HARD OUTER SHELL. PERFORMANCE SHOULD BE EQUAL TO THAT OF THE VERY MUCH SMALLER APOLLO SM CRYOGENIC DEWARS. TESTING OF THE FIRST PHASE THERMAL PROTECTION SYSTEM WILL BE COMPLETE BEFORE FY 72. CURRENTLY, THE SECOND PHASE OF THIS EFFORT EMBODIES AN INITIAL REFURBISHMENT OF THE VESSEL AIMED AT OPTIMIZING A THERMAL PROTECTION SYSTEM WHICH WOULD SATISFY THE SPACE SHUTTLE ORBITAL MANEUVERING SYSTEM 02 TANK REQUIREMENTS. THE THIRD CONTINUATION PHASE, CONSISTING OF A SECOND REFURBISHMENT, WILL BE FURTHER OPTIMIZATION AND COMPARATIVE TESTING. THIS EFFORT WILL CONTINUE A PROGRAM CURRENTLY UNDERWAY FOR THE DEVELOPMENT OF A CRYOGENIC THERMAL TEST ARTICLE TO BE MANUFACTURED AND TESTED IN SUPPORT OF THE SPACE SHUTTLE-ORBITAL MANEUVERING SYSTEM LH2 TANK(S). THE OBJECTIVE IS TO EVALUATE AND COMPARE THERMAL PROTECTION SYSTEMS USING THE LH2 TANK AS A TEST BED. THE PRIMARY OBJECTIVE IS TO MANUFACTURE AND TEST A FULL-SCALE VACUUM JACKET SHELL TO BE USED WITH THE CRYOGENIC HYDROGEN AND OXYGEN INSULATION SYSTEMS FOR THE SPACE SHUTTLE ORBITER. SECONDARY OBJECTIVES WILL BE TO DETERMINE MANUFACTURING COSTS, FINAL VACUUM JACKET WEIGHT, EASE OF FABRICATION, VACUUM MAINTENANCE DURING LOAD AND TEMPERATURE CYCLING FOR 100 SIMULATED FLIGHTS, AND EASE OF REPAIR AND FIELD MAINTENANCE.

RTOP NO. 908-42-38 TITLE: MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: STROUHAL, G. TEL. 713-483-3676
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE THE GENERATION OF DATA FOR PRELIMINARY DESIGN ACTIVITIES AND CONFIRMATION THAT APPROPRIATE PROCEDURES HAVE BEEN SELECTED FOR PROPERTY MEASUREMENTS, NONDESTRUCTIVE TESTING, AND DESIGN. PRELIMINARY DESIGN DATA WILL BE GENERATED FOR TWO CLASSES OF TPS MATERIALS - SURFACE INSULATION AND CARBON/CARBON COMPOSITES. PRELIMINARY PROPERTY AND PERFORMANCE SPECIFICATION WILL BE WRITTEN. THE OBJECTIVE OF THIS TASK IS TO DEVELOP THE ANALYTICAL METHODS NEEDED TO UNDERSTAND AND PREDICT THE THERMAL PERFORMANCE OF THE SPACE SHUTTLE THERMAL PROTECTION SYSTEM. THERMO-CHEMICAL, BOUNDARY-LAYER, AND MATERIAL RESPONSE ANALYSES AND COMPUTER PROGRAMS CURRENTLY IN USE AT MSC WILL BE MODIFIED AND UPDATED, AS REQUIRED, FOR APPLICATION TO THE SHUTTLE CONFIGURATION AND ENVIRONMENT. INVESTIGATION IS REQUIRED TO: PROVIDE AN ADHESIVE SYSTEM THAT WILL PERFORM IN THE 600 TO 700 F RANGE; IS STRAIN COMPATIBLE WITH SURFACE INSULATION UNDER THERMAL AND MECHANICAL CYCLING; HAVE MINIMUM DENSITY; AND HAVE REUSE CAPABILITY FOR 100 SHUTTLE MISSIONS. THIS WORK SHOULD INCLUDE STRUCTURAL ADHESIVES AND COMPOSITE RESINS, AND FLEXIBLE ADHESIVES SUCH AS THE SILICONE RUBBER SEALANTS.

RTOP NO. 908-42-39 TITLE: SPACE SHUTTLE - AEROTHERMODYNAMICS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GONZALEZ, R. G. TEL. 713-483-2237
TECHNICAL SUMMARY

THIS EFFORT IS DESIGNED TO PROVIDE CURRENT STATE-OF-THE-ART TECHNOLOGY STUDIES IN SUPPORT OF THE ENGINEERING DESIGN ANALYSIS ON THE SPACE SHUTTLE VEHICLES. IT INCLUDES ANALYTICAL STUDIES AND EXPERIMENTAL TESTING AS NECESSARY TO ANALYZE VEHICLE AEROTHERMODYNAMIC CHARACTERISTICS AND TO ACCURATELY DEFINE PERFORMANCE CAPABILITIES. DETAILED SIMULATION ANALYSIS OF THE SPACE SHUTTLE PLUME IMPINGEMENT PROXIMITY AERODYNAMICS EFFECTS DURING STAGE SEPARATION WILL BE PERFORMED. STUDIES WILL BE PERFORMED IN DEVELOPING AND IMPROVING THE ANALYSIS TECHNIQUES FOR VEHICLE AERODYNAMIC CONFIGURATION TRADE STUDIES CURRENTLY BEING USED FOR THE SPACE SHUTTLE VEHICLE DESIGN. ANALYTICAL STUDIES AND EXPERIMENTAL TESTING WILL BE PERFORMED TO ANALYZE THE AERODYNAMIC CONTROL EFFECTIVENESS OF THIS VEHICLES.

RTOP NO. 908-42-39 TITLE: AEROTHERMODYNAMICS - INTERFERENCE AEROTHERMODYNAMICS AND SHOCK IMPINGEMENT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GOODRICH, W. D. TEL. 713-483-2326
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS TO OBTAIN PARAMETRIC HEAT TRANSFER, PRESSURE, AND FLOW VISUALIZATION DATA, WHICH REFLECT THE INFLUENCE OF VEHICLE GEOMETRY AND FREE STREAM CONDITIONS ON THE AEROTHERMODYNAMICS ENVIRONMENT ASSOCIATED WITH (1) SEPARATED FLOW, (2) NON-EQUILIBRIUM SHOCK AND BOUNDARY LAYERS, AND (3) BOUNDARY LAYER TRANSITION IN THE SPECTRUM OF APPLICABILITY TO SPACE SHUTTLE CONFIGURATIONS. EXPERIMENTAL PROGRAMS WILL BE PERFORMED WHICH WILL PROVIDE THE DATA NECESSARY TO FULFILL THE TASK OBJECTIVES. PRETEST ANALYSES AND SUBSEQUENT DATA CORRELATION WILL COMPLETE THE OVERALL TASK OBJECTIVES.

RTOP NO. 908-42-42 TITLE: SIMULATION GUIDELINES AND TECHNIQUES FOR MULTIPLEX DATA SYSTEMS FOR SHUTTLE
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: NOLTING, A. G. TEL. 713-483-5121
TECHNICAL SUMMARY

THE GOAL OF THIS RESEARCH AND TECHNOLOGY OPERATING PLAN IS TO PROVIDE A COMPREHENSIVE SET OF AVIONICS SIMULATION REQUIREMENTS FOR AN INTERIM FUNCTIONAL SIMULATION AND THE SHUTTLE MISSION SIMULATOR. EFFORTS WILL BE DIRECTED TOWARD EVALUATING ALTERNATIVES, E.G., SIMULATION TECHNIQUES, SIMULATION COMPUTER COMPLEX CONFIGURATION, AND ESTABLISHING THE REQUIREMENTS FOR THE COMPUTER SYSTEMS AND PROGRAMS FOR THE SHUTTLE MISSION SIMULATOR. THE DATA GENERATED IS REQUIRED EARLY DURING THE SHUTTLE PHASE C EFFORT TO INFLUENCE CREW STATION DESIGN AND FOR _THE EARLY DEVELOPMENT OF SIMULATORS AND SOFTWARE PROGRAMS TO BE USED FOR CREW TRAINING.

RTOP NO. 908-44-13 TITLE: SPACE SYSTEMS - CONTAMINATION IDENTIFICATION, MEASUREMENT AND CONTROL IN SPACE ENVIRONMENT TEST CHAMBERS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: EHLERS, H. K. TEL. 713-483-2254
TECHNICAL SUMMARY

SINCE ENVIRONMENT SIMULATION PLAYS A SIGNIFICANT ROLE IN TODAY'S SPACE PROGRAMS. AS SPACE VEHICLE DESIGNS BECOME MORE COMPLEX AND SPACECRAFT MISSION DURATIONS INCREASE, SPACE SIMULATION FACILITIES ARE FACED WITH MANY STRINGENT CLEANLINESS REQUIREMENTS. A MAJOR CONCERN OF MANY EXPERIMENTORS IS THE MOLECULAR CONTAMINATION OF ULTRASENSITIVE EXPERIMENT COMPONENTS, VIZ. OPTICAL SYSTEMS, THERMAL CONTROL COATINGS, ETC. ALTHOUGH AN EXTENSIVE EFFORT HAS BEEN UNDERTAKEN AT MSC TO MEASURE, IDENTIFY, AND CONTROL CONTAMINANTS IN THE PAST, IT IS NOW NECESSARY TO UPDATE AND ADVANCE THE TECHNOLOGY IN THIS AREA. AN ANALYTICAL STUDY WILL BE PERFORMED TO DEFINE (1) A MATH MODEL OF MOLECULAR FLOW (FLUX) IN CHAMBER A AT MSC, (2) NEW MOLECULAR CONTAMINATION MEASUREMENT TECHNIQUES, AND (3) NEW METHODS OF CHAMBER CONTAMINATION CONTROL AND CLEANUP. "PROOF OF PRINCIPLE" HARDWARE WILL BE FABRICATED (WHERE NECESSARY), TESTED, AND EVALUATED IN THE MSC LABORATORIES. AT THE COMPLETION OF THESE EFFORTS, NEW ANALYTICAL TOOLS, IMPROVED CONTAMINATION MEASUREMENT EQUIPMENT, AND NEW CONTAMINATION CONTROL TECHNIQUES WILL BE AVAILABLE TO INSURE THAT MSC'S SPACE ENVIRONMENT SIMULATION FACILITIES MEET THE MINIMAL CLEANLINESS REQUIREMENTS FOR FUTURE TESTS.

RTOP NO. 908-44-13 TITLE: SPACE SYSTEM - CORONA DETECTION SYSTEM
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: BILLINGSLEY, D. G. TEL. 713-483-4226
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ITEM IS TO DEVELOP A MEASUREMENT DEVICE OR SENSOR/READOUT SYSTEM FOR THE REAL-TIME DETECTION OF CORONA/IONIZATION PHENOMENON IN LARGE SPACE ENVIRONMENT SIMULATION CHAMBERS. THE DESIRED DETECTION SYSTEM SHOULD HAVE SUFFICIENT DIRECTIONAL CAPABILITY TO PERMIT A MULTI-SENSORED SYSTEM TO LOCATE A CORONA CONDITION BY AZIMUTH INTERSECT METHODS, SHOULD PERMIT GROSS DETERMINATION OF CURRENT FLOW DUE TO CORONA PHENOMENA, AND SHOULD PERMIT DETERMINATION OF THE TYPE CORONA CONDITION PRESENT (I.E. "GLOW DISCHARGE," "SPARK DISCHARGE," "ARC", ETC). THE SYSTEM SHOULD NOT REQUIRE ELECTRICAL CONNECTION INTO THE SYSTEMS IN WHICH CORONA PHENOMENA MAY BE ENCOUNTERED. THE ENVISIONED APPROACH TO THIS DEVELOPMENT IS TO DETERMINE THE PHYSICAL CHARACTERISTICS OF CORONA CONDITIONS CAPABLE OF REMOTE SENSING, FABRICATE AND FIELD TEST A BREADBOARD SYSTEM, AND TO SPECIFY THE DESIGN CRITERIA FOR A PROTOTYPE SYSTEM.

RTOP NO. 908-44-31 TITLE: ONBOARD CONSUMABLES MANAGEMENT FUNCTIONAL REQUIREMENTS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: CASSETTI, M. D. TEL. 713-483-4581
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO DEVELOP A FEASIBLE CONCEPT FOR AN ONBOARD CONSUMABLES MANAGEMENT SYSTEM FOR MANNED SPACECRAFT. THIS CONCEPT WILL BE SELECTED FROM A TRADEOFF OF A MATRIX OF CONCEPTS WHICH ARE CONSISTENT WITH THE GOAL OF AUTONOMOUS OPERATIONS. THE SELECTED CONCEPT WILL BE ANALYZED TO DETERMINE THE FUNCTIONAL REQUIREMENTS IMPOSED UPON THE AVIONICS SOFTWARE SYSTEMS, SENSORS AND DISPLAYS, CREW TASKS, AND PREFLIGHT DATA AND PREDICTIONS.

RTOP NO. 908-44-35 TITLE: PROGRAM MANAGEMENT AND SYSTEMS MANAGEMENT TECHNOLOGY TRANSFERENCE
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MOLNAR, W., JR. TEL. 713-483-3918
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEMONSTRATE THE APPLICATION OF PROGRAM MANAGEMENT AND SYSTEMS MANAGEMENT TECHNIQUES DEVELOPED BY NASA/MSC DURING THE PAST MANNED SPACECRAFT PROGRAMS TO THE PROGRAMS OF OTHER CIVIC AGENCIES, SPECIFICALLY THE TEXAS TEKTITE PROGRAM. THE INTENT IS TO MAXIMIZE THE TECHNOLOGY TRANSFER FROM ONE ORGANIZATION TO ANOTHER IN THE AREA OF MANAGEMENT OF LARGE PROGRAMS.

RTOP NO. 908-44-35 TITLE: COST, SCHEDULE, AND TECHNICAL DATA FROM ADVANCED FLIGHT VEHICLES
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MANDELL, H. C. TEL. 713-483-2741
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY IS TO IMPROVE MSC'S CAPABILITY OF DEVELOPING COST AND SCHEDULE ESTIMATES AND RELATIONSHIPS FOR EXISTING AND FUTURE MANNED SPACECRAFT PROGRAMS. BECAUSE OF THE INHERENT DESIGN OF ADVANCED FLIGHT VEHICLES, TECHNICAL PARAMETERS THAT CORRELATE TO COST AND SCHEDULE CAN BE USED AS A BASIS FOR CREDIBLE PARAMETRIC ESTIMATING. THE APPROACH TO BE USED IN THIS STUDY WILL BE THAT OF TASKING VARIOUS MANUFACTURERS OF ADVANCED FLIGHT VEHICLES TO SUPPLY SELECTED DATA IN A FORM WHICH CORRELATES TO STANDARD NASA PROGRAM CONVENTIONS FOR COST, SCHEDULE, AND TECHNICAL PARAMETERS.

RTOP NO. 908-44-35 TITLE: SYSTEMS ENGINEERING - MASS PROPERTIES TECHNOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: PIERCY, N. A. TEL. 713-483-3319
TECHNICAL SUMMARY

TO DEVELOP METHODS AND TECHNIQUES FOR FORECASTING SPACECRAFT MASS PROPERTIES GROWTH AND VARIATIONS AS A FUNCTION OF DESIGN MATURITY.CORRELATION WILL BE MADE TO VEHICLE PARAMETERS, DESIGN

MILESTONES, COST AND SCHEDULE. THE TECHNIQUES WILL BE USED TO PROVIDE CONSISTENT EVALUATIONS FOR IN-HOUSE AND CONTRACTED EFFORTS. INITIAL EFFORTS WILL USE SPACECRAFT GEOMETRY AND PACKAGING FACTORS WITH PROGRAM CORRELATION COMPLETED IN THE FINAL PORTION OF THE STUDY. THIS ALLOWS DEVELOPMENT OF TECHNICAL APPROACHES EARLY AND PROVIDES AFOUNDATION FOR THE MORE EMPERICAL DERIVATIONS FOR THE PROGRAMMATIC CORRELATION.

RTOP NO. 908-44-36 TITLE: MECHANICAL SYSTEMS - SPACECRAFT DOCKING AND WINDOW TECHNOLOGY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: LIVINGSTON, L. E. TEL. 713-483-4966
TECHNICAL SUMMARY

DESIGN AND AID IN DEVELOPMENT OF A DOCKING SYSTEM FOR ADVANCED SPACECRAFT APPLICATION. PERFORM CONCEPT STUDIES, TRADE OFF ANALYSES, DYNAMIC ANALYSES, AND DESIGN ANALYSES, AND DO THE PRELIMINARY DESIGN WORK REQUIRED TO DEFINE THE DOCKING SYSTEM DESIGN AND PERFORMANCE. FABRICATION OF TEST HARDWARE FOR IN-HOUSE TEST AND EVALUATION. PERFORM DESIGN AND FABRICATION OF WINDOW CONCEPTS FOR FUTURE SPACECRAFT APPLICATION. WINDOW DEVELOPMENT WILL ENCOMPASS THOSE PROBLEMS EXPERIENCED IN PRESENT PROGRAMS. THE FABRICATED WINDOWS WILL BE USED AS TEST ARTICLES IN THE DEVELOPMENT PROGRAM WHICH IS TO BE CONDUCTED AT THE MANNED SPACECRAFT CENTER. FINAL RESULTS WILL BE TO DEFINE DESIGN FEASIBILITY AND PERFORMANCE OF THE CONCEPTS.

RTOP NO. 908-44-38 TITLE: SPACE SYSTEMS - MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: DAWN, F. S. TEL. 713-483-4336
TECHNICAL SUMMARY

ADVANCEMENT OF THE STATE-OF-THE-ART TECHNOLOGY TO DEVELOP A FLAME RESISTANT ORGANIC FIBROUS MATERIALS THAT WILL NOT SUPPORT COMBUSTION IN AN OXYGEN ENRICHED ENVIRONMENT. THE MATERIALS DEVELOPED WILL BE SUITABLE FOR THE FUTURE MANNED SPACECRAFT BECAUSE OF ITS DURABILITY, FLEXIBILITY, ABRASION RESISTANCE AND PHYSIOLOGICAL COMPATIBILITY TO SATISFY THE LONG MISSION REQUIREMENT. A NEW COMPOSITION OF HALOGENATED COMPOUNDS WILL BE DEVELOPED AND INCORPORATED INTO AROMATIC POLYMERS WHICH WILL RENDER FIBERS NONFLAMMABLE.

RTOP NO. 908-51-02 TITLE: SPACE STATION THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: VANIMAN, J. L. TEL. 205-453-3821
TECHNICAL SUMMARY

THE TASKS COVERED BY THIS RTOP ARE DIRECTED TOWARD PROVIDING TECHNOLOGICAL SOLUTIONS TO THERMAL CONTROL PROBLEMS INTRODUCED BY NEW SPACECRAFT REQUIREMENTS FOR LONG TERM HIGH RELIABILITY OPERATION IN SPACE FOR PERIODS UP TO TEN YEARS. LONG TERM TESTS OF THERMAL CONTROL SURFACES AND STUDIES OF ACTIVE THERMOELECTRIC SURFACE COATINGS AND

DEPLOYABLE AND ORIENTABLE RADIATORS WILL BE PERFORMED TO PROVIDE RESOLUTION AND CIRCUMVENTION OF LIMITED HEAT REJECTION CAPABILITY IMPOSED BY RADIATION BLOCKAGE OF CONTIGUOUSLY DOCKED MODULES AND BY SURFACE OPTICAL PROPERTY DEGRADATION/CONTAMINATION RESULTING FROM PROLONGED EXPOSURE TO THE SPACE ENVIRONMENT. THERMAL CAPACITOR, LONG LIFE CIRCULATION PUMP, HEAT MANAGEMENT, HEAT PIPE SYSTEM, AND THERMAL CONTACT CONDUCTANCE STUDIES WILL BE PERFORMED TO ASSURE EFFICIENT HIGHLY RELIABLE LONG LIFE THERMAL CONTROL SYSTEM TECHNOLOGY IS AVAILABLE FOR MODULE DESIGN. SCALE MODELING TECHNIQUES WILL BE DEVELOPED FOR MAKING THERMAL VACUUM DESIGN VERIFICATION TESTS OF FULL SYSTEMS PRACTICAL AND ECONOMICAL. PROJECTED TIME TO COMPLETE THE OBJECTIVES OF THIS RTOP IS 6 YEARS. FY 72 RESOURCE GUIDELINE IS 250K. FY 72 DIRECT MAN-YEARS REQUIREMENT IS 3.

RTOP NO. 908-51-04 TITLE: SPACE STATION ATTITUDE CONTROL PROPULSION SYSTEMS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: JONES, L. W. TEL. 205-453-3814
TECHNICAL SUMMARY

THIS PLAN IS TO ESTABLISH THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) DESIGN OPERATIONAL METHODOLOGY AND COMPONENT REQUIREMENTS TO SATISFY THE MANNED SPACE STATION REQUIREMENTS AND DEMONSTRATE THE NECESSARY COMPONENT, SYSTEM AND OPERATIONAL TECHNOLOGY. THIS EFFORT IS NECESSARY TO PROVIDE THE CAPABILITY TO MEET THE LONG DURATION AND LARGE IMPULSE NEEDS OF THE SPACE STATION WITH A MINIMUM OF CREW ACTIVITY FOR REFURBISHMENT AND RESUPPLY. THESE OBJECTIVES WILL BE ACCOMPLISHED BY A LOGICAL SEQUENCE OF REQUIREMENTS DEFINITION AND ANALYSIS, COMPONENT AND SYSTEM DESIGN AND TRADEOFF STUDIES, AND EXPERIMENTAL DEMONSTRATION OF BREADBOARD COMPONENTS AND SYSTEMS. THE ACPS REPAIR, RESUPPLY AND MAINTENANCE CONTRACTS BEGUN IN PREVIOUS FISCAL YEARS HAVE BEEN COMPLETED. THE "EVALUATION OF THE TRASH ROCKET CONCEPT" TASK WILL COMMENCE IN CY-71 AND CONTINUE FOR TEN MONTHS. IT IS A SOLE-SOURCE CONTRACT TO UNITED TECHNOLOGY CENTER, DIVISION OF UNITED AIRCRAFT CORP. WHICH WILL PROVIDE SOME FUNDAMENTAL DATA RELATIVE TO THE POTENTIAL OF THE HYBRID SYSTEM USING TRASH AS THE FUEL.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER - SPACE STATION PART II
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILLER, J. L. TEL. 205-453-4567
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO INVESTIGATE THE NATURE OF CELL TO CELL AND CELL TO SUBSTRATE PROBLEMS KNOWN TO EXIST THROUGH PREVIOUS EXPERIENCE AND TO DEVELOP CELL STACK TECHNOLOGY FOR SPACE STATION APPLICATION WITH HIGHEST RELIABILITY AND LONGEST LIFETIME. PROBLEM AREAS TO BE ADDRESSED SPECIFICALLY INCLUDE INTERCELL CONNECTION TECHNIQUES, BONDING TECHNIQUES AND MATERIALS COMPATIBILITY, HOT SPOT PHENOMENON RELATING TO NON-PRODUCING CELLS, REVERSE LEAKAGE AND AVALANCHE BREAKDOWN, THERMAL MASS EFFECTS OF VARIOUS CELL STACK AND SUBSTRATE DESIGNS. THE OBJECTIVES WILL BE

ACCOMPLISHED THROUGH A COMBINATION OF IN-HOUSE AND CONTRACTED EFFORTS BROKEN DOWN INTO INDIVIDUAL TASKS. IN GENERAL, EACH TASK AREA WILL BE WORKED IN THREE PHASES AS FOLLOWS: (1) ANALYSIS OF THE MATERIALS PROPERTIES RELATING TO THE PROBLEM, (2) DESIGN AND FABRICATION OF CELL STACK MATRIX TEST ARTICLES, AND (3) TEST AND EVALUATION. IT IS INTENDED THAT MAXIMUM COST EFFECTIVENESS BE REALIZED THROUGH APPROPRIATE USE OF MSFC TEST FACILITIES AND EXPERIENCE GAINED ON EARLIER PROGRAMS INCLUDING SKYLAB.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER - SPACE STATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GRAFF, C. B. TEL. 205-453 4560
TECHNICAL SUMMARY

THIS RTOP SETS FORTH A SERIES OF TEST THAT PURSUE TECHNOLOGY DEVELOPMENT AND ESTABLISHES TECHNOLOGY REQUIREMENTS NEEDED TO INTEGRATE NUCLEAR POWER CONVERSION UNIT INTO THE SPACE STATION/SPACE BASE. PERFORMANCE TESTING WILL BE CONDUCTED INHOUSE TO SOLVE INTERFACE REQUIREMENTS AND TO DEVELOP AUTOMATIC CONTROL EQUIPMENT, AUXILIARY POWER EQUIPMENT, ALSO DEVELOP CIRCUITRY AND POWER CONVERSION COMPONENTS AS RELATED TO NUCLEAR POWER. THE TEST RESULTS WILL BE USED TO INFLUENCE THE PROGRAMS FOR THE RESPECTIVE TECHNOLOGIES ADMINISTERED BY MSFC, MSC AND LERC. THIS IS A CONTINUATION OF THE PRESENT PROGRAM. NECESSARY COMPONENTS FOR THE CONSTRUCTION OF THE GAS MANAGEMENT LOOPS AND HEAT REJECTION LOOP HAVE BEEN PURCHASED. THIS PROPOSAL IS FOR THE FUNDING TO COMPLETE THE PURCHASE OF THE TEST SUPPORT EQUIPMENT AND THE SPECIAL INTERFACE EQUIPMENT.

RTOP NO. 908-51-07 TITLE: COMMUNICATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: LOWREY, D. O. TEL. 205-453-1578
TECHNICAL SUMMARY

TO DEVELOP AN ELECTRONICALLY STEERABLE MICROWAVE PHASED ARRAY AT S-BAND CAPABLE OF OPERATING ON THE SPACE STATION AND OTHER SPACE VEHICLES. THE ARRAY WILL PROVIDE A HIGH DATA RATE, TELECOMMUNICATIONS CAPABILITY WITH SIMULTANEOUS OR SEPARATE TRANSMIT, RECEIVE AND TRACKING FUNCTIONS. THE NARROW BEAM, HIGH GAIN SIGNAL WILL AUTOMATICALLY SCAN AND TRACK WITHIN A 120 DEGREE CONE. IT WILL BE CAPABLE OF OPERATING IN EITHER THE RETRODIRECTIVE SELF-FOCUSING OR PROGRAMMED MODE. THE ACTIVE ELECTRONICS MODULES OF THE ARRAY WILL UTILIZE 100 PERCENT MICROWAVE AND DIGITAL INTEGRATED CIRCUITRY, AND MICROCIRCUITRY TECHNIQUES TO ACHIEVE HIGH EFFICIENCY, WIDE BANDWIDTH, LONG OPERATING LIFETIME, SMALL SIZE, AND LIGHT WEIGHT SYSTEM. THE ARRAY WILL CONTAIN ALL THE ELECTRONIC CIRCUITRY AND ANTENNA ELEMENTS IN AN INTEGRAL PACKAGE TO PERFORM THE TRANSMIT, RECEIVE AND BEAMPOINTING CONTROL FUNCTIONS. HIGH REDUNDANCY AND GRACEFUL PERFORMANCE DEGRADATION WILL BE ACHIEVED THROUGH THE USE OF THE INDIVIDUAL ELECTRONIC MODULES, EACH OF WHICH CONTAINS COMPLETE TRANSMIT, RECEIVE AND LOGIC ELECTRONICS THAT ARE FREQUENCY COHERENT WITH A MASTER FREQUENCY CONTROL MODULE. LOW POWER LEVELS GENERATED

BY EACH MODULE ARE RADIATED BY THEIR INDIVIDUAL ASSOCIATED ANTENNA ELEMENT TO FORM THE COMPOSITE RADIATED SIGNAL. TECHNIQUES WILL BE DEVELOPED FOR PRODUCTION OF MICROELECTRONIC CIRCUITRY TO ACHIEVE LOW COST MODULES. EMPIRICAL DESIGN EQUATIONS DEVELOPED FOR THE ACTIVE ELECTRONICALLY STEERED PHASED ARRAY WILL BE MADE AVAILABLE TO AID IN THE DESIGN AND DEVELOPMENT OF ACTIVE ELECTRONICALLY STEERED PHASED ARRAYS AT HIGHER FREQUENCIES.

RTOP NO. 908-51-08 TITLE: STABILIZATION AND CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: SELTZER, S. M. TEL. 205-453-4713
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP BETTER DESIGN TECHNOLOGY SO THAT THE COMPUTER CONFIGURATION FOR THE ON-BOARD DIGITAL CONTROL SYSTEM CAN BE DETERMINED. THIS OBJECTIVE CONSISTS OF: (1) CONTINUING THE DEVELOPMENT OF COMPUTATIONAL PROGRAMS AND TECHNIQUES TO ANALYZE VARIABLE, MULTIRATE AND NONSYNCHRONOUS SAMPLED DATA CONTROL SYSTEMS PERFORMED UNDER CONTRACT NAS8-21377; (2) APPLYING PROMISING NEW TECHNIQUES THAT HAVE BEEN OR ARE NOW BEING DEVELOPED WITHIN THE BODY OF MODERN CONTROL THEORY. AN ADDITIONAL OBJECTIVE IS TO CONTINUE DEVELOPMENT EFFORT ON RELIABLE, LONG-LIFE CMG'S BY ADVANCING THE STATE-OF-THE-ART PAYING PARTICULAR ATTENTION TO "SIGNATURE ANALYSIS". THIS WOULD BE ACCOMPLISHED BY DEVELOPING A BEARING CONDITION DIAGNOSTIC SYSTEM FOR INCORPORATION INTO THE ADVANCED CONTROL MOMENT GYRO.

RTOP NO. 908-51-21 TITLE: MANUFACTURING AND INSPECTION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: HOLLAND, J. G. TEL. 205-453-5085
TECHNICAL SUMMARY

ONE OBJECTIVE FOR THIS EFFORT WILL BE TO PROVIDE TECHNOLOGY BY THE DEVELOPMENT OF METHODS, TECHNIQUES, PROCEDURES, TOOLS AND EQUIPMENT AND TO MAKE THIS TECHNOLOGY AVAILABLE FOR THE FABRICATION, PROCESS INSPECTION, ASSEMBLY, MAINTENANCE, AND SIMULATION TESTING OF SYSTEMS AND COMPONENTS APPLICABLE TO THE SKYLAB, SPACE STATION, SPACE BASE, AND/OR OTHER ADVANCED MANNED MISSIONS. IN-HOUSE WORK WILL CONTINUE TO BE PERFORMED TO ASSURE THE AVAILABILITY OF TECHNOLOGY NECESSARY FOR THE MANUFACTURE AND SIMULATION TESTING OF CRITICAL STRUCTURAL SYSTEMS, SUBSYSTEMS, AND COMPONENTS; AUTOMATION OF WELDING EQUIPMENT; MAINTENANCE; ELECTRONIC CIRCUITRY; ELECTRICAL NETWORK SYSTEMS; ETC. ALSO, THE OBJECTIVES OF THIS EFFORT ARE TO EVOLVE, THROUGH RESEARCH, DEVELOPMENT, AND TECHNOLOGY APPLICATIONS STUDIES, NEW INSPECTION TECHNIQUES REQUIRED FOR EFFECTIVE INSPECTION OF SPACE STATION HARDWARE, STRUCTURES, AND SYSTEMS. IN-PROCESS INSPECTION AND END ITEM INSPECTION TECHNIQUES EMPLOYING NONDESTRUCTIVE TESTING CONCEPTS, PROCESS CONTROL CONCEPTS, AND VISUAL INSPECTION CONCEPTS ARE TO BE STUDIED AND DEVELOPED TO PROVIDE THE TECHNIQUES REQUIRED BY THE PROGRAM. THROUGH STUDIES OF THE STRUCTURES, MATERIALS, SYSTEMS, AND HARDWARE PROPOSED FOR THE PROGRAM, THE INSPECTION REQUIREMENTS AND TECHNIQUES NECESSARY TO ASSURE QUALITY, PER PRESCRIBED DESIGN,

WILL BE IDENTIFIED. THESE REQUIREMENTS WILL BE COMPARED TO EXISTING TECHNIQUES AND, WHERE EXISTING TECHNIQUES ARE FOUND INSUFFICIENT, NEW TECHNIQUES WILL BE DEVELOPED OR FURTHER DEVELOPMENT PERFORMED TO ADVANCE EXISTING TECHNIQUES.

RTOP NO. 908-51-33 TITLE: INFORMATION MANAGEMENT SYSTEMS DATA MANAGEMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: GARRETT, H. TEL. 205-453-4070
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO PERFORM RESEARCH AND DEVELOPMENT OF ADVANCED SPACE COMPUTER HARDWARE, SOFTWARE, AND COMPUTER PERIPHERAL DEVICE TECHNOLOGY. ALSO RESEARCH AND DEVELOPMENT OF COMPUTER/SCIENTIST LANGUAGES AND INTERACTIONS WILL BE PERFORMED. THIS EFFORT WILL LEAD TO THE DEVELOPMENT OF AN ADVANCED SPACE MULTIPROCESSOR, A GENERALIZED SOFTWARE EXECUTIVE, ADVANCED PERIPHERAL DEVICES AND PROGRAMING TECHNIQUES YIELDING HIGH RELIABILITY PROGRAMS. INCLUDED UNDER THIS EFFORT ARE: RESEARCH AND DEVELOPMENT OF ADVANCED SPACE COMPUTERS, MULTIPROCESSORS, AND MULTICOMPUTER SYSTEMS, AND THE ASSOCIATED SOFTWARE; RESEARCH AND DEVELOPMENT OF ADVANCED COMPUTER PERIPHERAL DEVICES SUCH AS DISPLAYS, HISTORY PLOTTERS, KEYBOARDS, HARDCOPY DEVICES WILL BE PERFORMED; RESEARCH AND DEVELOPMENT OF HIGH LEVEL COMPUTER/SCIENTIST LANGUAGES TO FACILITATE MAN-MACHINE INTERACTION. THE RESEARCH AREAS SUPPORT FUTURE INFORMATION MANAGEMENT SYSTEMS AND DATA MANAGEMENT SYSTEMS SUCH AS THOSE ANTICIPATED FOR THE SPACE STATION.

RTOP NO. 908-52-08 TITLE: CONTROL SYSTEM TECHNOLOGY FOR SHUTTLE VEHICLES
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: LOVINGOOD, J. A. TEL. 205-453-0436
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DETERMINE THE BEST (OPTIMUM) CONTROLLER WHICH WILL ADEQUATELY STABILIZE AND CONTROL THE ATTITUDE MOTION OF A SPACE SHUTTLE VEHICLE FOR THE VARIED FLIGHT ENVIRONMENTS: (1) LAUNCH/ATMOSPHERIC FLIGHT, (2) REENTRY FLIGHT, AND (3) LANDING. THE APPROACHES WILL EMPHASIZE AUTOMATIC CONTROL SYSTEMS WITH MAN SERVING AS BACKUP FOR EMERGENCIES. CONSIDERATION WILL BE GIVEN TO IMPLEMENTING THE CONTROL BY CONVENTIONAL, ADAPTIVE, AND/OR OPTIMAL CONTROL TECHNIQUES WITH RELIABILITY AND SIMPLICITY AS THE DESIGN CRITERIA. THE CONTROL SYSTEM INTERFACES WITH THE GUIDANCE AND NAVIGATION FUNCTIONS WILL BE REVIEWED TO ESTABLISH REQUIREMENTS AND COMMONGUIDELINES. THE OBJECTIVE OF THE ANALYSES WILL REQUIRE THE DEVELOPMENT OF FLEXIBLE ANALYSIS TECHNIQUES CAPABLE OF MEETING THE WIDE RANGE OF SHUTTLE VEHICLE MISSIONS THAT ARE UNDER CONSIDERATION. THE RECENT ADVANCES IN APPLYING MODERN CONTROL THEORY TO COMPLEX HIGH ORDER SYSTEMS HAVE CREATED THE OPPORTUNITY TO DEVELOP TECHNIQUES THAT WOULD GREATLY REDUCE THE TIME (BOTH ENGINEERING AND COMPUTER) AND EFFORT NECESSARY TO DESIGN EFFECTIVE CONTROLLERS FOR GIVEN SPACE APPLICATION. IN SOME INSTANCES, WORK HAS BEEN DONE IN FY-71. THESE

CASES ARE SHOWN ON THE PERTINENT MILESTONE SCHEDULES (UNDER "NOTES").

RTOP NO. 908-52-18 TITLE: SHUTTLE SYSTEM STUDIES AND HARDWARE INVESTIGATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: WOJTALIK, F. S. TEL. 205-453-1422
TECHNICAL SUMMARY

THIS WORK WILL PROVIDE TECHNOLOGY FOR DEVELOPING SPACE SHUTTLE VEHICLE (SSV) SYSTEMS REQUIREMENTS AND DESIGNS IN THE AREAS OF EMI SPECIFICATIONS TO ESTABLISH OPERATION AND ACCEPTANCE STANDARDS; DEVELOPMENT OF SOLID-STATE, AUTOMATIC, ELECTROMAGNETIC TEST EQUIPMENT FOR EMC APPLICATIONS; DEVELOPMENT OF APPROACHES AND TECHNIQUES FOR GROUND VERIFICATION OF THE SSV DATA SYSTEM; IMPLEMENTATION OF ONBOARD CHECKOUT AND REDUNDANCY MANAGEMENT FOR THE REDUNDANT IMU SYSTEM; OPTIMUM BRAKING AND ANTI-SKID LANDING; AND DEVELOPMENT OF TECHNOLOGY FOR THE CHECKOUT MONITOR AND ONBOARD/GROUND ELECTRICAL SYSTEMS CONTROL. EMI SPECIFICATIONS REVIEW WILL INCLUDE SSV EQUIPMENT STUDIES, EQUIPMENT TEST DEFINITIONS, AND UPDATING OF PRESENT EMI TEST TECHNIQUES. EMC TEST EQUIPMENT RELIABILITY WILL BE IMPROVED AND PHYSICAL SIZE WILL BE REDUCED, UTILIZING LATEST STATE-OF-THE-ART TECHNIQUES. VERIFICATION OF THE SSV DATA SYSTEM WILL USE EXISTING EQUIPMENT, CORRELATING PROPOSED TEST SPECIFICATIONS TO PROPOSED TEST TECHNIQUES AND MODIFYING EQUIPMENT FOR GREATEST FLEXIBILITY. THE IMU CHECKOUT SYSTEM WILL IMPLEMENT PREVIOUSLY DEVELOPED PLANS FOR HARDWARE AND SOFTWARE. PROPOSED BRAKING AND ANTI-SKID LANDING SYSTEM WILL BE ANALYZED AND SIMULATED BY COMPUTER.

RTOP NO. 908-52-37 TITLE: SPACE SHUTTLE CRYOGENIC TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: WORLUND, A. L. TEL. 205-453-3853
TECHNICAL SUMMARY

THIS PLAN WILL PROVIDE TECHNOLOGY TO PROVIDE CONSISTENT DESIGN CRITERIA AND CONCEPTS FOR EFFICIENT UTILIZATION AND CONTROL OF CRYOGENS ABOARD THE SPACE SHUTTLE VEHICLE. EFFORTS PERFORMED UNDER THIS RTOP WILL ESTABLISH THE DESIGN AND SUBSYSTEM INTEGRATION CRITERIA AND HARDWARE FEASIBILITY NECESSARY TO MINIMIZE PERFORMANCE DEVIATION WITH EXTENDED OPERATIONAL LIFE AND REUSE. THE EFFORTS PERFORMED UNDER THIS RTOP WILL SUSTAIN INVESTIGATIONS OF NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN, AND TESTING. NINE TASKS ARE IDENTIFIED WHICH HAVE THE POTENTIAL TO PROVIDE PROPELLANTS INDEPENDENT OF THE VEHICLE ACCELERATION FIELD, MINIMIZE PROPELLANT BOILOFF LOSSES, INCREASE COMPONENT PERFORMANCE AND LIFE, AND ASSURE MINIMUM CONSTRAINTS WHILE LOADING CRYOGENIC FEEDLINES. SPECIFICALLY, THESE TASK PROVIDE FOR INVESTIGATING ZERO G FLUID RETENTION DEVICES, REUSABILITY OF MULTILAYER INSULATION, LH2 INTERNAL TANK INSULATION, COMPONENT LIFE TEST METHODOLOGY, VACUUM JACKETED DUCTING, SPACE LOX VENT SYSTEM, LONG LIFE VALVE DESIGNS, "ZERO-LEAKAGE" SEALS, AND FEEDLINE GEYSER SUPPRESSION. CONTRACTED EFFORTS ARE PLANNED TO BE COMPLEMENTED BY IN-HOUSE EFFORTS. FY-72 FUNDING PLAN IS 1250K.

RTOP NO. 908-52-39 TITLE: SPACE SHUTTLE AEROTHERMODYNAMICS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: DAHM, W. K. TEL. 205-453-1092
TECHNICAL SUMMARY

THE AEROTHERMODYNAMIC TECHNOLOGY STUDIES WILL DEFINE ADVANCED METHODS AND TECHNIQUES REQUIRED FOR THE STEADY STATE AERODYNAMIC DESIGN AND THE THERMODYNAMIC DESIGN OF SPACE SHUTTLE SYSTEMS. THE EXTENSIVE FLIGHT REGIMES AND EXTREME ATTITUDE RANGES OF THE SHUTTLE, INVOLVE NEW APPROACHES TO MANY AERODYNAMIC DISCIPLINES. THIS RTOP INVOLVES DEVELOPMENT OF CRITERIA AND METHODS WHERE INADEQUATE KNOWLEDGE OR ANALYSIS TOOLS EXIST FOR DEFINING APPROPRIATE AEROTHERMODYNAMIC ENVIRONMENTS OR DESIGN VALUES. KEY TASKS IN AEROTHERMODYNAMICS HAVE BEEN SELECTED THAT REPRESENT CRITICAL AREAS OF SHUTTLE DESIGN. APPROPRIATE EXPERIMENTAL AND ANALYTICAL STUDIES WILL BE FUNDED FOR BOTH PARAMETRIC AND SPECIFIC INVESTIGATIONS DEPENDING UPON THE STATE-OF-THE-ART OF THE PARTICULAR AREA. THE TASK AREAS ARE: 1. EXPERIMENTAL AERODYNAMIC STUDIES 2. ASCENT BASE HEATING 3. POWER-ON BASE PRESSURE 4. AERODYNAMIC HEATING 5. STAGING AERODYNAMICS AND PLUME IMPINGEMENT 6. RCS PLUME AERODYNAMICS 7. UNCERTAINTIES IN THERMODYNAMIC ENVIRONMENT

RTOP NO. 908-52-47 TITLE: UPPER ATMOSPHERE POLLUTION DUE TO SHUTTLE OPERATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: DEVRIES, L. L. TEL. 205-453-3108
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK ARE TO EXAMINE THE POTENTIAL OF SHUTTLE OPERATIONS TO CONTRIBUTE TO UPPER ATMOSPHERIC POLLUTION, BOUND THE PROBLEMS IF ANY OF SIGNIFICANCE ARE FOUND, AND OUTLINE AN INVESTIGATIVE APPROACH IF NECESSARY. THROUGH EXPLORATORY STUDY AND ANALYSIS, POTENTIAL SOURCES OF UPPER ATMOSPHERIC POLLUTION DUE TO SHUTTLE OPERATIONS WILL BE IDENTIFIED AND POSSIBLE APPROACHES FOR ALLEVIATION OF SUCH POLLUTION WILL BE INVESTIGATED. THERE ARE A NUMBER OF POTENTIAL ENVIRONMENTAL EFFECTS WHICH COULD BE CAUSED BY SHUTTLE OPERATIONS, INCLUDING CLOUD FORMATION (ICE CRYSTALS) IN THE STRATOSPHERE, EXCESSIVE STRATOSPHERIC INCREASES IN CARBON DIOXIDE AND WATER VAPOR, CHANGES IN OZONE CONCENTRATION, EXCESSIVE DISPERSION OF PARTICULATE MATTER IN THE STRATOSPHERE, INTRODUCTION OF GASEOUS POLLUTANTS (CARBON MONOXIDE, NITROGEN OXIDES, SULPHER OXIDES, HYDROCARBONS) INTO THE ATMOSPHERE, AND INTRODUCTION OF POLLUTANTS INTO THE AIR IN THE AREA SURROUNDING LAUNCH SITES. THE FIRST PHASE OF THIS PROGRAM WILL BE TO IDENTIFY THE TOTAL QUANTITY AND PHYSICAL AND CHEMICAL PROPERTIES OF THE COMBUSTION PRODUCTS AS A FUNCTION OF ALTITUDE. ESTIMATES WILL BE MADE OF THE LIFE HISTORY OF EACH PRIMARY COMBUSTION BY-PRODUCT AND ANY SECONDARY PRODUCTS FROM THE TIME OF ATMOSPHERIC INJECTION UNTIL THEY ARE DEPOSITED ON THE EARTH'S SURFACE. THE ENVIRONMENTAL EFFECTS OF THIS POLLUTION WILL BE DETERMINED TO IDENTIFY POTENTIAL ENVIRONMENTAL HAZARDS AND TO DETERMINE POSSIBLE APPROACHES FOR ALLEVIATION OF SUCH HAZARDS.IF SIGNIFICANT PROBLEM AREAS ARE IDENTIFIED, AN INVESTIGATIVE PROGRAM WILL BE OUTLINED TO PROVIDE DEFINITIVE ANSWERS TO POSSIBLE ENVIRONMENTAL QUESTIONS.

RTOP NO. 908-52-47 TITLE: SHUTTLE - ENVIRONMENT FOR DESIGN, TEST AND MISSION ANALYSIS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: VAUGHAN, W. W. TEL. 205-453-3106
TECHNICAL SUMMARY

THE SHUTTLE WILL OPERATE IN THE EARTH'S ATMOSPHERE FROM NEAR THE SURFACE OF THE EARTH TO ORBITAL ALTITUDES. INITIAL ESTIMATES OF THE DESIGN CRITERIA HAVE BEEN FORMULATED, COORDINATED WITH MSC AND KSC, AND PUBLISHED AS A LEVEL II SHUTTLE SYSTEM REQUIREMENT FOR PHASE B WORK. CONTRACTORS AND NASA ITERATIONS, TRADE-OFF STUDIES, AND VARIATIONS ON THE DESIGN GUIDELINES HAVE CREATED A CONTINUOUS NEED FOR REDEFINITION AND FORMULATION OF ENVIRONMENTAL INFORMATION AND GUIDELINES IN CONSISTENT ENGINEERING TERMS. ALL ASPECTS OF THE SHUTTLE PROGRAM DEVELOPMENT DEPEND UPON THIS INTERFACE ACTIVITY IN THE NATURAL ENVIRONMENT AREA IN ORDER THAT TIMELY AND PROPER RESPONSE MAY BE MADE TO ALL INQUIRIES. IN MANY CASES THESE INPUTS MUST BE ANTICIPATED BASED ON AVAILABLE SHUTTLE DESIGN TEST AND OPERATIONAL PLANS TO PROVIDE ADEQUATE LEAD TIME TO ACQUIRE THE PROPER DATA. SCIENTIFIC-ENGINEERING TALENTS AT MSFC HAVE ESTABLISHED A RESPONSIVE RELATIONSHIP TO MSFC, MSC, AND KSC PLUS THEIR PRIME SHUTTLE CONTRACTORS ON THIS SUBJECT. THIS INCLUDES PROVIDING CONSISTENT MODELS, TEST SUPPORT PLANNING, OPERATIONAL ANALYSIS, SPECIFIC DESIGN STUDY INTERPRETATIONS AND DEFINITIONS. THIS IS A CONTINUING ENDEAVOR WHICH REQUIRES INHOUSE SCIENTIFIC-ENGINEERING INTERFACE TALENTS SUPPORTED BY PROVISIONS FOR DATA RESOURCE ACQUISITION PLUS SUPPORTING ANALYSIS USING OTHER GOVERNMENT AGENCIES AND CONTRACTOR TALENTS. THIS WORK MUST BE CONTINUED TO AVOID COSTLY ERRORS ON ENVIRONMENT INPUTS TO THE SHUTTLE DEVELOPMENT AS REFLECTED BY ALL OTHER SHUTTLE RELATED RTOP'S, PRIME CONTRACTS, AND INHOUSE NASA EFFORTS.

RTOP NO. 908-53-36 TITLE: TEST OF A LOOPWHEEL SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: MILES, C. G. JR. TEL. 205-453-1120
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO IMPROVE AND ESTABLISH THE PERFORMANCE CHARACTERISTICS OF A LOOPWHEEL (CONTINUOUS TRACK) MOBILITY SYSTEM OF A TYPE ORIGINALLY DEVELOPED BY THE LOCKHEED CORPORATION. (1) USING FY'71 FUNDS, A CONTRACT HAS BEEN NEGOTIATED WITH THE LOCKHEED CORPORATION TO DESIGN AND FABRICATE A LOOPWHEEL TRACK WHICH WILL INCORPORATE MODIFICATIONS IN TRACK STIFFNESS CHARACTERISTICS, GROUSER STRUCTURE AND TRACK TENSION CHARACTERISTICS WHICH PRIOR TESTING INDICATES WILL IMPROVE PERFORMANCE OF THE LOOPWHEEL. (2) USING FY'72 FUNDS, A CONTRACT WILL BE NEGOTIATED WITH THE U.S. ARMY WATERWAYS EXPERIMENT STATION TO CONDUCT PERFORMANCE TESTING ON THE LOOPWHEEL AND TO DOCUMENT THE RESULTS. (3) IF THE TEST RESULTS OBTAINED JUSTIFY FURTHER PURSUIT OF THE SYSTEM, A CONTRACT WILL BE NEGOTIATED WITH THE LOCKHEED CORPORATION TO DESIGN, DEVELOP AND FABRICATE A FULL-SCALE MULTITRACK SYSTEM WHICH WILL BE USED BY THE GOVERNMENT TO EVALUATE STEERING AND DRIVING CHARACTERISTICS. THIS ACTIVITY WILL BE INITIATED IN FY'72 AND IS PLANNED FOR COMPLETION OF THE TEST PROGRAM IN FY'74.

RTOP NO. 908-54-05 TITLE: ELECTRICAL POWER
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ROBINSON, W. J. TEL. 205-453-0029
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO DEVELOP A SYSTEM WHICH SHALL BE SUFFICIENT TO DEMONSTRATETHE EFFICIENT (E IS GREATER THAN OR EQUAL TO 50%) WIRELESS TRANSMISSION OF POWER AND TO RIGOROUSLY IDENTIFY THE AREAS REQUIRING FURTHER DEVELOPMENT IF SUCH A SYSTEM IS TO BE DEPLOYED FOR PROJECT USE IN SPACE. THIS IS A CONTINUATION OF AN EFFORT INITIATED IN FY'71. AS A PART OF THE '71 RECEIVING ANTENNA) WAS ASSEMBLED AND TESTED. END-TO-END EFFICIENCY OF ABOUT 20% WAS MEASURED. ADDITIONALLY, AN ANALYSIS OF THE TOTAL SYSTEM WAS PERFORMED AND ESTIMATES WERE MADE OF EXPECTED RETURN PER INVESTED DOLLAR IN TERMS OF IMPROVEMENT IN EFFICIENCY FOR EACH MAJOR SUBSYSTEM. ON THIS BASIS, THE FOLLOWING EFFORTS ARE PLANNED FOR FY-72: A. COMPLETE ANALYSIS OF THE TRANSMITTER (R.F. CONVERTER-AMPLIFER) SECTION AND ESTABLISH SELECTION CRITERIA FOR THE R.F. AMPLIFIER TUBE. B. CONDUCT "SCREENING" OF AVAILABLE TUBES AND SELECT ONE OR MORE UNITS FOR USE. C. DESIGN AND FABRICATE A TRANSMITTING "HORN" MATCHED TO THE FREQUENCY-SEPARATION REQUIREMENTS OF THE SYSTEM.

RTOP NO. 908-54-05 TITLE: FLAT CONDUCTOR CABLE (FCC) SYSTEMS FOR FUTURE MISSIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ANGELE, W. TEL. 205-453-1500
TECHNICAL SUMMARY

THE MAJOR OBJECTIVE OF THIS EFFORT IS TO PROVIDE TECHNOLOGY (METHODS, TECHNIQUES, PROCEDURES, TOOLS AND EQUIPMENT) AND ESTABLISH MULTIPLE SOURCES OF SUPPLY FOR FLAT CONDUCTOR CABLE SYSTEM COMPONENTS WHICH WOULD MEET ALL REQUIREMENTS FOR ANY FUTURE MANNED OR UNMANNED MISSION. TO PROVIDE THIS NECESSARY TECHNOLOGY AND CAPABILITY, WORK WILL BE REQUIRED TO CONDUCT RESEARCH AND DEVELOPMENT AND MAKE APPLICATION TO EXPERIMENTAL PROTOTYPES; EVALUATE NEW MANUFACTURING METHODS, TECHNIQUES, EQUIPMENT AND FACILITIES; CONDUCT FEASIBILITY STUDIES OF PROPOSED DESIGNS; AND BUILD EXPERIMENTAL MODELS OR PROTOTYPES FOR TESTING AND EVALUATION. APPLICATION STUDIES RELATIVE TO PLANNED ORBITAL, LUNAR AND DEEP SPACE PROBES HAVE CLEARLY SHOWN THE REQUIREMENT FOR REDUCED PACKAGING WEIGHT IN ORDER TO ACCOMPLISH MORE EXTENSIVE EXPERIMENT PARAMETERS IN A GIVEN PAYLOAD WEIGHT LIMIT. DURING FY-72, THE IN-HOUSE EFFORT WILL BE FUNDED AND PERSONNEL UTILIZED IN THE CONTINUATION OF ESTABLISHED PROJECTS WHICH WILL BE UTILIZED FOR THE MAJOR AREAS OF INVESTIGATION AND DEVELOPMENT. SINCE A MAJOR EFFORT IS REQUIRED FOR A SUITABLE CONNECTOR, SUPPORTING CONTRACTS WILL BE UTILIZED TO PROCURE THE FINAL DESIGN, FABRICATION AND TESTING OF CORONA-PROOF FCC CONNECTOR HAVING INDIVIDUALLY SEALED PINS. UPON RECEIPT OF REQUESTED FUNDS FOR FY-73, WORK WILL CONTINUE ON THE DEVELOPMENT OF FCC CONNECTORS, DISTRIBUTION BOXES, SHIELDED FCC SYSTEMS, AND OTHER DEVELOPMENT WHICH ARE RELATED TO AND SUPPORT THE FCC SYSTEMS FOR FUTURE MISSIONS.

RTOP NO. 908-62-09 TITLE: SPACE SHUTTLE ABORT AND SAFETY
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP IS FOR WORK RELATED TO SPACE SHUTTLE OPERATIONS SAFETY. BOTH THE GENERAL PUBLIC AND ITS PROPERTY AND GOVERNMENT PERSONNEL AND PROPERTY ARE INVOLVED. ENGINEERING INVESTIGATIONS WILL BE MADE TO IDENTIFY AND TECHNICALLY DEFINE THE HAZARDS ATTENDANT TO OPERATIONS OF PROPOSED SPACE SHUTTLE CONFIGURATIONS. THESE HAZARDS WILL BE EVALUATED AGAINST VARIOUS EXISTING RISK CRITERIA, DEVELOPMENT COSTS, OPERATING COSTS, AND SCHEDULES TO IDENTIFY THE OPTIMUM APPROACH (DESIGN CHANGE, OPERATION CHANGE, OR COMBINATION) TO BRING THE RISK WITHIN ACCEPTABLE LIMITS. WHERE EXISTING CRITERIA ARE INADEQUATE, THIS RTOP PROVIDES FOR ANALYSES AND TESTS TO PRODUCE DATA NECESSARY TO ESTABLISH THE NEW CRITERIA NEEDED. AMONG THE SPECIFIC AREAS OF SAFETY CONCERN FOR INVESTIGATION DURING FISCAL YEAR 1972 UNDER THIS RTOP ARE: (1) EMERGENCY EGRESS OF PERSONNEL FROM THE SPACE SHUTTLE AND ADJACENT WORK AREAS DURING ALL GROUND OPERATIONS, (2) SAFETY CRITERIA FOR DESIGN AND OPERATIONS OF FACILITIES AND EQUIPMENT FOR ALL GROUND MOVEMENTS AND HANDLING OF THE SPACE SHUTTLE, AND (3) OVERFLY SAFETY REQUIREMENTS FOR PROPOSED LAUNCH AND LANDING SITES.

RTOP NO. 908-62-13 TITLE: SPACE SHUTTLE INSTRUMENTATION SENSORS
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP IS FOR WORK ON SPACE SHUTTLE SENSORS TO DETECT HAZARDOUS CONDITIONS RESULTING FROM SPILL OR LEAKAGE OF SPACE SHUTTLE PROPELLANTS. HYDROGEN AND OXYGEN PRODUCE FIRE AND EXPLOSION HAZARDS IN A WIDE RANGE OF MIXTURE CONCENTRATIONS. SPACE SHUTTLE HYDROGEN AND OXYGEN SYSTEMS, BOTH GROUND AND FLIGHT, WILL BE LARGE AND COMPLEX AND WILL CONTAIN MANY PARTLY ISOLATED COMPARTMENTS AND OPERATIONALLY INACCESSIBLE COMPONENTS. THESE SYSTEMS WILL EXIST AND OPERATE IN AMBIENT CONDITIONS THAT RANGE ALL THE WAY FROM THE CLEAN QUIETNESS OF SPACE VACUUM TO THE DIRTY, NOISY, WINDY, SALT MOISTURE LADEN EARTH'S SURFACE ATMOSPHERE OF THE KENNEDY SPACE CENTER. SYSTEM FUNCTIONS WILL RANGE ALL THE WAY FROM THE STATIC STEADY STATE OF BULK STORAGE TO THE HIGHLY DYNAMIC OPERATING STATE OF LARGE PUMPS, VALUES, AND LINES GOING FROM NO-FLOW AMBIENT TEMPERATURES TO FLOWS UP TO 20 THOUSAND GALLONS PER MINUTE AT CRYOGENIC TEMPERATURES WITH START UP CHILLDOWN LOSSES BY CHANGE OF STATE FROM LIQUID TO GAS AT THOUSANDS OF POUNDS PER MINUTE. THE SYSTEMS WILL BE MONITORED AND CONTROLLED BY REMOTELY LOCATED OPERATORS BOTH MANUAL AND AUTOMATIC. THE SAFE OPERATIONAL CONTROL OF THESE SYSTEMS WILL REQUIRE GOOD HYDROGEN FIRE SENSORS AND HYDROGEN AND OXYGEN GAS SENSORS. THE SENSORS MUST BE INDIVIDUALLY INEXPENSIVE TO ACQUIRE, OPERATE, AND MAINTAIN BECAUSE MANY WILL BE REQUIRED. THEY MUST BE RUGGED TO WITHSTAND THE OPERATING ENVIRONMENT. THEY MUST BE SENSITIVE, DEPENDABLE, AND ACCURATE TO PROVIDE THE INFORMATION NEEDED.

RTOP NO. 908-62-17 TITLE: SHUTTLE FLIGHT PREPARATION
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP ENCOMPASSES THOSE TECHNOLOGIES WHICH MUST BE ADVANCED TO ENABLE ATTAINMENT OF COST EFFECTIVE RAPID PREPARATION, TURNAROUND AND VERIFICATION OPERATIONS AT THE LAUNCH SITE AND FERRY LANDING SITES. IN ADDITION TO EFFICIENT HANDLING AND OPERATIONS TO CARRY OUT MORE ROUTINE TURNAROUND OPERATIONS, EFFICIENT FLIGHT READINESS VERIFICATION TECHNIQUES ARE ESSENTIAL FOR SUCCESSFUL LAUNCH AND MISSION OPERATIONS. MANY FACTORS CONTRIBUTE TO THE DIFFICULTY OF DETERMINING, WITH ASSURANCE, THAT SUB-SYSTEMS AND COMPONENTS WHICH MAKE UP THE SPACE SHUTTLE SYSTEM, ARE IN FACT IN A CONDITION ACCEPTABLE FOR USE/REUSE. SEVERAL AREAS OF TECHNOLOGY IN WHICH INVESTIGATION IN FY 72 IS PLANNED ARE: (1) MECHANICAL SYSTEMS READINESS ASSESSMENT, (2) STRUCTURAL INTEGRITY ASSESSMENT, (3) REDUNDANCY CHECKOUT TECHNIQUES, (4) FAILURE PREDICTION AND ANALYTICAL METHODS, AND (5) TEST AND FLIGHT ENGINEER ORIENTED COMPUTER LANGUAGE.

RTOP NO. 908-62-32 TITLE: GROUND OPERATIONS TECHNIQUES
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

ENGINEERING AND OPERATIONS INVESTIGATIONS ARE TO BE MADE TO FURTHER DEVELOP GROUND OPERATIONS TECHNIQUES FOR SPECIFIC APPLICATION TO SPACE SHUTTLE TURNAROUND. THESE TECHNIQUES WILL BE EVALUATED AGAINST DESIRED CRITERIA AND TECHNIQUES ESTIMATED TO BE REQUIRED TO ACHIEVE THE RAPID TURNAROUND OF THE SHUTTLE, AND THE PRESENT TECHNIQUES WHICH HAVE BEEN DEVELOPED FOR NASA AND DOD SPACE VEHICLES. WHERE EXISTING ENGINEERING INFORMATION AND OPERATIONAL METHODS AND CRITERIA ARE INSUFFICIENT, THIS RTOP PROVIDES FOR INVESTIGATIONS, ANALYSES, AND TESTS TO ESTABLISH THE NEEDED METHODS AND CRITERIA. SPECIFIC AREAS OF GROUND OPERATIONS TECHNIQUES TO BE INVESTIGATED UNDER THIS RTOP INCLUDE: (1) LEAK DETECTION OF FLUIDS AND GASES, (2) HANDLING OF PROPELLANTS AND GASES, (3) PAYLOAD HANDLING, (4) AIRLINE OPERATIONS, MAINTENANCE AND SAFETY APPLICATIONS, AND (5) SCHEDULING AND CONTROL SYSTEMS.

RTOP NO. 908-64-18 TITLE: ELECTRONIC TEST EQUIPMENT INFORMATION CENTER SUPPORT
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER
MONITOR: PARSONS, W. E. TEL. 308-867-5632
TECHNICAL SUMMARY

THIS RTOP IS FOR FUNDING AUTHORIZATION FOR NASA'S SUPPORT OF PROJECT SETE. THE PRIMARY OBJECTIVE OF SETE IS TO OPERATE A NATIONAL INFORMATION CENTER FOR THE ACCUMULATION, EVALUATION, COORDINATION, AND DISSEMINATION OF TECHNICAL INFORMATION ON THE PERFORMANCE, DEVELOPMENT, APPLICATION, AND FUTURE NEEDS FOR ELECTRONIC TEST EQUIPMENT. THIS OBJECTIVE IS MET BY THE INFORMATION CENTER LOCATED AT THE BRONX FACILITY OF NEW YORK UNIVERSITY, AND IS FINANCIALLY

SUPPORTED BY VARIOUS ELEMENTS OF THE U. S. GOVERNMENT INCLUDING, UNTIL FY-70, NASA.

RTOP NO. 908-71-08 TITLE: CONTROL COMPONENTS FOR SPACE STATION/BASE SUBSYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER
MONITOR: EVANS, H. E. TEL. 301-982-5194
TECHNICAL SUMMARY

THIS TASK COVERS DESIGN, TEST AND EVALUATION OF PROTOTYPE DRIVE MOTORS AND SPEED REDUCER SYSTEMS FOR SPACE STATION SUPPORT. WORK INCLUDES ESTABLISHING RELIABILITY THRU LIFE TESTING PROGRAMS. WHERE APPROPRIATE, NEW DESIGNS WILL BE UNDERTAKEN TO MEET SPACE STATION CONTROL SYSTEM REQUIREMENTS. GOALS FOR THIS PROGRAM ARE COMPONENT AND SYSTEMS DESIGN THAT MEET 10 YEARS OPERATION IN THE SPACE ENVIRONMENT. INITIAL EFFORTS COVER DESIGN, DEVELOPMENT, AND EVALUATION OF COMPONENTS FOR CMG SPIN MOTOR AND GIMBAL TORQUERS UTILIZING BRUSHLESS DC MOTOR DRIVES AND UNIQUE SPEED REDUCING ASSEMBLIES. TEST PROGRAMS WILL INCLUDE SIMULATED CMG LOADS; DUTY CYCLES, AND LOAD DISTURBANCES. ELECTRONIC CIRCUITRY REQUIRED TO PROVIDE CONTROL OVER THE DUTY CYCLE RANGE WILL BE DESIGNED AND EVALUATED IN A SIMULATED SPACE ENVIRONMENT. CLOSE COORDINATION WILL BE MAINTAINED WITH RELATED EFFORTS AT LRC, MSFC AND MSC TO INSURE PROGRAM COMPATIBILITY.

RTOP NO. 908-72-14 TITLE: EVALUATION OF PYROTECHNIC SYSTEMS FOR SPACE SHUTTLE AND SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP AND EVALUATE TECHNOLOGY FOR NEW AND IMPROVED EXISTING PYROTECHNIC SYSTEMS FOR USE ON SPACE SHUTTLE AND SPACE STATION MISSION. THE STUDY WILL INCLUDE THE APPLICABILITY OF PYROTECHNIC SYSTEMS TO THE PERFORMANCE OF MANY FUNCTIONS ON SPACE SHUTTLE, AND POSSIBLY A FOLLOW-ON CONCEPT DEMONSTRATION PROGRAM.

RTOP NO. 908-72-47 TITLE: SHUTTLE SONIC BOOM STUDY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE WORK UNDER THIS RTOP WILL PROVIDE A TECHNOLOGY BASIS FOR AN UNDERSTANDING OF SHUTTLE SONIC BOOM SIGNATURES. EXISTING SONIC BOOM TECHNOLOGY, AS DEVELOPED FOR AIRCRAFT, APPLIES PRIMARILY TO STEADY, LEVEL FLIGHT OF HIGH FINENESS RATIO VEHICLES AT LOW ANGLES OF ATTACK AT ALTITUDES OF LESS THAN 100,000 FEET AND AT MACH NUMBERS LESS THAN 3.0. THE SHUTTLE'S UNIQUE CHARACTERISTICSOF RELATIVELY LOW FINENESS RATIO VEHICLES AT LARGE ATTITUDES, STEADILY DECELERATING FROM AN ALTITUDE OF ABOUT 400,000 FEET WITH INITIAL MACH NUMBERS IN EXCESS OF

25 ESTABLISHES THE NEED FOR A CONCENTRATED TECHNOLOGY DEVELOPMENT PROGRAM TO PROVIDE THE MEANS OF OBTAINING REALISTIC PREDICTIONS OF SHUTTLE BOOM SIGNATURES. ONCE THIS CAPABILITY IS AVAILABLE, OPERATIONAL STUDIES WILL BE CONDUCTED TO DEFINE TECHNIQUES FOR ALLEVIATING THE OVERPRESSURE LEVELS AND/OR CONTROLLING THE LOCATION OF THE BOOM FOOTPRINT WITHIN RESTRICTED AREAS.

RTOP NO. 908-74-03 TITLE: SPACE SYSTEMS PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: SAARI, M. J. TEL. 216-433-6638
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY IS TO PROVIDE A POINT DESIGN OF A LH2/LO2 ENGINE OF ABOUT 10,000 POUNDS THRUST THAT COULD EFFICIENTLY PERFORM, USED IN DEPENDENTLY OR IN A CLUSTER, IN THE FOLLOWING NASA PROPOSED MISSIONS: SPACE TUG; OSSA VERSATILE UPPER STAGE (VUS); ON-ORBIT MANEUVERING SYSTEM (OMS) OF THE SPACE SHUTTLE. PARAMETRIC DATA AND DETAIL POINT DESIGNS ARE NOW BEING GENERATED FOR A HIGH PERFORMANCE 25,000 POUNDS THRUST ENGINE UNDER THREE PARALLEL CONTRACTS SPONSORED BY THE AIR FORCE ROCKET PROPULSION LABORATORY (AFRPL). THE APPROACH IS TO HAVE THE AFRPL TO AMEND THE THREE CONTRACTS TO OBTAIN ADDITIONAL POINT DESIGNS AT THE APPROXIMATELY 10,000 POUNDS THRUST LEVEL, USING THE PARAMETRIC DATA AND STATE-OF-THE-ART CONSISTENT WITH THE PRESENT 25,000 POUNDS THRUST DESIGNS.

RTOP NO. 908-74-35 TITLE: A SOLAR CELL ENERGY WHEEL SYSTEM
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THIS WORK WILL ESTABLISH THE FEASIBILITY OF A SOLAR CELL ENERGY WHEEL SYSTEM (SCEWS) THAT CAN PERFORM THE DUAL FUNCTION OF POWER GENERATION AND ATTITUDE CONTROL FOR MANNED SPACECRAFT. INITIAL EFFORTS WILL DEFINE SCEW SYSTEM AND COMPONENT DESIGN GOALS AND WILL INVESTIGATE THE IMPACT OF SPACECRAFT INTEGRATION ON SCEW SYSTEM DESIGN. ANALYSES AND SIMULATIONS WILL BE CONDUCTED TO DETERMINE THE SYSTEM POWER GENERATE COMPONENT PERFORMANCE SPECIFICATIONS COMPATIBLE WITH MISSION REQUIREMENTS. SYSTEM HARDWARE WHICH CANNOT BE DEVELOPED WITHIN STATE-OF-THE-ART TECHNOLOGY WILL BE IDENTIFIED, AND DESIGN AND BREADBOARD HARDWARE DEVELOPMENT EFFORTS WILL BE CARRIED OUT TO ASSURE THE SCEWS CONCEPT FEASIBILITY AND PRACTICABILITY. IF THE SCEWS CONCEPT PROVES VIABLE, LABORATORY PROTOTYPE SCEWS HARDWARE WILL BE BUILT AND EVALUATED USING EXISTING LRC STATIC AND DYNAMIC TEST SETUPS. ASSOCIATED DEVELOPMENT PROGRAMS WILL BE DIRECTLY COORDINATED WITH LERC, CSFC, AND MSC. PRIMARY PROBLEM AREAS INCLUDE THE IMPACT OF RELIABILITY, SAFETY, MAINTAINABILITY, FAILURE MODES, AND SYSTEM INTEGRATION ON SCEWS WEIGHTTRADE-OFFS; PERFORMANCE LIMITS OF COMPOSITE MATERIALS UNDER CYCLIC STRESSES AND EXTENDED-DURATION VACUUM; DEVELOPMENT OF BEARINGS AND SEALS CAPABLE OF LONG LIFE UNDER LARGE CYCLIC LOADS; DEVELOPMENT OF HIGH-POWER, EFFICIENT SPIN MOTORS AND GENERATORS; DEVELOPMENT OF HIGH-TORQUE, LOW-RATE GIMBAL

ACTUATORS; AND DEVELOPMENT OF GIMBAL SENSORS WITH HIGH RESOLUTION AND ACCURACY. SOLUTIONS TO THESE PROBLEMS WILL BE VERIFIED THROUGH SIMULATION AND HARDWARE TESTS, WHICH WILL DETERMINE POWER GENERATION CAPABILITY, CONTROL EFFECTIVENESS, AND SPINUP-SPINDOWN CYCLING EFFECT ON SYSTEM PERFORMANCE. SUCCESSFUL COMPLETION OF THIS

RTOP NO. 908-94-24 TITLE: DEVELOPMENT OF SHORT PULSE LASERS
ORGANIZATION: NASA HEADQUARTERS
MONITOR: REDFIELD, M. TEL. 202-962-0883
TECHNICAL SUMMARY

THIS WORK PERTAINS TO AND IS SUPPORTIVE OF CURRENT PROGRAMS WHICH INVOLVE LASER RANGING THE OPTICAL RETRO-REFLECTORS ON THE MOON. THE MAJOR FACTOR IN THE TIMELY DEVELOPMENT OF RELATIVELY LOW COST GROUND RANGING STATIONS OF HIGH ACCURACY IS THE SUPPORT OF RESEARCH AND DEVELOPMENT OF IMPROVED LASERS AND TIMING DEVICES. THE MOST PROMISING APPROACH FOR LUNAR RANGING SEEMS TO BE A HIGH AVERAGE POWER (GREATER THAN OR EQUAL TO 20 WATTS) MODE-LOCKED SHORT PULSE (0.1 NANOSECOND) HIGH REPETITION RATE (10 TO 30 PPS) FREQUENCY DOUBLED (5300 A), DIFFRACTION LIMITED NEODYMIUM LASER USING YTTRIUM ORTHO-ALUMINATE HOST CRYSTALS. THE PERFORMANCE OF THIS LASER WILL BE THOROUGHLY EVALUATED.

RTOP NO. 970-21-11 TITLE: NEUROPHYSIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

IT IS THE OBJECTIVE OF THIS WORK TO INVESTIGATE AND EVALUATE THE EFFECTS OF THE SPACE ENVIRONMENT ON VISUAL FUNCTIONS OF THE NERVOUS SYSTEM OF MAN. IT IS IMPERATIVE THAT THESE FUNCTIONS NOT BE IMPAIRED BY EXPOSURE TO ANY OF THE ENVIRONMENTAL VARIABLES ENCOUNTERED DURING THE COURSE OF MANNED MISSIONS. WHENEVER INEVITABLE TEMPORARY DISTURBANCES ARE EXPECTED, AS IN THE STRESS OF BLAST-OFF OR RE-ENTRY, IT WILL BE NECESSARY TO PROVIDE ADEQUATE COMPENSATORY MEASURES TO SAFEGUARD THE WELL-BEING OF THE ASTRONAUT AND THE SUCCESS OF THE MISSION. THIS PROJECT WILL PROVIDE FOR THE DEVELOPMENT OF PRACTICAL PROCEDURES AND EQUIPMENT FOR INFLIGHT EVALUATION OF VISUAL FUNCTIONS. THE EFFECTS OF UNUSUAL "G" ON DYNAMIC VISUAL ACCOMMODATION (FOCUSING) WILL BE INVESTIGATED BY: (1) UTILIZING THE SRI-AMES OPTOMETER TO MEASURE THE ACCOMMODATIVE FUNCTION UNDER BED REST AND/OR CENTRIFUGE CONDITIONS, AND (2) DEVELOPING AND UTILIZING A SPACERATED MODIFICATION OF THE SRI-AMES OPTOMETER FOR USE IN FLIGHT. THE EFFECTS OF MOTION SICKNESS ON THE LIMITS OF PERIPHERAL VISION AND ON VISUALLY-BASED ORIENTATION WIL BE INVESTIGATED USING THE ROTATIONAL FACILITIES OF USN-AMI AND TEST EQUIPMENT AND DATA-ANALYSIS TECHNIQUES WILL BE DEVELOPED FOR THE LINE MEASUREMENT AND CONTROL OF THE EXTENT OF MOTION-SICKNESS INDUCTION. THE CAPABILITY FOR PURSUING A PROGRAM OF SOPHISTICATED MEASUREMENTS OF VISUAL FUNCTIONING DURING SPACE

FLIGHT WILL BE DEVELOPED AS HUMAN VISION SPACE FLIGHT EXPERIMENT (T-006) AND WILL PROVIDE A COMPREHENSIVE SERIES OF TESTS OF VISUAL FUNCTIONING WITH THE RELATED EQUIPMENT CONSOLIDATED INTO A SINGLE VISION TESTER.

RTOP NO. 970-21-12 TITLE: CARDIOVASCULAR PHYSIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE RESPONSE OF THE HUMAN CARDIOVASCULAR SYSTEMWILL BE DETERMINED DURING THE VARIOUS FACTORS AND STRESSES ASSOCIATED WITH MANNED SPACE FLIGHT. PARTICULAR ATTENTION WILL BE GIVEN TO THE PHYSIOLOGICAL RESPONSES TO WEIGHTLESSNESS AND DURING MISSION WORKLOADS. THE MECHANISMS USED FOR SUCH RESPONSES WILL BE DETERMINED AS WELL AS THE TIME COURSE REQUIRED FOR ADAPTATION OF THE CARDIOVASCULAR SYSTEM TO SPACE FLIGHT CONDITIONS. WORK WILL BE CONDUCTED IN ANIMALS AND MAN IN ORDER TO ASSESS SYSTEM ADAPTATION DURING ACCELERATION, WEIGHTLESSNESS AND RETURN TO THE EARTH'S ENVIRONMENT FOLLOWING BRIEF OR EXTENDED PERIODS OF SPACE FLIGHT. HUMAN STUDIES WILL BE CONDUCTED BY NON-INVASIVE METHODS. ANIMAL STUDIES WILL BE PERFORMED IN APPROPRIATELY INSTRUMENTED, UNRESTRAINED CHRONIC ANIMAL PREPARATIONS. SUCH ANIMALS WILL BE USED TO OBTAIN INFORMATION CONCERNING BASIC MECHANISMS OF RESPONSE FOR THOSE SITUATIONS WHERE SUCH MEASUREMENTS WOULD CARRY A SIGNIFICANT RISK IF APPLIED TO MAN OR IN SITUATIONS WHERE SUCH MEASUREMENTS ARE NOT YET AVAILABLE IN MAN.

RTOP NO. 970-21-13 TITLE: RESPIRATORY PHYSIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

PULMONARY FUNCTION MUST UNDERGO SIGNIFICANT CHANGES IN WEIGHTLESSNESS. THE OBJECTIVE OF THIS PROGRAM IS TO DETERMINE THE MAGNITUDE OF CERTAIN OF THESE CHANGES AND DETERMINE THEIR EFFECTS ON THE ABILITY OF MAN TO ADJUST SUCCESSFULLY TO LONG DURATION SPACEFLIGHT AND TO READJUST TO NORMAL GRAVITY SUBSEQUENT TO SUCH A MISSION. IN ADDITION, THE PART PLAYED BY GRAVITY IN DETERMINING PULMONARY FUNCTION ON EARTH WILL BE EXAMINED TO OBTAIN BASELINE DATA AND IMPROVE THE PREDICTIONS WHICH CAN BE MADE REGARDING THE CHANGES EXPECTED IN WEIGHTLESSNESS.THE FUNCTIONS TO BE MEASURED ARE LUNG VOLUMES, OXYGEN AND CARBON DIOXIDE WASHOUT, REGIONAL PERFUSION, REGIONAL VENTILATION, TOTAL VENTILATION, VENTILATION/PERFUSION RATIOS FOR WHOLE LUNG AND DIFFERENT REGIONS, PULMONARY DIFFUSING CAPACITY, MIXED VENOUS CO2 TENSIONS, PULMONARY BLOOD VOLUME AND CARDIAC OUTPUT. A PROPOSAL FOR A FLIGHT EXPERIMENT HAS BEEN COMPLETED AND INITIAL LABORATORY WORK HAS BEEN CARRIED OUT. IN THE AREA OF AEROSOL DEPOSITION, WHERE SIGNIFICANT CHANGES ARE ALSO EXPECTED, EXPERIMENTS WILL BE CARRIED OUT UNDER HIGH AND ZERO GRAVITY CONDITIONS TO CONFIRM THE PREDICTED CHANGES IN DEPOSITION IN THE LUNG FROM THE LARGER PARTICLE SEDIMENTATION FACTOR. THE APPROACH WILL BE FOURFOLD: 1.

INVESTIGATIONS TO DETERMINE THE EFFECTS OF GRAVITY ON NORMAL HUMAN LUNG, WITH PARTICULAR REFERENCE TO MECHANICAL DEFORMATION AND ITS EFFECTS ON PULMONARY FUNCTION; 2. CONTINUED WORK ON BASELINE DATA REQUIRED FOR THE GROUND CONTROLS FOR A FUTURE FLIGHT EXPERIMENT; 3. FEASIBILITY DEMONSTRATIONS FOR HARDWARE SYSTEMS LATER TO BE CONVERTED INTO FLIGHT SYSTEMS; 4. CENTRIFUGE AND AIRCRAFT PARABOLIC----

RTOP NO. 970-21-14 TITLE: METABOLISM AND NUTRITION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE MAJOR EMPHASIS IS BEING PLACED ON THE DEVELOPMENT OF A BIOMEDICAL RESEARCH PROGRAM DIRECTED TOWARD THE DELINEATION OF ADVERSE PHYSIOLOGICAL RESPONSES TO WEIGHTLESSNESS AND REENTRY ACCELERATION, AN INVESTIGATION OF THE CAUSES OF THESE ADVERSE RESPONSES, AND A MAJOR EFFORT TO DEVISE AND TEST VARIOUS REMEDIAL PROCEDURES. RESEARCH IS BEING DIRECTED TOWARD LIPID AND CARBOHYDRATE METABOLISM, ENDOCRINE CONTROL OF CALCIUM METABOLISM AND BONE ELASTICITY, BODY TEMPERATURE REGULATION, WATER AND ELECTROLYTE BALANCE, TISSUE BREAKDOWN AND ALTERATION DURING WEIGHTLESSNESS, AND VARIOUS REMEDIAL MEASURES TO COMBAT THE SPACE SHUTTLE REENTRY ACCELERATION. SOME ANIMAL, BUT MAINLY HUMANS, WILL BE UTILIZED. BED REST WILL BE USED TO SIMULATE WEIGHTLESSNESS AND THE HUMAN CENTRIFUGE FOR SIMULATING THE SHUTTLE REENTRY PROFILES. THE MAJOR PORTION OF THE ABOVE RESEARCH WILL BE CONDUCTED IN-HOUSE.

RTOP NO. 970-21-16 TITLE: ENDOCRINOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THIS RESEARCH HAS TWO MAJOR OBJECTIVES: 1) TO INVESTIGATE THE MECHANISMS RESPONSIBLE FOR BODY FLUID LOSS DURING SIMULATED WEIGHTLESSNESS (BED-REST); AND 2) TO DETERMINE THE DECREMENT IN ACCELERATION TOLERANCE TO RE-ENTRY PROFILES AND TO TEST VARIOUS REHYDRATION PROCEDURES TO ALLEVIATE THE REDUCED TOLERANCE. BLACKOUT TOLERANCE TO +GZ (HEAD-TO-FOOT) ACCELERATION IS REDUCED FOLLOWING DEHYDRATION. BEDREST RESULTS IN DEHYDRATION PLUS OTHER PHYSIOLOGICAL CHANGES. BODY WATER BALANCE IS CONTROLLED BY VARIOUS HORMONES INCLUDING ANTIDIURETIC HORMONE, ALDOSTERONE, RENIN, ANGIOTENSIN, AND CORTISOL AND THEIR INFLUENCE ON BED-REST DIURESIS WILL BE DETERMINED. REDUCTION IN +GZ TOLERANCEFOLLOWING BED-REST IS GREATER THAN THAT FOLLOWING DEHYDRATION ALONE. SPACE TRAVELERS WILL PROBABLY BE EXPOSED TO PROLONGED PERIODS OF WEIGHTLESSNESS WITH CONCOMITANT ADVERSE PHYSIOLOGICAL CHANGES. ADEQUATE REHYDRATION SHOULD ALLEVIATE A PORTION OF THE ACCELERATION INTOLERANCE TO RE-ENTRY PROFILES.

RTOP NO. 970-21-25 TITLE: CHEMISTRY AND MICROBIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THIS PROGRAM HAS AS ITS OBJECTIVE THE DEFINITION AND STUDY OF POTENTIAL MICROBIOLOGICAL AND BIOCHEMICAL PROBLEMS OF MANNED SPACE FLIGHT. STUDIES WILL BE DIRECTED TO EXAMINE AND ASSESS ALTERATIONS BETWEEN MAN AND HIS MICROFLORA IN THE SPACECRAFT ENVIRONMENT DURING MANNED SPACE FLIGHT, ESPECIALLY AS THEY MAY ADVERSELY AFFECT ASTRONAUT HEALTH. RESEARCH WILL BE ORIENTED TOWARD A NUMBER OF PARAMETERS CONCERNED WITH VIRULENCE OF MICROORGANISMS, IMMUNITY TO INFECTION, RAPID DIAGNOSIS OF THE INFECTED STATE, MEASURES TO PREVENT OR LIMIT INFECTIOUS DISEASE, MICROBIAL SHOCK AND MUTATIONAL EFFECTS AS RELATED TO MANNED SPACE MISSIONS. THE OVERALL APPROACH WILL BE TO STUDY THE MECHANISM OF RESPONSIBILITY FOR UNDESIRABLE OR HAZARDOUS CHANGES IN THE HOST PARASITE SYSTEM IN A SPACECRAFT ENVIRONMENT, MAINLY BY A CONTINUATION AND EXPANSION OF GRANTS TO UNIVERSITIES PLUS SPECIFIC IN-HOUSE EFFORTS. THE LONG-TERM TOLERANCE OR TOXICITY OF EXPOSURE TO GASEOUS CONTAMINANTS KNOWN TO PRESENT A POTENTIAL PROBLEM IN SPACE CABINS WILL BE STUDIED. THOSE JUDGED AS CRITICAL BY THE SPACE SCIENCE BOARD WILL BE INVESTIGATED FOR 90 AND 180 DAY EXPOSURES IN RATS. CHANGES IN PHYSIOLOGY WILL BE ESTABLISHED. THE FORMER CHANGES CAN BE USED TO ASSESS SUSPECTED CHANGES IN ASTRONAUTS. CONCURRENT EXPERIMENTS WILL DETERMINE WHICH CONTAMINANTS ARE CRITICAL EITHER AS PRIME TOXICANTS OR AS SYNERGISTS.

RTOP NO. 970-21-35 TITLE: BIODYNAMICS AND ATMOSPHERES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

AEROSOLS, OF SOME CONCERN IN SPACECRAFT, WILL BE STUDIED IN BOTH ANIMALS AND HUMANS CORRELATIONS WILL BE MADE BETWEEN PHYSIOLOGIC ALTERATIONS CAUSED BY DAMAGING AGENT AND OBSERVED MORPHOLOGY. EXTENT OF DAMAGE AND REVERSIBILITY WILL BE ESTABLISHED USING MORPHOLOGY AS AN ENDPOINT. HUMAN, PARTICULATE INDUCED PATHOLOGY WILL BE STUDIED IN A SIMILAR MANNER AS A POINT OF REFERENCE WITH RESPECT TO THE STATE OF DAMAGE WHICH MAY OCCUR IN ASTRONAUTS. THE GREATER RISK OF DYSBARISM IN PRESENTLY PLANNED ATMOSPHERES REQUIRES INVESTIGATIONS INTO PREVENTATIVE OR REMEDIAL TECHNIQUES. TO THIS END, NITROGEN SCAVENGING COMPOUNDS ARE BEING DEVELOPED WHICH WILL REMOVE NITROGEN FROM TISSUES AND BLOOD. A PROGRAM IS BEING ESTABLISHED TO EVALUATE HUMAN DECOMPRESSION DATA AND TO DERIVE RELATIONSHIPS THERE FROM WHICH ARE APPLICABLE AS PREDICTIVE TOOLS FOR DECOMPRESSIVE MISHAPS IN SPACE FLIGHT SITUATIONS. DESIGN LIMITATIONS PREDICATE THAT CREW AND PASSENGERS ON SPACE VEHICLES WILL BE SUBJECTED TO 2-4 G'S FOR CONSIDERABLE PERIODS OF TIME UPON REENTRY. TOLERANCE OF HUMANS AFTER VARYING PERIODS OF SIMULATED WEIGHTLESSNESS WILL BE DETERMINE UNDER MEDICALLY CONTROLLED CONDITIONS. SUBSEQUENTLY, THE EFFECTS OF VARIOUS MEASURES AIMED AT COUNTERACTING REENTRY PROFILES FROM THE WEIGHTLESS STATE WILL BE ASCERTAINED.

RTOP NO. 970-21-51 TITLE: HUMAN BEHAVIOR AND PERFORMANCE
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE SUCCESS OF MANNED SPACE MISSIONS DEPENDS UPON MAN'S ABILITY TO PERFORM WELL UNDER NORMAL AND ADVERSE CONDITIONS. ONE CONDITION THAT MAY LEAD TO PERFORMANCE DECREMENTS IN SPACE FLIGHT IS ABNORMAL LIGHTING OF THE VEHICLE INTERIOR, DUE TO A HIGH INTENSITY BEAM OF SUNLIGHT ENTERING THE CREW COMPARTMENT. PERFORMANCE DECREMENTS ASSOCIATED WITH SUCH ILLUMINATION WILL BE DETERMINED. THIS INFORMATION WILL PERMIT SPECIFICATION OF ENGINEERING APPROACHES TO MORE OPTIMAL LIGHTING CONDITIONS. A RELATED EFFORT WILL INVOLVE FURTHER DEVELOPMENT OF THE AMES CREW EVALUATOR (ACE), A DEVICE DESIGNED TO MONITOR PERFORMANCE CAPABILITY IN A TASK INVOLVING HIGHER-ORDER MENTAL FUNCTIONING. PARAMETRIC STUDIES DESIGNED TO DETERMINE OPTIMUM TEST PROCEDURES WILL BE CONDUCTED. SLEEP DEPRIVATION STUDIES WILL ESTABLISH THE ABILITY OF THE TEST PROCEDURES TO DETECT PERFORMANCE DECREMENTS DUE TO STRESS. RESEARCH WILL INVESTIGATE THE EFFECT OF SOCIAL INTERACTION PROCESSES ON THE QUALITY OF INDIVIDUAL AND GROUP PERFORMANCE AND ADJUSTMENT DURING LONG DURATION ISOLATION AND CONFINEMENT. ANOTHER LINE OF EFFORT WILL EXPLORE THOSE ASPECTS OF THE ENVIRONMENT WHICH INHIBIT AND FACILITATE TASK PERFORMANCE IN TWO MAN GROUPS, WHEN COOPERATIVE ACTION IS REQUIRED. TECHNIQUES OF AUTONOMIC CONDITIONING WHICH MAY FACILITATE PERFORMANCE UNDER STRESS WILL BE INVESTIGATED. RESEARCH WILL BE CONDUCTED TO DEVELOP BEHAVIORAL TESTS OF ALERTNESS, AND TO CORRELATE THESE WITH PHYSIOLOGICAL (PARTICULARLY EEG) INDICES OF ALERTNESS. THE OBJECTIVE IS TO DEVELOP AUTOMATED TESTS OF ALERTNESS, SUITABLE FOR USE IN OPERATIONAL ENVIRONMENTS. MODELS OF MAN-COMPUTER INTERACTION ARE UNDER DEVELOPMENT FOR----

RTOP NO. 970-21-52 TITLE: BEHAVIORAL PHYSIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

A PRINCIPAL OBJECTIVE OF THIS AREA IS TO CONDUCT RESEARCH ON THE BEHAVIORAL ASPECTS OF PHYSIOLOGICAL CHANGES ASSOCIATED WITH SPACE FLIGHT. EFFORTS WILL BE DEVOTED TO THE STUDY OF INTERACTIONS BETWEEN PHYSIOLOGICAL FUNCTION AND BEHAVIOR, INCLUDING THE DETECTION OF SUBTLE BEHAVIORAL CHANGES RESULTING FROM ALTERED PHYSIOLOGICAL STATES. ONE PRINCIPAL TOPIC OF CONCERN INCLUDES CIRCADIAN RHYTHMS, SLEEP SCHEDULING, AND WORK REST CYCLES, AND THE ASSESSMENT OF THE EFFECTS OF RHYTHM DESYNCHRONIZATION AND SLEEP DEPRIVATION. THE EFFECTS OF DRUGS, NUTRITIONAL SUBSTANCES, TOXIC CONTAMINANTS, RADIATION, AND ALTERED RESPIRATORY GASES ON BEHAVIORAL PERFORMANCE WILL BE INVESTIGATED. ATTENTION WILL BE DEVOTED TO THE BEHAVIORAL ADJUSTMENTS AND ADAPTATIONS TO PHYSIOLOGICAL CHANGES ASSOCIATED WITH SPACE FLIGHT INCLUDING, FOR EXAMPLE, MOTIVATIONAL (THIRST) CHANGES ACCOMPANYING ALTERED FLUID AND ELECTROLYTE BALANCE. LONG RANGE STUDIES WILL INCLUDE INTEROCEPTIVE CONDITIONING, WHICH DEALS WITH THE REGULATION OF INTERNAL ORGANS THROUGH CONDITIONING AUTONOMIC REFLEXES. TECHNIQUES FOR THE QUANTIFICATION OF PHYSIOLOGICAL AND

BEHAVIORAL CIRCADIAN RHYTHMS, ELECTRICAL ACTIVITY OF THE BRAIN, AND OTHER BIOLOGICAL VARIABLES THAT ARE RESPONSIVE TO CERTAIN ENVIRONMENTAL FACTORS (SUCH AS LIGHT, TEMPERATURE, DRUGS, HYPOXIA, ETC.) WILL BE DEVELOPED AND APPLIED TO PROBLEMS ASSOCIATED WITH EXTENDED SPACE FLIGHT. MAN AS WELL AS A WIDE RANGE OF INFRAHUMAN SPECIES WILL BE STUDIED SO AS TO ARRIVE AT A GENERAL UNDERSTANDING OF BASIC MECHANISMS UNDERLYING BIORHYTHMICITY. BIOCHEMICAL, BIOPHYSICAL, PHYSIOLOGICAL, AND BEHAVIORAL METHODS WILL BE USED----

RTOP NO. 970-21-53 TITLE: SENSORY SYSTEMS AND NEUROBEHAVIORAL STUDIES
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO BROADEN AND DEEPEN OUR KNOWLEDGE OF POSTURAL AND ORIENTING MECHANISMS - ESPECIALLY THEIR RESPONSES TO UNUSUAL ENVIRONMENTAL FORCES. THIS INFORMATION WILL BE APPLIED TO THE EVALUATION, PREDICTION AND CONTROL OF THE ADVERSE EFFECTS OF THE UNUSUALLY HIGH AND LOW "G" FORCES AND UNUSUAL LINEAR AND ANGULAR ACCELERATIVE FORCES ENCOUNTERED IN EXTENDED SPACE MISSIONS. PARTICULAR ATTENTION WILL BE PAID TO VISUAL, VESTIBULAR, AND PROPRIOCEPTIVE (MUSCLE FEEDBACK) SYSTEMS, THEIR INTERACTIONS, AND THEIR RELATIONSHIPS WITH THE GENERAL MECHANISMS UNDERLYING SLEEP AND WAKEFULNESS. DESCRIPTIVE STUDIES WILL DEFINE THE EFFECTS OF ALTERED GRAVITY ON NEUROPHYSIOLOGICAL FUNCTION AND BEHAVIOR, ORIENTATION, SENSORIMOTOR COORDINATION, POSTURAL CONTROL AND LOCOMOTION. ANALYTICAL STUDIES WILL BE DEVOTED TO THE UNDERSTANDING OF THE NEURAL PROCESSES INVOLVED IN GRAVITY RECEPTION AND RESPONSE THRESHOLDS FOR DETECTING CHANGES IN ACCELERATION AND ROTATION, AND THE RATE AND LEVEL OF ADAPTATION TO CHRONIC EXPOSURE TO ALTERED GRAVITY. NEUROPHYSIOLOGICAL AND NEUROCHEMICAL STUDIES WILL ADDRESS THE MECHANISMS WHICH UNDERLIE LEVELS OF SLEEP AND AROUSAL ATTENTION, ALERTNESS, AND MOTIVATION. THE BEHAVIORAL ASPECTS OF MATURATION AND DEVELOPMENT WILL BE INVESTIGATED WITH EMPHASIS ON THE EFFECTS OF CHRONIC EXPOSURE TO LEVEL ABOVE AND BELOW EARTH GRAVITY. IN ADDITION, WORK ON THE MECHANISMS OF COMPLEX ORIENTATIONAL CAPACITIES IN MAN AND ANIMAL WILL ALSO RECEIVE ATTENTION. OTHER SENSORY SYSTEMS SUCH AS THOSE SERVING AUDITORY AND CUTANEOUS (TACTILE, THERMAL, AND PRESSURE) SENSIBILITIES, WILL BE INVESTIGATED AS NECESSARY IN SUPPORT OF FLIGHT EXPERIMENTS AND----

RTOP NO. 970-21-61 TITLE: REGULATORY BIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

TO ESTABLISH AND UNDERSTAND THE BIOCHEMICAL AND PHYSIOLOGICAL BASES FOR FUNCTIONAL VARIATIONS IN PLANT AND ANIMAL SYSTEMS EXPOSED TO THE SPACE ENVIRONMENT. RESEARCH WILL BE PERFORMED ON REPRESENTATIVE BIOLOGIC SPECIES AT DIFFERENT LEVELS OF BIOLOGIC ORGANIZATION TO DETERMINE THE INFLUENCE OF ALTERED GRAVITY ON MAJOR

BIOLOGIC FUNCTIONS. CHANGES IN GRAVITY WILL BE INTRODUCED BY MEANS SUCH AS ACCELERATION (CENTRIFUGE) OR GRAVITY COMPENSATION (CLINOSTAT). OBSERVATIONS WILL MADE ON THE BIOCHEMICAL PATHWAYS AND PHYSIOLOGIC PROCESSES ASSOCIATED WITH BODY FUNCTIONS LIKELY TO BE AFFECTED BY GRAVITY CHANGES. REGULATORY FACTORS IN HOMEOSTATIC ADJUSTMENT WILL BE STUDIED DURING SIMULATED AS WELL AS ACTUAL SPACE FLIGHT IN RELATION TO THE CONDITIONING AND DECONDITIONING TO AND FROM A GIVEN STRESS. MODELS WILL BE DEVELOPED FOR STUDYING THE CHEMICAL ABLATION OF BIOLOGIC PATHWAYS AS WELL AS CHEMICAL NEUTRALIZATION OF CONDITIONING FACTORS. INFORMATION OF THIS NATURE IS DESIRED FOR THE UNDERSTANDING AND PRECISE INTERPRETATION OF THE EFFECTS OF WEIGHTLESSNESS AND OTHER DYNAMIC FACTORS ASSOCIATED WITH SPACE FLIGHT.

RTOP NO. 970-21-62 TITLE: DEVELOPMENTAL BIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

TO DETERMINE THE EFFECTS OF THE SPACE ENVIRONMENT ON DIFFERENTIATION, GROWTH, DEVELOPMENT, MATURATION AND SENESCENCE OF LIVING SYSTEMS. RESEARCH WILL BE PERFORMED ON THE ROLE OF GRAVITY, FROM HIGH G TO WEIGHTLESSNESS, IN THE MAINTENANCE OF CELLULAR INTEGRITY, OF CELLULAR SPATIAL RELATIONSHIPS AND IN BIOCHEMICAL AND BIOPHYSICAL REACTIONS THAT CONTROL DIFFERENTIATION, GROWTH, DEVELOPMENT, AND MATURATION OF EMBRYONIC SYSTEMS, BOTH PLANT AND ANIMAL. OF GENERAL IMPORTANCE IS THE DETERMINATION OF ANY SUBTLE OR GROSS EFFECT OF ALTERED GRAVITY ON THE ORGANIZATION OF LIVING MATTER DURING A COMPLETE LIFE SPAN IN THE SPACE ENVIRONMENT AND ITS SUBSEQUENT READAPTATION TO EARTH'S GRAVITY. THE QUANTITATIVE COMPARATIVE DIFFERENTIATION BETWEEN GRAVITY-DEPENDENT AND GRAVITY-INDEPENDENT SYSTEMS WILL BE EVALUATED CRITICALLY.

RTOP NO. 970-21-64 TITLE: GENETIC BIOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

THE OBJECTIVE OF THE GENETIC BIOLOGY PROGRAM IS TO DETERMINE THE EFFECTS OF SPACE FLIGHT ON GENETIC INTEGRITY USING WELL-ESTABLISHED, WELL-CHOSEN ENDPOINTS. EXPERIMENTS HAVE BEEN SELECTED WHICH CAN BE DEVELOPED INTO FLIGHT EXPERIMENTS. LABORATORY TESTS WILL BE REQUIRED TO DEVELOP PROCEDURES AND ESTABLISH BASELINE GENETIC DATA. IMPROVED TECHNIQUES WILL BE USED TO MEASURE SPECIFIC ENDPOINTS, SUCH AS THE USE OF ELECTRON MICROSCOPY IN ANALYZING SPINDLE MALFUNCTIONS IN PLANTS. METHODS OF FIXATION OF BIOLOGICAL MATERIAL IN SPACE FOR PROLONGED STORAGE WILL BE DEVELOPED. A SELF-POWERED UNIT FOR FIXATION AND PRESERVATION WILL BE BUILT. CHROMOSOME REJOINING WILL BE STUDIED USING X-RAYS OR CHEMICAL MUTAGENS TO INDUCE BREAKS. THE OCCURRENCE OF SEX-LINKED, RECESSIVE, LETHAL MUTATIONS AND TRANSLOCATIONS WILL BE DETERMINED IN DROSOPHILA. SOMATIC CHROMOSOME ALTERATIONS AFTER IRRADIATION WILL BE OBSERVED CYTOLOGICALLY. THE TRANSMISSION OF MUTATIONS THROUGH SEVERAL GENERATIONS IN FLIGHT WILL

BE MEASURED. MITOTIC NON-DISJUNCTION AND RECOMBINATION WILL BE QUANTITATED IN ALGAE SYSTEMS. SELECTION OF MUTANT BACTERIAL STRAINS, RESISTANT TO SPACE FLIGHT FACTORS, WILL PROVIDE RELIABILITY FOR A CLOSED BIOREGENERATIVE WASTE MANAGEMENT SYSTEM. RADIATION SOURCES WILL BE DEVELOPED FOR IN FLIGHT USE TO DETECT SYNERGISM OF RADIATION AND WEIGHTLESSNESS IN PRODUCING GENETIC DAMAGE. THE EFFECT OF HIGH Z COSMIC RAY PARTICLES WILL BE DETERMINED.

RTOP NO. 970-22-20 TITLE: FOOD, ATMOSPHERE, WATER, AND WASTE SUBSYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

A PROGRAM TO CONDUCT LIFE SUPPORT RESEARCH AND ADVANCED TECHNOLOGY WILL BE CARRIED OUT BY THIS CENTER. THE LIFE SUPPORT AREAS TO BE INVESTIGATED ARE: (A) ATMOSPHERE STORAGE AND GENERATION INCLUDING CARBON DIOXIDE ELECTROLYSIS, WATER VAPOR ELECTROLYSIS, ADVANCED ACADEMIC LIFE SUPPORT RESEARCH, NON-CRYOGENIC NITROGEN SUPPLY, STATIC FEED WATER ELECTROLYSIS, HYDROGEN-DEPOLARIZED CARBON DIOXIDE CONCENTRATOR, AND TRACE CONTAMINANT CONTROL. (B) WATER MANAGEMENT INCLUDING WATER PURIFICATION BY REVERSE OSMOSIS. (C) WASTE MANAGEMENT INCLUDING WASTE INCINERATION. (D) FOOD TECHNOLOGY INCLUDING CHEMICAL AND ENZYMATIC FOOD PRODUCTION AND FRESH FOODS.

RTOP NO. 970-22-30 TITLE: CREW EQUIPMENT SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

AMES RESEARCH CENTER WILL CONDUCT A PROGRAM TO PERFORM RESEARCH AND ADVANCED TECHNOLOGY IN CREW EQUIPMENT SYSTEMS. THE AREAS THAT WILL BE INVESTIGATED ARE: (A) SPACE SUITS WHICH INCLUDES DEVELOPMENT OF A HIGHLY ARTICULATE FULL PRESSURE GLOVE. (B) THERMAL CONTROL WHICH INCLUDES ADVANCED LIQUID COOLED GARMENT DEVELOPMENT AND LIQUID COOLED GARMENT-THERMAL CONTROL. (C) PORTABLE LIFE SUPPORT SYSTEMS WHICH INCLUDES ADVANCED EXTRAVEHICULAR PORTABLE LIFE SUPPORT SYSTEM DEVELOPMENT AND SYNTHESIS OF SOLID CHEMICALS FOR OXYGEN SUPPLY AND CARBON DIOXIDE REMOVAL. (D) ADVANCED RESPIRATORY PROTECTIVE SYSTEMS STUDY.

RTOP NO. 970-23-10 TITLE: SPACE SHUTTLE: INTEGRATED DISPLAY REQUIREMENTS FOR APPROACH AND LANDING
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE PILOT'S ROLE IN MONITORING AN AUTOMATIC GUIDANCE AND CONTROL SYSTEM AND PROVIDING MANUAL BACKUP DURING THE TERMINAL AREA APPROACH AND LANDING IS BEING STUDIED WITH THE GOAL OF OPTIMIZING THE MANNED SYSTEM FOR SAFETY AND RELIABILITY. A SYSTEMS ANALYSIS STUDY IS BEING

PERFORMED TO DEVELOP A SYSTEMS MODEL OF THE LANDING PHASE FOR THE VEHICLE. THE MODEL WILL INCLUDE SYSTEM ELEMENTS, COMMAND INPUTS, DISTURBANCES, AND THEIR INTERACTIONS IN AN ANALYTICAL FRAMEWORK SO THAT THE RELATIVE EFFECTS OF CHANGES IN THE VARIOUS SYSTEM ELEMENTS ON PRECISION OF CONTROL, PILOT/CO-PILOT WORKLOADS AND AVAILABLE MARGINS OF SAFETY THROUGHOUT THE TERMINAL OPERATIONS ENVELOPE CAN BE ESTIMATED. CONCURRENT WITH THE SYSTEMS STUDY, PILOTED SIMULATOR STUDIES OF TERMINAL AREA OPERATIONS WILL BE MADE UTILIZING VARIOUS DISPLAY CONCEPTS AND CONFIGURATIONS. THE RESULTS OF THE SYSTEM ANALYSIS STUDY AND THE SIMULATOR DISPLAY RESEARCH WILL BE COMBINED TO PROVIDE RECOMMENDED PILOT PROCEDURES DURING THE TERMINAL AREA PHASE OF THE MISSION.

RTOP NO. 970-23-20 TITLE: TELEOPERATOR MANIPULATOR AND EFFECTOR TECHNOLOGY
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT STUDIES ARE REQUIRED TO DEVELOP TELEOPERATOR SYSTEMS SUITABLE FOR EXTENDING MAN'S CAPABILITIES TO REMOTE OR HAZARDOUS ENVIRONMENTS ENCOUNTERED IN EXPLORATION OF SPACE AND ON LUNAR OR PLANETARY SURFACES. RESEARCH IS PRESENTLY UNDERWAY IN-HOUSE AND BY CONTRACT. IN-HOUSE STUDIES INCLUDE DEVELOPMENT OF A REMOTE MANIPULATOR STEREO TELEVISION AND COMPUTER GENERATED DISPLAY, AND END EFFECTOR (HAND). UNDER CONTRACT, TACTILE SENSORS AND END EFFECTORS ARE BEING STUDIED IN CONJUNCTION WITH COMPUTER CONTROL OF THE MANIPULATOR SYSTEM. RESULTS OF THESE EFFORTS ARE EXPECTED TO PROVIDE USEFUL INPUTS TO BOTH THE DEFINITION AND CONDUCT OF A SPACE TELEOPERATOR EXPERIMENT AND TO THE DEVELOPMENT OF OPERATIONAL TELEOPERATOR SYSTEMS FOR SPACE EXPLORATION AND FOR APPLICATIONS ON EARTH.

RTOP NO. 970-23-30 TITLE: BIOINSTRUMENTATION
ORGANIZATION: AMES RESEARCH CENTER
MONITOR: KLEIN, H. P. TEL. 415-961-2735
TECHNICAL SUMMARY

THE INSTRUMENTATION EFFORT IN THIS AREA WILL SUPPORT THE LIFE SCIENCES INFLIGHT RESEARCH PROGRAM. DIFFERENT MEASUREMENTS WILL BE REQUIRED TO ASSESS CARDIOVASCULAR PERFORMANCE, PULMONARY PERFORMANCE, FLUID ELECTROLYTE BALANCE AND CALCIUM METABOLISM. NON-INVASIVE METHODS PRESENTLY UNDER DEVELOPMENT FOR MEASURING AND EVALUATING CARDIAC FUNCTION IN MAN WILL BE CONTINUED AND DEVELOPED TO THE FLIGHT PROTOTYPE LEVEL. NEW METHODS FOR MEASURING ECG AND/OR DEEP BODY TEMPERATURE IN MAN BY SWALLOWABLE TRANSMITTERS WILL ALSO BE INVESTIGATED. ADVANCED METHODS FOR VECTOR ELECTROCARDIOGRAPHY AND SURFACE MAPPING OF BODY POTENTIALS BY MULTIPLE TELEMETERED SIGNALS FROM THE BODY SURFACE WILL ALSO BE INVESTIGATED. THESE LATTER METHODS SHOW PROMISE IN ALLOWING DETERMINATION OF HEART VOLUME AND BLOOD HEMATOCRIT BY NON-INVASIVE MEANS. NEW METHOD FOR DATA COMPRESSION OF VIDEO IMAGE INFORMATION WILL ALSO BE PURSUED AS WELL

AS WORK IN CONTINUING TO OBTAIN X-RAY IMAGES OF CHEST AND/OR ABDOMINAL ORGANS FOR STUDY DURING FLIGHT BY AN ON-BOARD X-RAY SYSTEM. WORK WILL CONTINUE IN SUPPORT OF ADVANCED INFLIGHT PROPOSALS FOR MANUAL NAVIGATIONAL SIGHTINGS, HUMAN TRANSFER FUNCTION, AND MEASUREMENT OF BONE DENSITOMETRY.

RTOP NO. 970-31-11 TITLE: NEUROPHYSIOLOGY - HUMAN RESPONSE TO THE INERTIAL ENVIRONMENT OF SPACE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

IN SPACE FLIGHT MAN IS EXPOSED TO THE STATE OF WEIGHTLESSNESS OR AS A POSSIBLE ALTERNATIVE HE MAY BE EXPOSED TO ARTIFICIAL GRAVITY. THESE INERTIAL CHARACTERISTICS OF THE SPACE ENVIRONMENT HAVE A DIRECT INFLUENCE ON MAN'S VESTIBULAR AND ASSOCIATED NEUROLOGICAL SYSTEMS, WHICH IN TURN AFFECT HIS CAPABILITY TO PERFORM AND SUSTAIN ADEQUATE PERFORMANCE OVER EXTENDED PERIODS. THE PURPOSE OF THIS RESEARCH IS TO EXTEND STUDIES OF THESE CONDITIONS AND EFFECTS. THE INERTIAL CONDITIONS OF THE SPACE ENVIRONMENTS SUCH AS REDUCED GRAVITY AND ROTATION WILL BE SIMULATED IN GROUND BASED FACILITIES AND EQUIPMENTS AND BY AIRPLANE FLIGHT TRAJECTORIES AND MAN'S RESPONSE AND PERFORMANCE WILL BE EXAMINED. PARTICULAR EMPHASIS WILL BE PLACED IN PROBLEMS OF SPATIAL ORIENTATION UNDER CONDITIONS OF ZERO AND REDUCED GRAVITY, OF MOTION SICKNESS INDUCED BY THE ENVIRONMENTAL CONDITIONS, AND OF VISUAL PERCEPTION. FURTHER, STUDIES OF ADAPTATION TO THE ENVIRONMENTAL CONDITION WILL ALSO BE EMPHASIZED. THE IMPROVEMENT OF BIOINSTRUMENTATION FOR EVALUATING HUMAN PERFORMANCE AND RESPONSE TO THE VARIOUS CONDITIONS OF THE SPACE ENVIRONMENT ARE REQUIRED AND ARE INCLUDED HERE AS OVERGUIDELINES.

RTOP NO. 970-31-51 TITLE: HUMAN BEHAVIOR AND PERFORMANCE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

TO ESTABLISH THE BASIC PRINCIPLES FOR OPTIMAL STRUCTURING OF SMALL GROUPS UNDER CONDITIONS OF ISOLATION, CONFINEMENT, AND OTHER STRESSES. TO ADVANCE KNOWLEDGE OF HUMAN CAPABILITIES AND LIMITATIONS IN BEHAVIOR AND PERFORMANCE RELEVANT TO ROLES MAN MUST FULFILL IN SPACE.MAJOR INITIAL EMPHASIS WILL BE PLACED ON THE DEVELOPMENT OF CRITERIA FOR THE SELECTION OF INDIVIDUALS FOR MEMBERSHIP IN GROUPS WHICH ARE ASSIGNED SPECIFIC MISSION TASKS. METHODS FOR CONTINUOUS ASSESSMENT OF PERFORMANCE AND GROUP INTERACTION OVER LONG PERIODS OF TIME WILL BE DEFINED AND VALIDATED. SUCH METHODS SHOULD BE SUFFICIENTLY SENSITIVE TO DETECT ALTERATION IN THE EFFECTIVENESS OF INDIVIDUAL AND GROUP FUNCTIONING UNDER ADVERSE CONDITIONS SUCH AS RHYTHM DESYNCHRONIZATION, SLEEP DEPRIVATION, AND SITUATIONAL STRESS. RESEARCH WILL BE DEVOTED TO THE PROGRAMMING OF ENVIRONMENTAL EVENTS AND PROCEDURES FOR THE PREVENTION AND CORRECTION OF UNDESIRABLE BEHAVIOR RESULTING FROM SOCIAL AND ENVIRONMENTAL CONDITIONS ANALOGOUS TO THOSE ENCOUNTERED IN SPACE FLIGHT.

RTOP NO. 970-32-10 TITLE:
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

SPACE MISSIONS REQUIRE HIGHLY RELIABLE LIFE SUPPORT SYSTEMS WHICH PROVIDE THE WATER, OXYGEN, FOOD WASTE REMOVAL, AND ENVIRONMENT CONTROL NEEDED TO SUSTAIN THE CREWMEN FOR LONG DURATIONS OF TIME. CANDIDATE SUBSYSTEMS, SUCH AS VAPOR DIFFUSION WATER RECLAMATION AND A ZERO GRAVITY SHOWER MUST BE DEVELOPED, SCALED UP TO REALISTIC CAPACITIES, INTEGRATED INTO COMPLETE SYSTEMS WITH EMPHASIS ON AUTOMATION, RELIABILITY, MAINTAINABILITY, AND PACKAGABILITY AND PERFORMANCE TESTED BY MEANS OF MANNED AND UNMANNED TESTS. IN-HOUSE AND CONTRACT RESEARCH IS UNDERWAY AND WILL BE SUPPLEMENTED TO FURNISH AND TEST THE MOST PROMISING UNITS TO PROVIDE THE LIFE SUPPORT FUNCTIONS. OPERATIONAL HARDWARE IS BEING DEVELOPED AND A MANNED TEST OF INTEGRATED SUBSYSTEMS OF ATMOSPHERE SUPPLY AND PRESSURE CONTROL, CARBON DIOXIDE REMOVAL AND REDUCTION, OXYGEN RECLAMATION, CONTAMINANT CONTROL, WATER AND WASTE MANAGEMENT, AND PERSONAL HYGIENE WILL BE PERFORMED. EFFORTS ARE ALSO DIRECTED TOWARD PROVIDING CHEMICAL, BACTERIAL, AND VIRAL ANALYTICAL LABORATORY SUPPORT WHICH INCLUDE NONPERSONAL SERVICE STAFFING AND OPERATION. A WASHER/DRYER AND DISHWASHER UNITS WILL BE DEVELOPED WHICH WILL PROVIDE FOR ZERO GRAVITY AND PARTIAL GRAVITY OPERATION. THESE UNITS WILL BE EVALUATED SINGLY AND AS INTEGRATED UNITS IN CONJUNCTION WITH THE SHOWER, WATER RECOVERY UNITS AND OTHER COMPONENTS OF THE LIFE SUPPORT SYSTEM. AN OVERGUIDELINE EFFORT IS INCLUDED TO CONTINUED STUDY OF EC/LSS COMPONENTS AND APPLICATIONS FOR SPACE SHUTTLE.

RTOP NO. 970-32-20 TITLE: FOOD, ATMOSPHERE, WATER, WASTE
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE PURPOSE OF THIS RESEARCH AND DEVELOPMENT PROGRAM IS TO PROVIDE THE TECHNOLOGY FOR LIFE SUPPORT SUBSYSTEMS FOR FUTURE NEAR EARTH MANNED SPACE MISSIONS. THIS EFFORT WILL PROVIDE THE NECESSARY DEVELOPMENT AND DESIGN VERIFICATION TESTING, BOTH IN-HOUSE AND ON CONTRACT TO DEMONSTRATE THE PRACTICALITY, THE RELIABILITY, AND THE ADEQUACY OF ADVANCED ENVIRONMENTAL-THERMAL CONTROL/LIFE SUPPORT SYSTEMS (ETC/LSS). EMPHASIS WILL BE PLACED ON THE ESTABLISHMENT OF PERFORMANCE DATA, MAINTENANCE REQUIREMENTS, FAILURE RATES, SUBSYSTEM AUTOMATION, AND INTERFACE REQUIREMENTS. THESE EFFORTS WILL BE CENTERED ON CURRENTLY PROMISING ADVANCED ETC/LSS SUBSYSTEM AND COMPONENT CONCEPTS, INCLUDING IMPROVED AMINE CARBON DIOXIDE CONCENTRATION, SOLID ELECTROLYTE CARBON DIOXIDE REDUCTION, SOLID POLYMER WATER ELECTROLYSIS, AND A COMPLETE CONTAMINANT CONTROL SYSTEM, INCLUDING REGENERABLE CHARCOAL. WATER AND WASTE MANAGEMENT EFFORTS WILL EMPHASIZE ADVANCED CONCEPT DEVELOPMENT AND DESIGN VERIFICATION TESTING, BOTH IN-HOUSE AND ON CONTRACT IN AN EFFORT TO OPTIMIZE BOTH THE WATER RECLAMATION PROCESSES THEMSELVES AS WELL AS THE ANCILLIARY REQUIREMENTS OF STORAGE, PROVISION, INVENTORY CONTROL, AUTOMATIC OPERATION, AND POTABILITY ASSAY. FURTHER DEVELOPMENT OF SENSING AND CONTROL MECHANISMS FOR CHLORINE GENERATION METHODS AS A

PART OF THE STERILIZATION EFFORT IS SUBMITTED AS OVERGUIDELINES. IN ADDITION, A NEW EFFORT ON HYDROGEN DEPOLARIZED CARBON DIOXIDE CONCENTRATION IS INCLUDED AS OVERGUIDELINE.

RTOP NO. 970-33-10 TITLE: WORK/MOBILITY IN ZERO/ARTIFICIAL GRAVITY
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE IS TO PERFORM STUDIES IN SIMULATED SPACE ENVIRONMENTS FOR DEVELOPING DEVICES, OPERATIONAL PROCEDURES AND DESIGN CRITERIA TO ASSIST MAN'S MOBILITY AND HIS ABILITY TO WORK IN SPACE.THE SPECIFIC OBJECTIVES ARE TO (A) PERFORM NEUTRAL BUOYANCY STUDIES AND ESTABLISH CRITERIA FOR SPACE VEHICLES INTRAVEHICULAR ACTIVITIES; (B) TO PROVIDE TECHNICAL AND OPERATIONS SUPPORT FOR SPACE SIMULATION ACTIVITIES; (C) TO STUDY MAN/USE ASSIST DEVICES FOR WEIGHTLESSNESS AND REDUCED GRAVITY; (D) TO STUDY HUMAN PERFORMANCE IN A ROTATING ENVIRONMENT AND DEVELOP DESIGN CRITERIA FOR ARTIFICIAL GRAVITY SPACECRAFT; AND (E) TO PERFORM STUDIES AND DEVELOP DESIGN CRITERIA FOR SHUTTLE EMERGENCY ESCAPE SYSTEMS, WHICH IS BEING SUBMITTED AS OVERGUIDELINES.

RTOP NO. 970-42-30 TITLE: CREW EQUIPMENT SYSTEMS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: CARPENTER, L. R. TEL. 805-258-3311
TECHNICAL SUMMARY

PROVIDE APPLIED TECHNOLOGY AND FLIGHT CONCEPT VERIFICATION OF RESTRAINT SUBSYSTEMS FOR EARLY SPACE SHUTTLE TEST VEHICLES, AND PROVIDE RESTRAINT AND ENVIRONMENTAL CONTROL SYSTEMS (ECS) TECHNOLOGY FOR THE SCALED SHUTTLE. SHUTTLE RESTRAINT AND CREW PROTECTION EQUIPMENT TECHNOLOGY THROUGH FABRICATION AND TEST OF CONCEPT VERIFICATION OF COCKPIT EQUIPMENT INCLUDING ENERGY ABSORPTION AND CREW SEATING AND RESTRAINT SUBSYSTEMS. SCALED SHUTTLE COCKPIT, ECS, AND RESTRAINT SYSTEMS TECHNOLOGY THROUGH DESIGN AND TESTING.

RTOP NO. 970-43-10 TITLE: SHUTTLE PILOT REQUIREMENTS
ORGANIZATION: FLIGHT RESEARCH CENTER
MONITOR: CARPENTER, L. R. TEL. 805-258-3311
TECHNICAL SUMMARY

TO DEVELOP INFORMATION AND PROCEDURES FOR THE SPACE SHUTTLE ON THE TERMINAL PHASES, APPROACH AND LANDING, AND THE COCKPIT VISIBILITY REQUIREMENTS FOR HIGH VELOCITY LETDOWN AND LANDING. EMPHASIZE THE UTILIZATION OF AIRCRAFT TO PERFORM RESEARCH ON SPACE SHUTTLE APPROACH ANGLES AND LANDING DYNAMICS TO IDENTIFY THE COCKPIT VISIBILITY CHARACTERISTICS FOR SAFETY DURING THE TERMINAL PHASE. EFFECTS OF SIDE VISION BLURRING DUE TO FAST APPROACHES AND FORWARD VISION DUE TO STRUCTURES INTERFERENCE WILL BE STUDIED IN AIRCRAFT.

RTOP NO. 970-52-10 TITLE: LIFE SUPPORT SYSTEMS PROGRAM
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: WILLIS, N. C. TEL. 713-483-2171
TECHNICAL SUMMARY

THE OBJECTIVE OF THE CURRENT ETC/LSS DEVELOPMENT PROGRAM IS TO DESIGN, DEVELOP AND TEST A FLIGHT PROTOTYPE SUBSYSTEM TO SUPPORT FUTURE LONG DURATION EARTH ORBITAL MISSIONS. AN EQUALLY IMPORTANT OBJECTIVE OF THIS PROGRAM IS TO EXERCISE A MANAGEMENT APPROACH TO ADVANCED HARDWARE DEVELOPMENT WHICH WILL REDUCE THE ULTIMATE COST OF FLIGHT SYSTEMS. THE PROGRAM PHILOSOPHY ENTAILS DEVELOPMENT OF THE ETC/LSS LIFE SUPPORT SYSTEM HARDWARE UTILIZING A FLIGHT QUALIFIABLE DESIGN WITH SUFFICIENT FLEXIBILITY, SUCH THAT THE PROGRAM COULD BE APPLICABLE TO A VARIETY OF MISSION CONSIDERATIONS. SPECIFICALLY, THE SPACE STATION PROTOTYPE (SSP) ETC/LSS MAINTAINS VEHICLE CABIN PRESSURE, PROVIDES A CONDITIONED SHIRTSLEEVE ATMOSPHERE FOR THE CREW, MAINTAINS THERMAL CONTROL OF ELECTRONIC EQUIPMENT AND CONTROL OF THE CLOSED-CYCLE WATER-SUPPLY SYSTEM AND SOLID WASTES, UTILIZING THE RECOVERY OF USEFUL PRODUCTS IN ORDER TO ACCOMMODATE LONG DURATION MISSIONS. THE PROGRAM DOES NOT PRESUME TO BE THE SPECIFIC DESIGN FOR A SPACE STATION; HOWEVER, THE REALISM ASSOCIATED WITH DESIGNING AND TESTING A SYSTEM WITH FLIGHT TYPE CONSIDERATIONS IS NECESSARY TO ATTACK THE SYSTEMS INTEGRATION AND MAINTENANCE CONCEPTS ASSOCIATED WITH ADVANCED ETC/LSS AND TO DEVELOP A LOW COST APPROACH TO MANAGING COMPLEX SYSTEMS FOR ADVANCED PROGRAMS. DEVELOP AN INTEGRATED SHUTTLE ENVIRONMENTAL/THERMAL CONTROL AND LIFE SUPPORT SYSTEM (ETC/LSS) PRELIMINARY DESIGN, INCLUDING HEAT REJECTION, WHICH OPTIMALLY MEETS THE OPERATIONAL FLEXIBILITY IMPOSED BY THE MISSION, AS WELL AS THE UNIQUE DESIGN CONSTRAINTS OF REUSABILITY, RAPID LAUNCH TURNAROUND, MINIMUM CREW PARTICIPATION AND GROUND SUPPORT, QUIESCENT----

RTOP NO. 970-52-20 TITLE: FOOD, ATMOSPHERE, WATER, AND WASTE SUBSYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: SAMONSKI, F. H. TEL. 713-483-5536
TECHNICAL SUMMARY

THE FOOD, ATMOSPHERE, WATER AND WASTE SUBSYSTEMS FOR ADVANCED SPACECRAFT REQUIRE ADVANCEMENT IN SEVERAL AREAS OF TECHNOLOGY IN ORDER TO PROVIDE AN ACCEPTABLE BASE OF CONFIDENCE FOR SPACE STATION/SHUTTLE APPLICATIONS. THE REQUIRED TECHNOLOGY BASE DICTATES THAT CERTAIN IMPROVEMENTS BE ACHIEVED IN ANALYTICAL TECHNIQUES AND IN HARDWARE DEVELOPMENTS. THE HARDWARE DEVELOPMENTS ARE INTENDED TO RESULT IN THE FABRRICATION AND EXTENSIVE EVALUATION OF FULL-SCALE DEVELOPMENT UNITS IN THE SPECIFIC AREAS OF FOOD SYSTEMS, WATER AND WASTE MANAGEMENT, INSTRUMENTATION, AND ATMOSPHERE SUPPLY AND CONTROL. THE HIGH REUSABILITY AND MINIMAL MAINTENANCE ASPECTS OF OPERATION, AS WELL AS OPERATIONAL FLEXIBILITY REQUIRED IN LIFE SUPPORT FOR VARIABLE NUMBERS OF CREW MEMBERS, COUPLED WITH A WIDE VARIATION IN THE REGIMES WHICH REQUIRE DIFFERENT HEAT REJECTION MECHANISMS, ARE ALSO KEY DRIVING REQUIREMENTS.THE ANALYSIS METHOD DEVELOPMENTS ARE INTENDED TO PROVIDE PERFORMANCE PREDICTIONS AND INDICATE SUBSYSTEM INTERACTIONS.

RTOP NO. 970-52-30 TITLE: CREW EQUIPMENT SYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: HAYS, E. L. TEL. 713-483-4933
TECHNICAL SUMMARY

DEFINE IV SUIT/LSS REQUIREMENTS AND SHUTTLE BOOSTER AND ORBITER INTERFACE REQUIREMENTS IN ORDER TO PROVIDE A BASELINE FOR THE PREPARATION OF DETAILED SPECIFICATIONS FOR IV EQUIPMENT. DESIGN, FABRICATE, AND TEST PROTOTYPES OF ADVANCED TECHNOLOGY SUITS. THIS EFFORT WILL BE COORDINATED WITH THE SHUTTLE SUIT/LSS REQUIREMENTS DEFINITION PROGRAM IN ORDER TO INCORPORATE DEFINITE SHUTTLE REQUIREMENTS WHERE POSSIBLE. DEFINE EVA EQUIPMENT/SHUTTLE INTERFACE REQUIREMENTS AND DEFINE EXPECTED EVA REQUIREMENTS IN ORDER TO PROVIDE A BASELINE FOR THE PREPARATION OF DETAILED SPECIFICATIONS FOR EVA EQUIPMENT. ADVANCE THE STATE-OF-THE-ART TO DEVELOP AN ELASTOMERIC FIBROUS MATERIAL THAT SHALL BE FLAME RESISTANT IN AN OXYGEN ENRICHED ATMOSPHERE OF 10 PSIA AT 65/35 RATIO OF NITROGEN AND OXYGEN. THE FIBER SHALL POSSESS PHYSICAL PROPERTIES EQUIVALENT TO THOSE OF SPANDEX. FURTHERMORE, THIS MATERIAL ALSO SHALL BE CAPABLE OF MOLDING AND EXTRUSION AND MAINTAIN RESILENCY AND ELASTICITY. ADVANCE THE STATE-OF-THE-ART FOR RESTRAINT AND SUPPORT OF PERSONNEL DURING LONG TERM EYEBALLS-DOWN ACCELERATIONS AFTER PERIODS OF WEIGHTLESSNESS AND VERTICAL LAUNCH. TRADE-OFF STUDIES TO DETERMINE THE BEST METHOD OF SUPPORT AND RESTRAINT TO INSURE ENTRY CAPABILITY AFTER WEIGHTLESSNESS. DESIGN STUDY TO MEET NEWER SPACECRAFT REQUIREMENTS.

RTOP NO. 970-53-10 TITLE: SHUTTLE CREW TRAINING REQUIREMENTS AND MAINTAINABILITY
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: MCELMURRY, T. U. TEL. 713-483-6416
TECHNICAL SUMMARY

THE GOAL OF THIS RESEARCH AND TECHNOLOGY OPERATING PLAN IS TO DEVELOP A SET OF PROCESS AND PRODUCT SPECIFICATIONS AND SIMULATOR REQUIREMENTS SPECIFICATIONS WHICH CAN BE USED TO INITIATE DEVELOPMENT OF OPERATIONAL TECHNIQUES AND RESOURCES ASSOCIATED WITH CREW INTEGRATION, CREW TRAINING AND CREW OPERATIONS FOR SPECIFIC NEAR FUTURE MANNED SPACE PROGRAMS. TASK 21 - SHUTTLE FULL MISSION SIMULATOR DEFINITION STUDY - THIS TASK DEVELOPS AND DOCUMENTS THE REQUIREMENTS SPECIFICATIONS FOR A SHUTTLE FULL MISSION SIMULATOR AND PROVIDES A BASIS FOR INITIATION OF SIMULATOR DESIGN. TASK 22 - SHUTTLE SIMULATOR VISUAL SYSTEM DEFINITION STUDY - THIS TASK DEVELOPS AND DOCUMENTS THE REQUIREMENTS SPECIFICATIONS FOR A SHUTTLE CREW TRAINING VISUAL SIMULATION SYSTEM. TASK 31 - IN-FLIGHT MAINTENANCE AND STOWAGE OPERATIONS STUDY (PHASE II) - THIS TASK DEVELOPS PROCESS AND PRODUCT SPECIFICATIONS FOR CONTROLLING AND MANAGING CREW INTERFACE REQUIREMENTS FOR IN-FLIGHT MAINTENANCE AND STOWAGE FUNCTIONS.

RTOP NO. 970-53-20 TITLE: ATTACHED MANIPULATOR SYSTEM FOR SHUTTLE AND SPACE STATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: DAVIDSON, R. B. TEL. 713-483-3319
TECHNICAL SUMMARY

ANALYSIS AND EVALUATION WILL BE CONTINUED OF A MANIPULATOR TECHNIQUE FOR DOCKING THE SHUTTLE IN EARTH ORBIT, LOADING AND UNLOADING SHUTTLE CARGO, AND ASSEMBLING A MODULAR SPACE STATION FROM SHUTTLE-LAUNCHED MODULES. THE ANALYSIS WILL INVOLVE INTEGRATED SYSTEMS TO DEMONSTRATE THE SUBSYSTEM TECHNOLOGY. THE OBJECTIVES OF THIS EFFORT WILL BE TO DEVELOP THE FINAL DEFINITION OF THE SELECTED MANIPULATOR CONCEPTS FROM THE STUDY CONDUCTED UNDER FY71 RTOP 127-51-40 AND TO CONDUCT AN IN-HOUSE SIMULATION PROGRAM TO INVESTIGATE AND EVALUATE VARIOUS MANIPULATOR TECHNIQUES AND CONCEPTS.

RTOP NO. 970-53-30 TITLE: ADVANCED BIOINSTRUMENTATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: POOL, S. L. TEL. 713-483-4121
TECHNICAL SUMMARY

SINCE THE FIRST SUCCESSFUL LUNAR LANDING IN 1969, THE NASA HAS BEEN PLACING MORE AND MORE EMPHASIS ON SCIENTIFIC ENDEAVORS IN THE SPACE ENVIRONMENT. THE APOLLO EXPERIMENTS PROGRAM HAS BEEN EXPANDED, THE EXPERIMENTAL EMPHASIS OF THE SKYLAB PROGRAM CONTINUES AND THE CORE LABORATORY APPROACH TO SPACE STATION EXPERIMENTS IS EVIDENCE OF THE EMPHASIS ON SCIENTIFIC ENDEAVOR IN ADVANCE AGENCY PLANNING. THE LIFE SCIENCES PROGRAMS ARE WELL SUITED TO CARRY FORWARD THE SCIENTIFIC INTEREST IN THE SPACE ENVIRONMENT AND ITS AFFECTS ON MAN. IN ORDER TO ADEQUATELY PREPARE FOR FUTURE MISSIONS, THE LIFE SCIENCES PROGRAM HAS ORIGINATED AND PROPOSED PROGRAMS IN A WIDE VARIETY OF FIELDS OF MEDICAL INTEREST INCLUDING ADVANCED BIOINSTRUMENTATION EFFORTS. THE ADVANCED BIOINSTRUMENTATION PROGRAMS PROPOSED IN THIS RTOP INCLUDE MANY ONGOING EFFORTS ALONG WITH A LIMITED NUMBER OF NEW PROGRAMS. THE SCOPE OF THE RTOP IS BROAD IN THE SENSE THAT A DIVERSE GROUP OF FIELDS ARE COVERED FROM NEUROLOGY TO ADVANCED ENGINEERING. THE OVERALL THRUST OF THE ADVANCED BIOINSTRUMENTATION PROGRAMS IS TO DEVELOP AND TEST BIOINSTRUMENTATION TECHNIQUES WHICH APPEAR MOST PROMISING FROM THE STANDPOINT OF (1) PROVIDING A UNIQUELY SPACE APPLICABLE TECHNIQUE ADAPTED FROM GROUND BASED TECHNOLOGY TO (2) A BASIC ADVANCE IN THE STATE-OF-THE-ART FROM BIOINSTRUMENTATION ON EARTH AS WELL AS SPACE.

RTOP NO. 970-53-50 TITLE: HABITABILITY FUNCTIONAL MOCKUP EVALUATION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: LOUVIERE, A. J. TEL. 713-483-4966
TECHNICAL SUMMARY

TO DESIGN, DEVELOP AND FABRICATE PROTOTYPE HARDWARE FOR A GALLEY/WARDROOM COMPARTMENT INCLUDING HYGENIC PROVISIONS. THE DESIGN SHALL INCLUDE: ALL AREA FURNISHINGS; ARCHITECTURAL CONSIDERATIONS FOR VOLUME, ARRANGEMENT, ORIENTATION AND AESTHETICS; ENVIRONMENTAL DESIGN FOR LIGHTING, ACOUSTICS, COLOR, TEMPERATURE AND GRAVITY

LEVELS; AND THE ACCEPTANCE OF ALL ELECTRICAL OR MECHANICAL EQUIPMENT INSTALLATIONS.THE DESIGN WILL ALSO REFLECT ANALYSIS OF MOBILITY AND RESTRAINT AIDS, FOOD AND HYGIENE SYSTEM DEVELOPMENT, AND HOUSEKEEPING TECHNIQUES. THE RESULTANT PROTOTYPE COMPARTMENTS WILL BE TESTED UNDER EARTH CONDITIONS FOR FEASIBILITY AND POTENTIAL PROBLEM AREAS. UTILIZING SPECIFICATIONS AND DRAWINGS PROVIDED BY FY71 FUNDED STUDIES, FABRICATE HOUSEKEEPING EQUIPMENT IN THE FORM OF WASTE SHREDDER, COMPACTOR, WASTE CONTAINER AND VACUUM CLEANER FOR TERRESTRIAL TESTING AND EVALUATION. EQUIPMENT WILL ALSO BE USED FOR IN-HOUSE MSC MANNED TEST PROGRAMS SUCH AS A SIMULATED SPACE STATION TEST. WORKING FROM CONCEPTS PROVIDED BY MSC, DESIGN AND FABRICATE A CARGO LOCKER STORAGE SYSTEM FOR SUBSEQUENT FEASIBILITY TESTING AT MSC AND LANGLEY RESEARCH CENTER. THIS HARDWARE DEVELOPMENT AND TESTING PROGRAM IS AIMED AT REDUCING THE CARGO LOADING, UNLOADING AND TRANSFER PROBLEMS ASSOCIATED WITH SHUTTLE LOGISTICS FLIGHTS. CARGO LOCKER, LOCKING MECHANISMS AND RACK DESIGN, CONSTRUCTION, AND INSTALLATION WILL BE INVOLVED IN THE DESIGN AND FABRICATION.

RTOP NO. 970-62-20 TITLE: FOOD, ATMOSPHERE, WATER AND WASTE MANAGEMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: HOPSON, G. D. TEL. 205-453-3832
TECHNICAL SUMMARY

THE PURPOSE OF THIS RTOP IS TO PROVIDE THE TECHNOLOGY FOR SPACE APPLICATION NECESSARY TO ASSURE PROPER CONTROL OF HUMAN WASTES, ATMOSPHERE TEMPERATURE AND CO2 LEVELS, RECOVERY OF POTABLE WATER AND RELIABLE AND LONG LIVED MECHANICAL COMPONENTS FOR THE ABOVE SYSTEMS. INHOUSE PROFESSIONAL MANPOWER TO SUPPORT THIS PROGRAM IN FY 72 IS APPROXIMATELY THREE MEN. NOMINAL DURATION OF THE CONTRACTS IN THESE TASKS WILL BE ONE YEAR.

RTOP NO. 970-63-10 TITLE: REQUIREMENTS FOR WORK PERFORMANCE DESIGN
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: LEWIS, C. S. TEL. 205-453-3743
TECHNICAL SUMMARY

TO MAXIMIZE HUMAN PERFORMANCE, TWO MAJOR EFFORTS SHOULD BE UNDERTAKEN; I.E., THE DEFINITION OF LABORATORY WORKSTATION REQUIREMENTS TO MAXIMIZE THE PRODUCTIVITY OF THE SCIENTIFIC RESEARCHER AND A CORRELATED SET OF EXPERIMENTS DEDICATED TO A COMPREHENSIVE EXAMINATION OF MAN/SYSTEM PERFORMANCE CAPABILITIES. FUNCTIONAL PERFORMANCE REQUIREMENTS WILL BE DEVELOPED THROUGH TASK ANALYSES PERFORMED ON RESEARCH AND APPLICATION EXPERIMENTS FROM THE BLUE BOOK, WITH PRIORITY ASSIGNED TO THE FOLLOWING: LIFE SCIENCES, EARTH RESOURCES, ASTRONOMY, SPACE PHYSICS, AND MATERIALS PROCESSING. REQUIREMENTS ALLOCATION WILL BE GENERATED WHICH WILL BE EXPANDED INTO WORK STATION DESIGN REQUIREMENTS AND GUIDELINES AND CONSTRAINTS. EXPERIMENT SUPPORT REQUIREMENTS WILL BE SEPARATED INTO "INTEGRAL" OR "CARRY-ON" EQUIPMENT, TAKING INTO CONSIDERATION THE TOTAL SYSTEM REQUIREMENTS FOR EXPERIMENT ACCOMMODATION.WORKSTATION CONCEPTS WILL BE DEVELOPED WHICH INCORPORATE COMMON EQUIPMENT AND PROVIDE

INTERFACES FOR CARRY-ON EQUIPMENT SO AS TO ALLOW TO THE MAXIMUM EXTENT PRACTICABLE STANDARD EARTH-BASED LABORATORY TECHNIQUES. REQUIREMENTS WILL BE COMPARED WITH EXISTING TECHNOLOGY AND AVAILABLE HARDWARE CONCEPTS FROM CURRENT AND PAST PROGRAMS TO IDENTIFY AREAS WHERE ADDITIONAL TECHNOLOGY IS REQUIRED. MOCKUPS WILL BE CONSTRUCTED OF DEVELOPED CONCEPTS AND SIMULATIONS WILL BE CONDUCTED TO VERIFY BOTH THE CONCEPTS AND THE CRITERIA. IN THE ASSESSMENT OF MAN'S WORK PERFORMANCE IN ZERO AND PARTIAL GRAVITY, OBJECTIVE ESTIMATES OF OBSERVED CHANGES ARE UNAVAILABLE. EXPERIMENTS WILL BE CONDUCTED DEDICATED TO A COMPREHENSIVE EXAMINATION OF THE MAN-SYSTEM PERFORMANCE CAPABILITIES IN ZERO "G",

RTOP NO. 970-63-20 TITLE: TELEOPERATOR CONTROL AND MANIPULATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: JOHNSON, W. G. TEL. 205-453-1115
TECHNICAL SUMMARY

TO DEVELOP THE COMPONENT AND INTEGRATED SYSTEM TECHNOLOGY REQUIRED FOR THE UTILIZATION OF TELEOPERATORS IN SPACE SHUTTLE PAYLOAD, ORBITING STATION, AND SURFACE EXPLORATION MISSIONS. THROUGH IN-HOUSE AND CONTRACTED STUDIES, AND STATE OF THE ART SURVEYS, ESTABLISH THE FUNCTIONAL AND PERFORMANCE REQUIREMENTS FOR TELEOPERATORS PROPOSED FOR SPACE SHUTTLE PAYLOAD MISSIONS. THROUGH IN-HOUSE AND CONTRACTED EFFORTS PERFORM SIMULATIONS TO ESTABLISH SYSTEM AND SUBSYSTEM PARAMETERS, DESIGN AND OPERATIONAL CRITERIA AND METHODS, AND FOR THE EVALUATION OF EXISTING HARDWARE. CONDUCT FEASIBILITY STUDIES AND TECHNICAL INVESTIGATIONS TO THE SUBSYSTEM LEVEL IN: ADVANCED MANIPULATOR AND END EFFECTOR CONCEPTS; VISUAL SENSORS AND DISPLAYS FOR MANIPULATION AND MOBILITY UNITS; MOBILITY UNIT REMOTE NAVIGATION AND CONTROL; HUMAN ENGINEERING AND MAN-MACHINE INTEGRATION; AND SYSTEM ANALYSIS AND DEFINITION. BOTH IN-HOUSE AND CONTRACTED EFFORTS WILL BE UTILIZED. PERFORM PRELIMINARY DESIGN OF AN ENGINEERING MODEL OF A MANIPULATOR SYSTEM. IT WILL CONSIST OF MANIPULATORS, VISUAL SENSORS, COMMUNICATIONS, AND REMOTE CONTROL STATION. FINAL DESIGN AND FABRICATION WILL BE EITHER IN-HOUSE OR CONTRACTED. IT WILL BE FULLY EVALUATED AS A SUBSYSTEM AND FURTHER AS AN INTEGRAL PART OF A SYSTEM CONSISTING OF THE MANIPULATOR AND A GUIDANCE, NAVIGATION, AND CONTROL TEST VEHICLE. THROUGH IN-HOUSE AND CONTRACTED EFFORTS CONDUCT PHASED MISSION FEASIBILITY AND DEFINITION STUDIES FOR SPACE SHUTTLE PAYLOADS.

RTOP NO. 970-63-50 TITLE: MAN/SYSTEM INTEGRATION CRITERIA - DEVELOPMENT AND EVALUATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: WATTERS, H. H. TEL. 205-453-3748
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO CONTINUE AND CONSOLIDATE THE DEVELOPMENT, VERIFICATION AND APPLICATION OF MAN/SYSTEM INTEGRATION CRITERIA RESULTING FROM RECENT EMPIRICAL STUDIES OF THE LARC 90-DAY CHAMBER TEST AND PROJECT TEKTITE II. MSFC WILL WORK IN THE FOLLOWING AREAS: (1) VERIFICATION OF HABITABILITY GUIDELINES AND CRITERIA, (2)

MAN/SYSTEM PERFORMANCE ASSESSMENT, AND (3) MAINTAINABILITY ASSESSMENT. THESE RESEARCH PROGRAMS WILL UTILIZE AND HELP DEFINE A MANNED SYSTEMS SIMULATOR CURRENTLY UNDER DEVELOPMENT AT MARSHALL SPACE FLIGHT CENTER. THIS SIMULATOR, SIZED TO BE COMPATIBLE WITH EVENTUAL SPACE SHUTTLE CAPABILITIES, WILL BE DESIGNED TO ACCOMMODATE SIX MEN WITHOUT RESUPPLY FOR 30 DAYS. PLANS CALL FOR INCORPORATION OF AN EXPERIMENT AREA (OR GENERAL PURPOSE LAB) AS WELL AS CREW QUARTERS. SIMULATOR DESIGN WILL STRESS FLEXIBILITY TO PERMIT RESULTS OF MAN/SYSTEM TESTING TO BE ITERATIVELY EVALUATED. SIMULATOR DEVELOPMENT COSTS ARE NOT A PART OF THIS RTOP EXCEPT FOR THOSE HARDWARE COSTS DIRECTLY AND UNIQUELY SUPPORTIVE OF THE TASKS RELATED TO THIS RTOP.

RTOP NO. 970-71-61 TITLE: REGULATORY BIOLOGY
ORGANIZATION: WALLOPS STATION
MONITOR: HOLTON, E. M. TEL. 703-824-3411
TECHNICAL SUMMARY

TO UNDERSTAND THE BIOCHEMICAL AND PHYSIOLOGIC MECHANISMS ASSOCIATED WITH THERMOREGULATION AND THE RESPONSE OF LIVING SYSTEMS TO A RANGE OF ENVIRONMENTAL TEMPERATURES. THE PRINCIPLE OF DEPRESSED METABOLISM WILL BE EXPLORED AS A POTENTIAL SIMULATOR OF WEIGHTLESSNESS, AN ANTAGONIST TO RADIATION-INDUCED DAMAGE AND THE UNDERSTANDING OF THE MECHANISMS OF DELAYED METABOLISM WHICH ALLOW INJURY REPAIR PROCESSES TO AVOID UNTOWARD EFFECTS. DIFFERENCES IN FUNCTION WILL BE ESTABLISHED BETWEEN RAPIDLY METABOLIZING SYSTEMS AND THOSE MORE MATURE AND METABOLICALLY STABLE. REGULATORY, INTERMEDIARY PATHWAYS ARE BEING ESTABLISHED.

RTOP NO. 970-83-20 TITLE: ADVANCED TELEOPERATOR SYSTEMS REQUIREMENTS
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: HEER, E. TEL. 213-354-3060
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY AND DEVELOP THE REQUIREMENTS FOR MAN IN THE USE OF TELEOPERATORS/ROBOTS FOR SPACE EXPLORATIONS WHERE MAN IS LOCATED AT A REMOTE CONTROL STATION. THIS WORK WILL GIVE INSIGHT INTO THE FUNCTIONS TO BE ALLOCATED BETWEEN MAN AND MACHINE FOR REMOTE OPERATIONS ON LUNAR AND PLANETARY SURFACES. (1) THE TECHNOLOGY REQUIREMENTS WILL BE IDENTIFIED AND DEVELOPED FOR DISPLAYS, CONTROLS, COMMUNICATIONS AND ARTIFICIAL INTELLIGENCE FOR PLANETARY EXPLORATIONS USING TELEOPERATORS/ROBOTS. (2) ANALYTICAL STUDIES AND LABORATORY EXPERIMENTS WILL BE PERFORMED TO DEFINE THE PERFORMANCE REQUIREMENTS FOR MAN IN LUNAR AND PLANETARY EXPLORATION USING TELEOPERATOR/ROBOT SYSTEMS WHERE MAN IS LOCATED AT A DISTANT SITE. OPTIMUM FUNCTION ALLOCATIONS BETWEEN MAN AND MACHINE WILL BE ESTABLISHED FOR DIFFERENT COMMUNICATION TIME DELAY REQUIREMENTS. (3) SIMULATED AUTOMATED ROVER CONTROL AND NAVIGATION STUDIES WILL BE PERFORMED WHERE MAN IS CONTROLLING FROM AN EARTH BASE. THIS WORK WILL BE COORDINATED WITH RELATED EFFORTS AT LARC AND MSFC.

RTOP NO. 975-03-04 TITLE: ADVANCED FORMING AND PROCESSING
ORGANIZATION: LEWIS RESEARCH CENTER
MONITOR: LAD, R. A. TEL. 216-433-6601
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO EXPLORE THE POTENTIAL OF EARTH ORBITAL SPACE IN THE MANUFACTURE OF NEW MATERIALS. TECHNIQUES WILL BE DEVELOPED FOR THE PREPARATION OF ULTRAPURE METALS UNDER SPACE VACUUM AND LOW GRAVITY CONDITIONS. METHODS WILL BE EXAMINED FOR THE PREPARATION OF POROUS BODIES WHICH WOULD HAVE APPLICATION AS CATALYSTS FOR SUCH PURPOSES AS WATER PURIFICATION AND PETROCHEMISTRY. FULLY DENSE BODIES WILL BE PREPARED WHICH CAN BE EXPECTED TO HAVE ENTIRELY NEW PROPERTIES. CONSOLIDATION METHODS WILL INCLUDE COLD PRESSING AND SLIP CASTING.

RTOP NO. 975-79-03 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS (SUPERFLUID HELIUM)
ORGANIZATION: JET PROPULSION LABORATORY
MONITOR: LUCAS, J. W. TEL. 213-354-4530
TECHNICAL SUMMARY

TO PERFORM BASIC RESEARCH IN THE PHYSICS OF SOLIDS AND LIQUIDS, ASUPERFLUID HELIUM EXPERIMENT WILL BE DEFINED TO BE PERFORMED IN AN EARTH ORBITING LABORATORY, AND TO BE USED TO STUDY THE UNUSUAL PROPERTIES OF SUPERFLUID DROPS. THIS EXPERIMENT - THE FIRST TO OBSERVE THE HYDRODYNAMICS OF SUPERFLUID HELIUM IN THE ABSENCE OF CONSTRAINING WALLS - WILL HELP ANSWER THE QUESTION: WHAT ROLE DO SUCH WALLS PLAY IN THE MANY AND VARIED PHENOMENA THAT HAVE BEEN OBSERVED IN SUPERFLUID HELIUM IN THE LAST THIRTY YEARS? THE PHENOMENON OF SUPERCONDUCTIVITY ALSO ENTERS THE EXPERIMENT: THE ARRAY OF MAGNETIC VORTICES IN A SOLID SPHERE OF HARD SUPERCONDUCTOR SHOULD MODEL THE ARRAY OF VORTICES IN A SPHERICAL DROP OF SUPERFLUID HELIUM SO THAT KNOWLEDGE OF ONE ARRAY COULD SHED LIGHT ON THE OTHER. SUPERCONDUCTIVITY ENTERS ANOTHER WAY. IN THE EXPERIMENT, THE VORTICES WITHIN THE DROP WILL BE GENERATED BY THE NOVEL USE OF SMALL SUPERCONDUCTING SPHERES. THESE ARE SUSPENDED WITHIN THE DROP AND MADE TO ROTATE BY AN IMPOSED MAGNETIC FIELD. THIS EFFECT MAY ITSELF HAVE AN APPLICATION INDICATING THAT A SMALL SUPERCONDUCTING SPHERE CAN DETECT A MAGNETIC FIELD. TECHNIQUES TO BE DEVELOPED IN THE DESIGN AND PERFORMANCE OF THE EARTH-ORBITING EXPERIMENT FOR HANDLING, AND EVEN MANUFACTURING, SUPERFLUID HELIUM IN SPACE WILL BE USEFUL FOR FUTURE SPACE MISSIONS. THE USE ON FUTURE MISSIONS OF: A) LARGE SUPERCONDUCTING MAGNETS NEEDED TO MEASURE ENERGETIC PARTICLES, B) JOSEPHSON JUNCTIONS TO MEASURE SMALL MAGNETIC FIELDS, AND C) COOLED DETECTORS TO MEASURE LOW FREQUENCY RADIATION, ALL WILL REQUIRE USE OF LIQUID HELIUM. SUPERFLUID HELIUM, UNLIKE ORDINARY LIQUIDS, WILL NOT BOIL - IT IS A "QUIET" LIQUID - AND MOREOVER IS A HEAT CONDUCTOR A THOUSAND TIMES BETTER THAN COPPER. A

RTOP NO. 975-79-03 TITLE: ORBITAL FATIGUE EXPERIMENT
ORGANIZATION: LANGLEY RESEARCH CENTER
MONITOR: DAVIDSON, J. R. TEL. 703-827-3012
TECHNICAL SUMMARY

THE DEVELOPMENT OF LONG-LIVED SPACE VEHICLES REQUIRES KNOWLEDGE OF THE FATIGUE BEHAVIOR OF ENGINEERING MATERIALS IN THE SPACE ENVIRONMENT. DATA FROM EARTH-BOUND TESTS IN SIMULATED ENVIRONMENTS MUST BE CORRELATED WITH DATA OBTAINED IN ORBIT. THE CAPABILITY FOR CONDUCTING FATIGUE TESTS IN ORBIT WILL BE DEVELOPED IN THREE PHASES. SPECIMEN GEOMETRY AND SIZE WILL BE DETERMINED IN PHASE I. A FATIGUE TESTING MACHINE WILL BE DESIGNED IN PHASE II. ONE PROTOTYPE MACHINE WILL BE CONSTRUCTED AND TESTED IN A HARD VACUUM IN GROUND FACILITIES IN PHASE III. OPERATION IN ORBIT WILL BE ACCOMPLISHED WHEN A VEHICLE IS AVAILABLE.

RTOP NO. 975-84-46 TITLE: HIGH ALTITUDE PARTICLE PHYSICS EXPERIMENT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: KURZ, R. J. TEL. 713-483-5171
TECHNICAL SUMMARY

HIGH ENERGY COSMIC RAY PHYSICS EXPERIMENTS WILL BE PERFORMED ON HIGH-ALTITUDE BALLOON FLIGHTS OF EXPERIMENT PAYLOADS INCORPORATING A SUPERCONDUCTING MAGNETIC SPECTROMETER. THE BALLOON-BORNE EXPERIMENTS WILL YIELD SIGNIFICANT NEW DATA ON THE COSMIC RADIATION AND ESSENTIAL FLIGHT EXPERIENCE WITH TECHNIQUES AND INSTRUMENTATION THAT ARE FORERUNNERS OF THOSE PROPOSED FOR FUTURE EARTH ORBITAL MISSIONS (BOTH MANNED AND UNMANNED). THESE ACTIVITIES WILL MAKE VITAL CONTRIBUTIONS TO SPACE STATION AND SPACE SHUTTLE EXPERIMENT DEFINITION AND DEVELOPMENT, ESPECIALLY IN THE AREA OF EXPERIMENTS INVOLVING SUPERCONDUCTING MAGNETIC SPECTROMETERS.

RTOP NO. 976-30-01 TITLE: SPACE SHUTTLE STRUCTURAL DESIGN CRITERIA
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: KEY, J. E. TEL. 205-453-4349
TECHNICAL SUMMARY

DESIGN CRITERIA WERE DEVELOPED DURING PHASE A OF THE SHUTTLE DEVELOPMENT STUDIES; HOWEVER, THESE DESIGN CRITERIA WERE VERY GENERAL AND DID NOT CONTAIN DETAILS THAT APPLY TO SPECIFIC CONFIGURATIONS OR MISSIONS. ADDITIONAL CRITERIA WILL BE DEVELOPED FOR THE CONFIGURATIONS AND MISSIONS SELECTED DURING THE PHASE B STUDIES. IN ADDITION, STRUCTURAL CRITERIA PROBLEM AREAS IDENTIFIED IN THE PHASE A AND PHASE B EFFORTS WILL BE STUDIED IN DEPTH TO DETERMINE THE REQUIRED YIELD, PROOF, AND ULTIMATE FACTORS FOR STRUCTURES AND PROPELLANT TANKS, DETERMINE METHODS OF COMBINING LOADS AND ENVIRONMENTAL CONDITIONS, AND DETERMINE THE FAIL-SAFE APPROACH FOR STRUCTURES. THIS RTOP IS A CONTINUATION OF THE EFFORT INITIATED IN RTOP'S 908-52-01 AND 976-30-61. FY 72 FUNDS OF $300K AND A MANPOWER LEVEL OF .6 MANYEARS ARE REQUIRED TO CONTINUE THIS EFFORT.

RTOP NO. 976-30-04 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION SUBSYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: TEL. 205-453-3845
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS THE ESTABLISHMENT OFTHE TECHNOLOGY BASE COMPLEMENTARY OF THAT BEINGDEVELOPED UNDER RTOP 731-13-48 AND THE MANNEDSPACE FLIGHT CENTER AUXILIARY PROPULSION SYSTEMTECHNOLOGY PROGRAM. THE FY72 EFFORT WILL CONTINUETHE LIQUID HYDROGEN (LH2) AND LIQUID OXYGEN (LO2)TURBOPUMP ASSEMBLIES (TPA) TECHNOLOGY DEVELOPMENT.CONCEPT SCREENING, DETAIL DESIGN, FABRICATION,TESTING, HARDWARE DELIVERIES AND TECHNICAL SUPPORTFOR NASA INHOUSE APS TESTING WILL BE PROVIDED BYINDUSTRY UNDER MSFC CONTRACT. ADVANCEDDEVELOPMENT WILL PROVIDE AN EARLY IDENTIFICATIONAND SOLUTION OF POTENTIAL CRITICAL TPA PROBLEMAREAS.

RTOP NO. 976-30-04 TITLE: ATTITUDE CONTROL PROPULSION
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: POHL, H. O. TEL. 713-483-4971
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO IMPROVE THE REACTION CONTROL SYSTEM (RCS) DEVELOPMENT POSTURE FOR THE SPACE SHUTTLE BY ACQUIRING COMPONENT DESIGN AND OPERATING DATA WHICH WILL SUPPORT AND BE DIRECTLY APPLICABLE TO THE PHASE C AND EARLY PHASE D MAINSTREAM VEHICLE EFFORTS. THE PROGRAMS TO BE ACCOMPLISHED UNDER THIS RTOP WILL BE FOCUSED ON THE ANALYSIS, DESIGN, DEVELOPMENT AND FABRICATION OF REALISTIC AND REPRESENTATIVE PROPELLANT CONDITIONING COMPONENTS FOR A HIGH PRESSURE OXYGEN-HYDROGEN RCS BREADBOARD TEST SYSTEM. SPECIFIC PROGRAMS WILL BE INITIATED TO DEVELOP GAS GENERATOR/TURBOPUMP ASSEMBLIES, AND GAS GENERATOR/HEAT EXCHANGER ASSEMBLIES FOR BOTH OXYGEN AND HYDROGEN BASED UPON BEST CURRENT JUDGMENTS OF SHUTTLE RCS REQUIREMENTS. PROGRAMS WILL BE INITIATED TO DEVELOP PRESSURE REGULATORS AND MASS FLOW REGULATORS FOR BOTH HYDROGEN AND OXYGEN. A PROGRAM WILL ALSO BE INITIATED TO STUDY OVERALL PROPELLANT CONDITIONING SYSTEM CONTROLS, ESPECIALLY AS THEY RELATE TO CONTROL OF THE GAS GENERATORS. TO CONSOLIDATE THESE HARDWARE DEVELOPMENT AND FABRICATION PROGRAMS, A PROGRAM WILL BE UNDERTAKEN TO DESIGN AND BUILD UP A BREADBOARD TEST SYSTEM AT MSC IN WHICH THE PROPELLANT CONDITIONING ASSEMBLY COMPONENTS CAN BE OPERATED AND EVALUATED ON A SEPARATE COMPONENT OR COMPLETE ASSEMBLY BASIS. THE DATA AND INFORMATION FROM THESE SIX PROGRAMS WILL PERMIT EARLY IDENTIFICATION AND CONSIDERATION OF COMPONENT AND SYSTEM DESIGN PROBLEMS BY NASA AND THE PRIME VEHICLE CONTRACTOR, AND WILL INSURE THAT ASSIGNED OR IMPLIED COMPONENT AND SYSTEM FUNCTIONAL REQUIREMENTS ARE CONSISTENT WITH REALISTICALLY ACHIEVABLE GOALS.

RTOP NO. 976-30-05 TITLE: SPACE SHUTTLE - ELECTRICAL POWER - MARK I FUEL CELL DEVELOPMENT
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: RICE, W. E. TEL. 713-483-5273
TECHNICAL SUMMARY

THIS EFFORT REPRESENTS A 12-MONTH CONTINUATION OF EXISTING CONTRACTS WITH PRATT AND WHITNEY AIRCRAFT (NAS 9-11034) AND GENERAL ELECTRIC COMPANY (NAS 9-11033) WITH THE OBJECTIVE OF ADVANCING THE TECHNOLOGY OF THE BASIC ELECTROLYTE FUEL CELL AND ACID FUEL CELL RESPECTIVELY. PRIMARY OBJECTIVES OF BOTH PROGRAMS ARE TO IDENTIFY THE PROBLEMS AND FORMULATE THE SOLUTIONS REQUIRED TO DESIGN AND FABRICATE A FUEL CELL HAVING A LIFE CAPABILITY OF 5000 HOURS. THE APPROACH UTILIZED IN ACHIEVING THESE OBJECTIVES IS TO DEFINE A LOGICAL TECHNICAL EXTENSION OF THE PRESENT (FY71) EFFORT, A 2000-HR. OBJECTIVE, WHICH CONCENTRATES ON THE SPECIFIC LIMITING AREAS IDENTIFIED IN THE PREVIOUS PROGRAM. THE SPECIFIC TECHNICAL TASKS ARE FURTHER DIRECTED TOWARD DIRECT SUPPORT OF THE SPACE SHUTTLE REQUIREMENTS BY MAINTAINING AN ACTIVE LIAISON EFFORT BETWEEN THE FUEL CELL CONTRACTOR AND THE PRIME SHUTTLE CONTRACTOR.

RTOP NO. 976-30-38 TITLE: MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: SMITH, J. A. TEL. 713-483-3676
TECHNICAL SUMMARY

INVESTIGATE THE UTILITY OF METAL MATRIX COMPOSITES FOR EXTERNAL USE ON THE SPACE SHUTTLE SUCH AS SKIN PANELS TO 800 F AND POLYMER MATRIX COMPOSITES TO 600 F. DATA CONCERNING STRENGTH, STIFFNESS, THERMAL CYCLING CAPABILITY, AND STABILITY WILL BE GENERATED. INVESTIGATE THE FEASIBILITY OF DIE-LESS PRODUCTION FOR LARGE METAL MATRIX PANELS.THE SURFACE INSULATION CLASS OF MATERIAL SHOWS PROMISE OF MEETING THE THERMAL PROTECTION SYSTEM REQUIREMENTS FOR LARGE AREAS OF THE SPACE SHUTTLE ORBITER AND BOOSTER. UNDER THIS RTOP, FULL-SCALE PRODUCTION CAPABILITY OF AN OPTIMIZED SURFACE INSULATION MATERIAL WILL BE INITIATED AND DESIGN VERIFICATION TESTS ON FULL-SCALE TPS COMPONENTS WILL BE CONDUCTED. THE RESULTS OF THIS PROGRAM PHASE WILL LEAD TO SELECTION OF AN OPTIMIZED THERMAL PROTECTION SYSTEM FOR THE SHUTTLE PROGRAM. OXIDATION RESISTANT REINFORCED CARBON MATERIAL OFFER A WEIGHT COMPETITIVE SOLUTION AS A MULTIMISSION THERMAL PROTECTIVE SYSTEM FOR TEMPERATURES ABOVE 2000 F. TO INCREASE CONFIDENCE IN THIS THERMAL PROTECTION CONCEPT, FULL-SCALE STRUCTURAL DESIGNS WILL BE DEVELOPED AND VERIFICATION TESTS PERFORMED. DESIGN CONCEPTS WILL BE REFINED BY CONCENTRATION ON MINIMIZING STRUCTURAL WEIGHT, INDUCED STRESSES, EASE OF MANUFACTURING, ATTACHMENT METHODS, AND COST EFFECTIVENESS.

RTOP NO. 976-30-39 TITLE: SPACE SHUTTLE AEROTHERMODYNAMICS
ORGANIZATION: MANNED SPACECRAFT CENTER
MONITOR: GONZALEZ, R. G. TEL. 713-483-2237
TECHNICAL SUMMARY

THIS EFFORT IS DESIGNED TO PROVIDE CURRENT STATE-OF-THE-ART THE

TECHNOLOGY STUDIES IN SUPPORT OF THE ENGINEERING DESIGN ANALYSIS ON THE SPACE SHUTTLE VEHICLES. IT INCLUDES ANALYTICAL STUDIES AND EXPERIMENTAL TESTING AS NECESSARY TO ANALYZE VEHICLE AEROTHERMODYNAMIC CHARACTERISTICS AND TO ACCURATELY DEFINE PERFORMANCE CAPABILITIES. STUDIES WILL BE PERFORMED TO INVESTIGATE AND EVALUATE THE MUTUAL AERODYNAMIC INFLUENCE OF THE ORBITER/BOOSTER AERODYNAMICS ON THE TOTAL LAUNCH VEHICLE. STUDIES WILL BE PERFORMED TO EVALUATE THE FLIGHT CONTROL DYNAMIC RESPONSE CHARACTERISTICS OF THE SHUTTLE VEHICLES DUPING HIGH ANGLE OF ATTACH ATTITUDE TRANSITION MANEUVERS. STUDIES WILL ALSO BE PERFORMED TO PARAMETRICALLY INVESTIGATE AND EVALUATE THE EFFECTS OF STRUCTURAL ELASTICITY ON THE STATIC AND DYNAMIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE SPACE SHUTTLE VEHICLES.

RTOP NO. 976-30-40 TITLE: SPACE SHUTTLE DYNAMICS AND AEROELASTICITY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: COONS, H. J. TEL. 205-453-1124
TECHNICAL SUMMARY

THIS RTOP UPDATES AND SUPERSEDES RTOP 908-52-40 DYNAMICS AND AEROELASTICITY AND 976-30-40 SYNTHESIS OF SHUTTLE DYNAMICS UTILIZING SUBSTRUCTURE TESTING. THIS RTOP WILL PROVIDE THE TECHNOLOGICAL BASIS IN THE AREA OF DYNAMICS AND AEROELASTICITY FOR THE DEVELOPMENT OF NEW AND/OR IMPROVED ANALYSIS TECHNIQUES AND TEST METHODS APPROPRIATE TO SPACE SHUTTLE. PARTICULAR EMPHASIS WILL BE PLACED ON TECHNOLOGY IMPROVEMENTS NEEDED BECAUSE OF UNIQUE SHUTTLE MISSION REQUIREMENTS AND ENVIRONMENTS, THE EXTREME WEIGHT CRITICALITY, THE UNIQUE CONTROL REQUIREMENTS, AND THE SENSITIVITY OF VEHICLE WEIGHT TO THE INDUCED ENVIRONMENTS. THIS RTOP PROVIDES THE TECHNOLOGICAL BASIS FOR IMPROVEMENT AND DEVELOPMENT OF ANALYTICAL AND TEST TECHNIQUES REQUIRED TO SOLVE CRITICAL PROBLEMS IN THE FOLLOWING DISCIPLINE AREAS; BUFFET, FLUTTER, LIQUID BEHAVIOR, VEHICLE DYNAMICS AND RESPONSE, NOISE AND VIBRATION AND GROUND WINDS. FY-72 FUNDS OF $1,800K ARE REQUESTED TO ACCOMPLISH THIS PROGRAM WITH A MANPOWER REQUIREMENT OF 11.0 MAN-YEARS.

RTOP NO. 976-30-43 TITLE: SPACE SHUTTLE MISSION SIMULATION TESTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ENGLER, E. E. TEL. 205-453-3958
TECHNICAL SUMMARY

THIS STUDY WILL DEVELOP OPTIMUM STRUCTURAL SYSTEMS, PRIMARILY THERMAL PROTECTION SYSTEMS, FOR VARIOUS TEMPERATURE REGIMES FOR THE SPACE SHUTTLE VEHICLE. THE PROGRAM OBJECTIVES ARE: TO ESTABLISH DESIGN, FABRICATION, INSPECTION TECHNIQUES, AND HARDWARE EXPERIENCE NECESSARY TO MINIMIZE DEVELOPMENT RISKS; TO PROVIDE SOUND THERMAL PROTECTION SYSTEM (TPS)/PRIMARY LOAD-CARRYING STRUCTURE RECOMMENDATIONS; TO PROVIDE REALISTIC STRUCTURAL WEIGHT AND COST DATA; TO DEMONSTRATE THE VALIDITY OF DESIGN AND ANALYSIS METHODS, FABRICATION METHODS, INSPECTION METHODS, REFURBISHMENT METHODS; AND REUSABILITY. THE APPROACH WILL INCLUDE STUDIES, INVESTIGATIONS, AND MISSION SIMULATION TESTS ON COMPONENTS AND LARGE STRUCTURAL TEST

ITEMS OF MAJOR STRUCTURAL PORTIONS OF A TYPICAL SPACE SHUTTLE VEHICLE. THERMAL/ACOUSTIC TEST PANELS OF A DESIGN SIMILAR TO THE LARGE TEST ITEM DESIGNS WILL BE DESIGNED, FABRICATED, AND TESTED. THE LARGE TEST ITEMS WILL INCLUDE: TEST ITEM NO. 1, BOOSTER SECTION; AND TEST ITEM NO. 2, ORBITER SECTION. CONTRACTED AND IN-HOUSE TECHNOLOGY INVESTIGATIONS WILL BE PERFORMED IN THE AREA OF STRUCTURAL DESIGN AND ANALYSIS, THERMAL ENGINEERING, MATERIAL EVALUATION, FABRICATION, AND QUALITY ASSURANCE. THE PROGRAM WAS INITIATED IN FY 1970 AND WILL EXTEND THROUGH FY 1975. MANPOWER REQUIREMENTS AVERAGE ABOUT 41 MANYEARS PER YEAR.

RTOP NO. 976-30-43 TITLE: SPACE SHUTTLE THERMAL PROTECTION SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: KING, H. M. TEL. 205-453-1127
TECHNICAL SUMMARY

THIS EFFORT WILL SELECT OR DEVELOP AND EVALUATE OPTIMUM INSULATION MATERIALS FOR USE UNDER THE RERADIATIVE PANELS OF A SHUTTLE THERMAL PROTECTION SYSTEM. THE INVESTIGATIONS WILL INCLUDE PANEL INSULATIONS, WITH APPROPRIATE PACKAGING OR CONFIGURATION FOR REQUIRED HANDLING, INSTALLATION AND MOISTURE RESISTANCE, AND LOAD BEARING INSULATIONS TO TRANSMIT MECHANICAL LOADS FROM THE PANEL TO PRIMARY STRUCTURE WITH MINIMUM HEAT LEAK. THE EVALUATION SHALL PROVIDE DATA FOR DESIGN PURPOSES AND FOR ASSESSMENT OF THE RELIABLE REUSE LIFETIME UNDER SHUTTLE OPERATING ENVIRONMENTS. ACTIVE AND PASSIVE STRUCTURAL COOLING SYSTEMS CONCEPTS AND SYSTEM DESIGNS WILL BE DEVELOPED TO INCLUDE WEIGHT, COST, RELIABILITY, AND REDUNDANCY. CONCEPTS TO BE STUDIED ARE ACTIVE COOLING, HEAT SINK, HEAT PIPE, AND PHASE CHANGE MATERIAL AND PASSIVE SYSTEMS.

RTOP NO. 976-52-39 TITLE: SPACE SHUTTLE AEROTHERMODYNAMIC DATA MANAGEMENT (SADSAC)
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER
MONITOR: ANDREWS, C. D. TEL. 205-453-2519
TECHNICAL SUMMARY

THE PRINCIPLE OBJECTIVE OF THE SHUTTLE AEROTHERMODYNAMIC DATA MANAGEMENT SYSTEM IS TO PROVIDE A CENTRALIZED STORAGE AND RETRIEVAL FILE FOR NASA WIDE SHUTTLE DESIGN WORK. THIS RAPID AND TIMELY INTERCOMMUNICATION OF DATA IS IN THE FORM OF TABULAR LISTINGS AND PLOTTED DATA IN STANDARDIZED REPORT FORMATS. A SECONDARY GOAL IS TO PROVIDE THE RESULTS OF THE COMPUTATIONAL CAPABILITIES OF THE DATA HANDLING SYSTEM AS A DIRECT AID TO THE SHUTTLE VEHICLE DESIGN PROCESS. THE CONTRACTOR WILL UTILIZE THE SADSAC COMPUTER SYSTEM AS A BASIS FOR PROVIDING CENTRALIZED AEROTHERMODYNAMIC DATA MANAGEMENT FOR SHUTTLE. THE DATA AND ACCOMPANYING EXPERIMENTAL TEST INFORMATION TO BE MANAGED WILL BE FURNISHED TO THE CONTRACTOR IN A PRE-SPECIFIED FORMAT BY NASA, DOD AND SHUTTLE CONTRACTORS. THESE DATA SHALL BE PROCESSED THROUGH THE COMPUTER SYSTEM BY THE CONTRACTOR AND A DOCUMENTED OUTPUT DATA REPORT PROVIDED. ALL ACCUMULATED DATA WILL BE STORED IN THE COMPUTER SYSTEM FOR LATER RECALL. A MASTER LOG OF AEROTHERMODYNAMIC DATA STORED WILL BE MAINTAINED, AND A DATA FILE

CONTENTS RECORD REPORT PREPARED MONTHLY. THIS PROGRAM IS A RESULT OF A NEED ARISING OUT OF THE SPACE SHUTTLE AEROTHERMODYNAMIC WORKING GROUP. A DATA MANAGEMENT SYSTEM (SADSAC) HAS BEEN DESIGNED AND IS FUNCTIONING AS A DATA BANK AND DATA REDUCTION TOOL. BASIC AEROTHERMODYNAMIC INFORMATION IS AVAILABLE TO ALL NASA CANTERS AND SHUTTLE PRIME CONTRACTORS. THE FY'72 EFFORT IS TO PROVIDE FOR THE CONTINUATION OF THIS DATA MANAGEMENT PROGRAM.

SPACE SHUTTLE TECHNOLOGIES (OART/OMSF)

RTOP NO. 117-07-01 TITLE: SPACE SHUTTLE CONFIGURATIONS, AEROTHERMODYNAMICS, AND OPERATIONAL ANALYSIS

ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365

MONITOR: BROOKS, G. W. TEL. 703-827-2042

TECHNICAL SUMMARY

FULLY AND PARTIALLY REUSABLE SPACE SHUTTLE SYSTEMS ARE BEING STUDIED BY NASA/DOD TO SUPPORT FUTURE EARTH FOCUSED SPACE MISSIONS. CURRENT CONTRACTOR CONCEPT-DEFINITION AND PRELIMINARY-DESIGN STUDIES ARE SCHEDULED TO END WITH FY 1971. TO ASSESS THE CONCEPTS AND TO MAKE RECOMMENDATIONS WHICH WILL HELP NASA IDENTIFY A PREFERRED CONFIGURATION THERE IS A NEED TO (1) EXAMINE THE AERODYNAMIC CHARACTERISTICS OF CANDIDATE ORBITER, BOOSTER, AND LAUNCH VEHICLE CONCEPTS FROM SUBSONIC THROUGH HYPERSONIC SPEEDS, (2) PERFORM DIAGNOSTIC STUDIES IN THE HYPERSONIC SPEED REGIME TO PROVIDE INSIGHT INTO (A) LOCAL FLOW FIELD CONDITIONS AND (B) POTENTIAL PROBLEM AREAS, (3) EXAMINE THE AEROHEATING CHARACTERISTICS OF CANDIDATE CONCEPTS, INDIVIDUALLY AND IN COMBINATION, (4) EXAMINE THE ABILITY OF CANDIDATE CONCEPTS TO PERFORM MAJOR OPERATIONAL AND MISSION REQUIREMENTS, (5) PERFORM SYSTEMS WEIGHT, BALANCE, PACKAGING, AND DETAILED COMPONENT DESIGN STUDIES OF BOTH BOOSTER AND ORBITER, AND (6) IDENTIFY FROM AEROTHERMODYNAMIC AND SYSTEMS CONSIDERATIONS FEASIBLE SUBSCALE ORBITER AND BOOSTER FLIGHT TEST VEHICLES. THIS RTOP ENCOMPASSES THE ACTIVITIES OF THE LANGLEY AEROTHERMODYNAMIC, SYSTEMS, AND OPERATIONS SPACE SHUTTLE TECHNOLOGY PROGRAM, COORDINATED WITH OTHER NASA CENTERS THROUGH THE AEROTHERMODYNAMICS/CONFIGURATIONS WORKING GROUP, TO ACCOMPLISH THE PRECEDING OBJECTIVES IN CONJUNCTION WITH COMPLEMETARY STUDIES IN THE AREAS OF STRUCTURES, MATERIALS, AND THERMAL PROTECTION AND DYNAMIC LOADS AND AEROELASTICITY.

RTOP NO. 117-07-02 TITLE: SPACE SHUTTLE - CONFIGURATIONS AND AEROTHERMODYNAMICS

ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

TO EVALUATE THE AERODYNAMIC PERFORMANCE, STABILITY AND CONTROL, HEATING AND SONIC BOOM OVERPRESSURES OF SPACE SHUTTLE VEHICLES; TO PINPOINT AND FIND THE SOLUTION TO AEROTHERMODYNAMIC PROBLEMS OF THESE VEHICLES IN EVALUATION OF PHASE B AND SUPPORT OF PHASE C/D STUDIES. ACCORDINGLY, MODELS RESULTING FROM CONTRACTOR AND IN-HOUSE STUDIES WILL BE TESTED IN SUBSONIC, TRANSONIC, SUPERSONIC AND HYPERSONIC FACILITIES OF THE AMES RESEARCH CENTER. SHADOWGRAPH AND OIL-FLOW PHOTOGRAPHS, FLOW-FIELD PRESSURE SURVEYS, HEAT TRANSFER AND STATIC AND DYNAMIC AERODYNAMIC DATA WILL BE OBTAINED. THE WIND-TUNNEL DATA, TRAJECTORY DATA, AND RECENTLY OBTAINED STABILITY CRITERIA WILL BE USED TO EVALUATE THE SPACE SHUTTLE CHARACTERISTICS RELATIVE TO EXISTING AIRPLANES AND ENTRY VEHICLES SUCH AS LIFTING BODIES. THE EFFECTS OF REALISTIC GAPS, JOINTS, AND SURFACE CONDITIONS ON BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER WILL BE DETERMINED. TECHNIQUES WILL BE DEVELOPED FOR PREDICTING THE INVISCID AND VISCOUS REAL GAS FLOW FIELDS ABOUT SHUTTLE SPACECRAFT. TRAJECTORY CONSTRAINTS REQUIRED TO LIMIT SONIC BOOM OVERPRESSURES WILL BE DETERMINED.

RTOP NO. 747-81-01 TITLE: LIFTING ENTRY VEHICLE TRANSONIC FLIGHT-TEST PROGRAM
ORGANIZATION: FLIGHT RESEARCH CENTER P.O. BOX 273 EDWARDS,
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311
TECHNICAL SUMMARY

THE LOW SUPERSONIC AND SUBSONIC CHARACTERISTICS OF LIFTING REENTRY VEHICLES ARE BEING STUDIED BY MEANS OF A COORDINATED FLIGHT AND WIND-TUNNEL TEST PROGRAM WITH M2-F3, AND X-24A AIRCRAFT. THE PROGRAM WILL YIELD THE DETAILED AERODYNAMIC CHARACTERISTICS OF THESE AIRCRAFT AND A MEASURE OF THE ABILITY OF THE WIND TUNNELS TO PREDICT THESE CHARACTERISTICS. IN ADDITION, OPERATIONAL CHARACTERISTICS IN THE TERMINAL AREA ARE BEING EXPLORED. THIS EFFORT WILL ULTIMATELY YIELD AN IFR TERMINAL AREA ENERGY MANAGEMENT AND APPROACH TECHNIQUE APPLICABLE TO UNPOWERED LOW L/D ENTRY VEHICLES. AFTER ACCOMPLISHING THE BASIC FLIGHT OBJECTIVES, THE M2-F3 WILL BE USED TO EVALUATE COMMAND CONTROL SYSTEM CONCEPTS AND REACTION CONTROL BLENDING TECHNIQUES. SUBSEQUENT TO THE BASIC PROGRAM, THE X-24A WILL BE CONVERTED TO AN FDL-8 SHAPE TO EVALUATE A NEW CLASS OF VEHICLE.

RTOP NO. 908-42-39 TITLE: AEROTHERMODYNAMICS - INTERFERENCE AEROTHERMODYNAMICS AND SHOCK IMPINGEMENT
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: GOODRICH, W. D. TEL. 713-483-2326
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS TO OBTAIN PARAMETRIC HEAT TRANSFER, PRESSURE, AND FLOW VISUALIZATION DATA, WHICH REFLECT THE INFLUENCE OF VEHICLE GEOMETRY AND FREE STREAM CONDITIONS ON THE AEROTHERMODYNAMICS ENVIRONMENT ASSOCIATED WITH (1) SEPARATED FLOW, (2) NON-EQUILIBRIUM SHOCK AND BOUNDARY LAYERS, AND (3) BOUNDARY LAYER TRANSITION IN THE SPECTRUM OF APPLICABILITY TO SPACE SHUTTLE CONFIGURATIONS. EXPERIMENTAL PROGRAMS WILL BE PERFORMED WHICH WILL PROVIDE THE DATA NECESSARY TO FULFILL THE TASK OBJECTIVES. PRETEST ANALYSES AND SUBSEQUENT DATA CORRELATION WILL COMPLETE THE OVERALL TASK OBJECTIVES.

RTOP NO. 908-42-39 TITLE: SPACE SHUTTLE - AEROTHERMODYNAMICS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: GONZALEZ, R. G. TEL. 713-483-2237
TECHNICAL SUMMARY

THIS EFFORT IS DESIGNED TO PROVIDE CURRENT STATE-OF-THE-ART TECHNOLOGY STUDIES IN SUPPORT OF THE ENGINEERING DESIGN ANALYSIS ON THE SPACE SHUTTLE VEHICLES. IT INCLUDES ANALYTICAL STUDIES AND EXPERIMENTAL TESTING AS NECESSARY TO ANALYZE VEHICLE AEROTHERMODYNAMIC CHARACTERISTICS AND TO ACCURATELY DEFINE PERFORMANCE CAPABILITIES. DETAILED SIMULATION ANALYSIS OF THE SPACE SHUTTLE PLUME IMPINGEMENT PROXIMITY AERODYNAMICS EFFECTS DURING STAGE SEPARATION WILL BE PERFORMED. STUDIES WILL BE PERFORMED IN DEVELOPING AND IMPROVING THE ANALYSIS TECHNIQUES FOR VEHICLE AERODYNAMIC CONFIGURATION TRADE STUDIES CURRENTLY BEING USED FOR THE SPACE SHUTTLE VEHICLE DESIGN. ANALYTICAL STUDIES AND EXPERIMENTAL TESTING WILL BE PERFORMED TO ANALYZE THE AERODYNAMIC CONTROL EFFECTIVENESS OF THIS VEHICLES.

RTOP NO. 908-52-39 TITLE: SPACE SHUTTLE AEROTHERMODYNAMICS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: DAHM, W. K. TEL. 205-453-1092
TECHNICAL SUMMARY

THE AEROTHERMODYNAMIC TECHNOLOGY STUDIES WILL DEFINE ADVANCED METHODS AND TECHNIQUES REQUIRED FOR THE STEADY STATE AERODYNAMIC DESIGN AND THE THERMODYNAMIC DESIGN OF SPACE SHUTTLE SYSTEMS. THE EXTENSIVE FLIGHT REGIMES AND EXTREME ATTITUDE RANGES OF THE SHUTTLE, INVOLVE NEW APPROACHES TO MANY AERODYNAMIC DISCIPLINES. THIS RTOP INVOLVES DEVELOPMENT OF CRITERIA AND METHODS WHERE INADEQUATE KNOWLEDGE OR ANALYSIS TOOLS EXIST FOR DEFINING APPROPRIATE AEROTHERMODYNAMIC ENVIRONMENTS OR DESIGN VALUES. KEY TASKS IN AEROTHERMODYNAMICS HAVE BEEN SELECTED THAT REPRESENT CRITICAL AREAS OF SHUTTLE DESIGN. APPROPRIATE EXPERIMENTAL AND ANALYTICAL STUDIES WILL BE FUNDED FOR BOTH PARAMETRIC AND SPECIFIC INVESTIGATIONS DEPENDING UPON THE STATE-OF-THE-ART OF THE PARTICULAR AREA. THE TASK AREAS ARE: 1. EXPERIMENTAL AERODYNAMIC STUDIES 2. ASCENT BASE HEATING 3. POWER-ON BASE PRESSURE 4. AERODYNAMIC HEATING 5. STAGING AERODYNAMICS AND PLUME IMPINGEMENT 6. RCS PLUME AERODYNAMICS 7. UNCERTAINTIES IN THERMODYNAMIC ENVIRONMENT

RTOP NO. 976-30-39 TITLE: SPACE SHUTTLE AEROTHERMODYNAMICS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: GONZALEZ, R. G. TEL. 713-483-2237
TECHNICAL SUMMARY

THIS EFFORT IS DESIGNED TO PROVIDE CURRENT STATE-OF-THE-ART THE TECHNOLOGY STUDIES IN SUPPORT OF THE ENGINEERING DESIGN ANALYSIS ON THE SPACE SHUTTLE VEHICLES. IT INCLUDES ANALYTICAL STUDIES AND EXPERIMENTAL TESTING AS NECESSARY TO ANALYZE VEHICLE AEROTHERMODYNAMIC CHARACTERISTICS AND TO ACCURATELY DEFINE PERFORMANCE CAPABILITIES. STUDIES WILL BE PERFORMED TO INVESTIGATE AND EVALUATE THE MUTUAL AERODYNAMIC INFLUENCE OF THE ORBITER/BOOSTER AERODYNAMICS ON THE TOTAL LAUNCH VEHICLE. STUDIES WILL BE PERFORMED TO EVALUATE THE FLIGHT CONTROL DYNAMIC RESPONSE CHARACTERISTICS OF THE SHUTTLE VEHICLES DURING HIGH ANGLE OF ATTACH ATTITUDE TRANSITION MANEUVERS. STUDIES WILL ALSO BE PERFORMED TO PARAMETRICALLY INVESTIGATE AND EVALUATE THE EFFECTS OF STRUCTURAL ELASTICITY ON THE STATIC AND DYNAMIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE SPACE SHUTTLE VEHICLES.

RTOP NO. 114-08-05 TITLE: SPACE SHUTTLE DYNAMICS AND AEROELASTICITY
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP THE LOADS, STRUCTURAL DYNAMICS, LIQUID DYNAMICS, AND AEROELASTICITY TECHNOLOGY OF SPACE SHUTTLE VEHICLES. SPECIFICALLY TECHNOLOGY TO SOLVE PROBLEMS SUCH AS BUFFET; FLUTTER; PANEL FLUTTER, GROUND WIND LOADS; PROPELLANT SLOSH; WIND, GUST, AND CONTROL LOADS; POGO; BOUNDARY LAYER NOISE; AND SHOCK LOADS WILL BE DEVELOPED. PROPOSED SPACE SHUTTLE CONFIGURATIONS AND OPERATING REQUIREMENTS INTRODUCE THE NEW FACTORS OF ASYMMETRY, PARALLEL-STAGED MULTIBODIES, AND HIGH TEMPERATURE INTO THESE DYNAMICS PROBLEMS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES ARE REQUIRED TO DETERMINE CRITICAL LOADING CONDITIONS, VEHICLE CHARACTERISTICS, VEHICLE RESPONSES, AND STABILITY BOUNDARIES. DYNAMIC MODELS AND WIND TUNNELS WILL BE USED EXTENSIVELY FOR THIS IN-HOUSE AND CONTRACT EFFORT. THE RESULTS WILL INFLUENCE CONFIGURATION SELECTION AND LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN THE FINAL CONFIGURATION.

RTOP NO. 114-08-06 TITLE: SPACE SHUTTLE: DYNAMICS AND AEROELASTICITY
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

WIND TUNNEL TESTS AND ANALYSIS WILL BE CONDUCTED TO INVESTIGATE SEVERAL DYNAMIC AND AEROELASTIC PROBLEMS THAT MUST BE CONFRONTED IN THE EVALUATION OF CONFIGURATIONS AND THE DEVELOPMENT OF A SPACE SHUTTLE VEHICLE. THE PRIMARY EMPHASIS WILL BE ON TRANSONIC BUFFET (INCLUDING AEROELASTIC EFFECTS), AERODYNAMIC NOISE INPUTS AND RESPONSE, FLUTTER, MODE ALLEVIATION, AND FAILURE DETECTION. MOST OF THE WORK WILL BE EXPERIMENTAL. BOTH LIGHT-WEIGHT RIGID AND ELASTICALLY SCALED MODELS WILL BE TESTED IN WIND TUNNELS TO INVESTIGATE BUFFETING AND FLUTTER. FLOW VISUALIZATION TESTS OF CANDIDATE CONFIGURATIONS WILL BE CONDUCTED TO IDENTIFY AND LOCATE REGIONS OF HIGH INTENSITY TURBULENCE, AND THEN PRESSURE FLUCTUATIONS WILL BE MEASURED IN THESE REGIONS TO EVALUATE AERODYNAMIC NOISE INPUTS. IT IS INTENDED THAT FULL-SCALE PANELS WILL EVENTUALLY BE TESTED TO STUDY RESPONSE AND FATIGUE CHARACTERISTICS. A TECHNIQUE BEING DEVELOPED FOR SIMULATING, ON LARGE-SCALE MODELS, THE LATERAL FORCES PRODUCED BY THRUST VECTOR CONTROL OF LAUNCH VEHICLES WILL BE USED TO STUDY CRITICAL VIBRATION MODES OF SPACE SHUTTLE STRUCTURES AND ACTIVE AND PASSIVE SYSTEMS FOR MODE ALLEVIATION. AN INSTRUMENT DEVELOPED AT AMES FOR ON-LINE ANALYSIS OF DAMPING WILL BE FURTHER DEVELOPED AND EVALUATED AS A STRUCTURAL FAILURE-DETECTION DEVICE.

RTOP NO. 114-08-17 TITLE: IMPULSE TESTING TECHNIQUES
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: MODLIN, C. T., JR. TEL. 713-483-2076
TECHNICAL SUMMARY

INVESTIGATE AND DEVELOP IMPULSE TRANSFER FUNCTION TESTING TECHNIQUES FOR APPLICATION IN DETERMINING THE STRUCTURAL DYNAMIC CHARACTERISTICS OF THE SPACE SHUTTLE VEHICLE AND SPACE SHUTTLE

STRUCTURAL COMPONENTS. AN ANALYTICAL METHOD FOR PREDICTING THE DYNAMIC CHARACTERISTICS AND DYNAMIC RESPONSE OF A STRUCTURE FROM EXPERIMENTALLY DETERMINED IMPULSE TRANSFER FUNCTIONS. THE METHOD WILL BE VERIFIED BY COMPARING RESPONSES DETERMINED BY THE IMPULSE METHOD TO THOSE MEASURED ON A TYPICAL SPACECRAFT STRUCTURE DURING APPLICATION OF IMPACT AND SUSTAINED VIBRATION TYPE LOADINGS.

RTOP NO. 976-30-40 TITLE: SPACE SHUTTLE DYNAMICS AND AEROELASTICITY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: COONS, H. J. TEL. 205-453-1124
TECHNICAL SUMMARY

THIS RTOP UPDATES AND SUPERSEDES RTOP 908-52-40 DYNAMICS AND AEROELASTICITY AND 976-30-40 SYNTHESIS OF SHUTTLE DYNAMICS UTILIZING SUBSTRUCTURE TESTING. THIS RTOP WILL PROVIDE THE TECHNOLOGICAL BASIS IN THE AREA OF DYNAMICS AND AEROELASTICITY FOR THE DEVELOPMENT OF NEW AND/OR IMPROVED ANALYSIS TECHNIQUES AND TEST METHODS APPROPRIATE TO SPACE SHUTTLE. PARTICULAR EMPHASIS WILL BE PLACED ON TECHNOLOGY IMPROVEMENTS NEEDED BECAUSE OF UNIQUE SHUTTLE MISSION REQUIREMENTS AND ENVIRONMENTS, THE EXTREME WEIGHT CRITICALITY, THE UNIQUE CONTROL REQUIREMENTS, AND THE SENSITIVITY OF VEHICLE WEIGHT TO THE INDUCED ENVIRONMENTS. THIS RTOP PROVIDES THE TECHNOLOGICAL BASIS FOR IMPROVEMENT AND DEVELOPMENT OF ANALYTICAL AND TEST TECHNIQUES REQUIRED TO SOLVE CRITICAL PROBLEMS IN THE FOLLOWING DISCIPLINE AREAS; BUFFET, FLUTTER, LIQUID BEHAVIOR, VEHICLE DYNAMICS AND RESPONSE, NOISE AND VIBRATION AND GROUND WINDS. FY-72 FUNDS OF $1,800K ARE REQUESTED TO ACCOMPLISH THIS PROGRAM WITH A MANPOWER REQUIREMENT OF 11.0 MAN-YEARS.

RTOP NO. 113-60-10 TITLE: SPACE SHUTTLE ELECTRICAL POWER PROCESSING AND DISTRIBUTION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO ESTABLISH THE TECHNICAL CRITERIA WHICH WILL PERMIT THE CONCURRENT OPTIMIZATION OF ELECTRICAL SYSTEMS FOR REUSABLE HYBRID AIR AND SPACEBORNE CRAFT. THE SYSTEMS OF INTEREST ARE: 1) THE POWER SOURCE, 2) THE POWER DISTRIBUTION, 3) THE POWER CONVERSION SYSTEM, AND 4) THE POWER UTILIZATION SYSTEM. THE OPTIMIZATION IS TO BE ACHIEVED OVER THE POWER RANGE OF 10 KW TO MORE THAN 100 KW. DUE CONSIDERATION WILL BE GIVEN IN THE OPTIMIZATION TO THE EFFECT ON THE POWER SYSTEM OF ATMOSPHERIC REENTRY. A SECOND OBJECTIVE IS TO ESTABLISH THE TECHNOLOGY FOR CRITICAL SUBSYSTEMS AND COMPONENTS OF THE ABOVE SYSTEMS WHERE NEW TECHNOLOGY IS REQUIRED. APPLICATIONS INCLUDE REUSABLE SPACE SHUTTLE LAUNCH AND ORBITER CRAFT; AND OTHER AIR AND LARGER SPACECRAFT. THE APPROACH IS TO ACQUIRE KNOWLEDGE ON THE NATURE OF POWER SYSTEM CHARACTERISTICS AND THE ASSOCIATED SUBSYSTEMS UNDER GIVEN CONSTRAINTS AND TRANSLATE THE RESULTS OF COMPARATIVE WEIGHTING OF CONTRIBUTING FACTORS INTO CRITERIA FOR DESIGN. ESTABLISH TECHNOLOGY FOR CRITICAL SUBSYSTEMS, COMPONENTS FOR POWER CONTROL, POWER TRANSFER AND TRANSMISSION, ELECTRIC ENERGY MANAGEMENT AND POWER FAULT DETECTION.

RTOP NO. 115-17-01 TITLE: SPACE SHUTTLE: SYSTEMS FOR NAVIGATION, GUIDANCE AND CONTROL DURING APPROACH AND LANDING
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: ROBERTS, L. TEL. 415-961-2280
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP A TECHNOLOGY BASE FOR THE DESIGN OF THE SYSTEMS FOR NAVIGATION, GUIDANCE AND CONTROL OF THE SPACE SHUTTLE VEHICLE (SSV) DURING THE APPROACH AND LANDING. THE PROGRAM INCLUDES ANALYSIS, PILOTED FLIGHT SIMULATION, AND FINALLY, FLIGHT TESTS TO DEVELOP AND EVALUATE SYSTEM CONCEPTS. DURING FY'71 ANALYSIS AND SIMULATION WERE EMPHASIZED ON BOTH IN-HOUSE AND CONTRACT STUDIES. IN FY'72 ANALYSIS AND SIMULATION WILL CONTINUE IN-HOUSE BUT EMPHASIS WILL SHIFT TO FLIGHT EVALUATION OF THE CONCEPTS DEVELOPED. ANALYSIS AND SIMULATION FOR FY'72 INCLUDE: 1. DETAILED EXAMINATION OF THE AUTOMATIC/MANUAL CONTROL SYSTEM INTERFACE 2. EXAMINATION OF PERFORMANCE OF CANDIDATE SYSTEMS CONCEPTS 3. EVALUATION OF HANDLING QUALITIES OF CANDIDATE VEHICLE CONFIGURATIONS. THE FLIGHT PROGRAMS FOR FY'72 ARE: 1. FLIGHT TESTS USING THE CONVAIR 340 TO CONFIRM NAVIGATION PERFORMANCE OBTAINED FROM IN-HOUSE ANALYSIS AND SIMULATION OF BLENDED INERTIAL/RADIO NAVIGATION SYSTEMS. 2. A MORE EXTENSIVE FLIGHT TEST PROGRAM USING THE CONVAIR 990 TO STUDY AUTOMATIC AND PILOTED LANDING SYSTEM CONCEPTS AND TO CONFIRM NAVIGATION, GUIDANCE AND CONTROL SYSTEM PERFORMANCE OBTAINED FROM ANALYSIS AND SIMULATIONS CONDUCTED IN-HOUSE AND ON CONTRACT. THESE FLIGHT TESTS WILL DUPLICATE, AS NEARLY AS POSSIBLE THE SHUTTLE TRAJECTORY AND PERFORMANCE FROM ABOUT 40,000 FEET TO TOUCHDOWN.

RTOP NO. 115-17-02 TITLE: TERMINAL AREA NAVIGATION, GUIDANCE, AND DISPLAY CONCEPTS
ORGANIZATION: FLIGHT RESEARCH CENTER P. O. BOX 273 EDWARDS, CA
MONITOR: GEE, S. W. TEL. 805-258-3311
TECHNICAL SUMMARY

AN ANALYTICAL STUDY WILL BE CONDUCTED USING AN IBM 360 COMPUTER TO INVESTIGATE THE ENERGY MANAGEMENT AND GUIDANCE EQUATIONS FOR A CURVED, UNPOWERED, INSTRUMENT APPROACH TO A RUNWAY IN A VEHICLE OF LOW LIFT AND HIGH DRAG CONFIGURATION. A COMPUTER SIMULATION USING THE VEHICLE EQUATIONS OF MOTION AND A COCKPIT WITH CHANGEABLE DISPLAYS WILL BE USED TO EVALUATE THE GUIDANCE SYSTEM AND PILOT WORK LOAD. SIMULATION RESULTS WILL BE VALIDATED BY FLIGHT TESTS USING A DATA LINK WITH AN F-104 AIRCRAFT.

RTOP NO. 115-17-04 TITLE: SHUTTLE GUIDANCE
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: INGRAM, H. L. TEL. 205-453-0445
TECHNICAL SUMMARY

IN RECENT YEARS A SERIES OF ALGORITHMS FOR TRAJECTORY OPTIMIZATION AND GUIDANCE HAVE BEEN DEVELOPED WHICH SHOW THE FEASIBILITY OF USING GENUINE OPTIMIZATION TECHNIQUES FOR REAL TIME GUIDANCE AND MISSION PLANNING. THESE ALGORITHMS ARE MODIFIED SHOOTING METHODS WHICH ARE CAPABLE OF REPETITIVE ON-BOARD OPTIMIZATION OF MULTIPLE BURN ORBIT TRANSFERS. USING THESE ALGORITHMS, AN OPTIMAL GUIDANCE SCHEME HAS ALREADY BEEN DEVELOPED FOR POWERED VACUUM MANEUVERS; AND, IN A PARALLEL EFFORT TO THIS STUDY (UNDER 908-52-10 FY'71 FUNDING), THE FINISHING TOUCHES ARE BEING PUT ON AN OPTIMAL GUIDANCE SCHEME FOR USE DURING POWERED ASCENT THROUGH THE ATMOSPHERE. UNDER THE CONTRACTUAL EFFORT PRESENTLY FUNDED UNDER THIS RTOP, A LIMITED REENTRY OPTIMIZATION CAPABILITY WILL BE DEVELOPED - AGAIN USING THE ALGORITHMS PREVIOUSLY MENTIONED. UNDER FY '72 FUNDING OF THIS RTOP, THIS EFFORT WILL BE EXTENDED TO THE DEVELOPMENT OF A FULLY REALISTIC OPTIMAL REENTRY GUIDANCE SCHEME FOR THE SPACE SHUTTLE, CAPABLE OF OPTIMIZING THERMAL PERFORMANCE SUBJECT TO THERMAL AND STRUCTURAL CONSTRAINTS. UNDER ANTICIPATED FOLLOW-ON FUNDING UNDER THIS RTOP (FY'73 AND BEYOND), THE THREE APPLICATIONS OF THE DEVELOPED ALGORITHMS (ASCENT, RENDEZVOUS AND REENTRY) WILL BE BROUGHT TOGETHER TO FORM A UNIFIED GUIDANCE SCHEME WHICH TAKES ADVANTAGE OF THE COMMONALITY THAT EXISTS IN THE EQUATIONS AND TECHNIQUES EMPLOYED TO PROVIDE OPTIMAL GUIDANCE DURING ALL THREE SPACE SHUTTLE FLIGHT PHASES. THE ADVANTAGES OF SUCH A UNIFIED SYSTEM WILL INCLUDE MINIMUM COMPUTER STORAGE REQUIREMENTS, MINIMUM SOFTWARE DEVELOPMENT, MINIMUM PROPELLANT REQUIREMENTS, AND MAXIMUM RELIABILITY.

RTOP NO. 115-21-01 TITLE: MANNED SPACE SHUTTLE - DEVELOPMENT OF ANTENNA TECHNIQUES AND MATERIALS
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

CRITICAL ANTENNA TECHNOLOGY WILL BE DEVELOPED TO MEET THE

REQUIREMENTS IMPOSED BY STRUCTURAL DESIGN CONSIDERATIONS, THERMAL CONDITIONS, AND THE OVERALL REENTRY ENVIRONMENT OF THE SPACE SHUTTLE. THE REUSE CAPABILITY OF ANTENNA WINDOW AND THERMAL PROTECTION MATERIALS WILL BE DETERMINED BY MEASURING THE DIELECTRIC PROPERTIES OF THESE MATERIALS AFTER REPEATED THERMAL CYCLING. ANTENNA DESIGNS WILL BE DEVELOPED WHICH USE THESE MATERIALS IN LAYERS TO REDUCE ANTENNA TEMPERATURES. COMPUTERIZED DESIGN TECHNIQUES WILL BE DEVELOPED TO DETERMINE THE IMPEDANCE AND PATTERNS OF ANTENNAS ON SPACE SHUTTLE VEHICLES.

RTOP NO. 115-21-02 TITLE: MANNED SPACE SHUTTLE - MICROWAVE AMPLIFIERS FOR SPACE SHUTTLE VEHICLE
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VA 23365
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

C-BAND MICROWAVE POWER AMPLIFIERS WILL BE DEVELOPED FOR THE COMMUNICATION SUBSYSTEM OF THE SPACE SHUTTLE. PRESENTLY AVAILABLE DESIGN TECHNIQUES WILL BE USED WITH SLIGHT MODIFICATION OF CONVENTIONAL TRAVELING WAVE TUBE CONFIGURATIONS. EMPHASIS WILL BE PLACED ON INCREASED POWER OUTPUT, IMPROVED EFFICIENCY, AND HIGH RELIABILITY. THE NOMINAL POWER OUTPUT WILL BE 100 WATTS WITH SATISFACTORY OPERATION THROUGH THE 20 TO 100-WATT RANGE. THE POWER AMPLIFIERS WILL BE DESIGNED FOR COMPATIBLE OPERATION THROUGH THE INTELSAT IV SATELLITE RELAY COMMUNICATIONS SYSTEM. ENGINEERING MODELS WILL BE CONSTRUCTED WHICH CAN BE USED IN THE INITIAL PHASE OF FLIGHT QUALIFICATION AND LIFE TEST PROGRAMS. IN ADDITION, EFFORTS WILL BE UNDERTAKEN TO EXTEND THE C-BAND TECHNOLOGY TO K SUB U BAND. PARALLEL EFFORT WILL ALSO ASSESS FEASIBILITY OF SOLID STATE TECHNIQUES AT THESE POWER LEVELS.

RTOP NO. 115-21-11 TITLE: SPACE SHUTTLE LOW NOISE RECEIVER
ORGANIZATION: GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
MONITOR: DALLE MURA, P. H. TEL. 301-983-5036
TECHNICAL SUMMARY

THE SPACE SHUTTLE COMMUNICATION THROUGH SYNCHRONOUS SATELLITES WILL REQUIRE INCREASED ANTENNA SIZES OR MORE SENSITIVE RECEIVING SYSTEMS. SINCE RE-ENTRY IS A FACTOR, IT IS OBVIOUS THAT THE LATTER AREA OF CONCERN SHOULD BE DEVELOPED. THIS RTOP WILL DEVELOP A SPACE QUALIFIED PARAMP TECHNOLOGY AT C-BAND, K SUB U BAND AND S-BAND. THE C-BAND PARAMP WILL HAVE A NOISE FIGURE OF LESS THAN 2DB AND THEREBY SIGNIFICANTLY REDUCE THE SIZE REQUIREMENT OF THE ANTENNA. THIS EFFORT WILL BE PRIMARILY CONTRACTURAL WITH SOME EFFORT PERFORMED IN-HOUSE. THE C-BAND UNIT MUST BE DEVELOPED COMPLETELY, WHEREAS THE PROTOTYPE K SUB U BAND UNIT WILL BE DEVELOPED FOR THE TDRS PROGRAM. THIS PROTOTYPE MUST THEN BE DEVELOPED THROUGH THE SPACE QUALIFICATION SEGMENT. THE S-BAND UNIT HAS BEEN DEVELOPED THROUGH THE PROTOTYPE STAGE FOR THE TDRS PROGRAM. THIS PROTOTYPE WILL BE EXTENDED THROUGH A SPACE QUALIFICATION DEVELOPMENT PHASE.

RTOP NO. 115-23-31 TITLE: ADVANCED COMPUTER SYSTEM TECHNIQUES FOR DATA MANAGEMENT SYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: MARLOWE, G. D. TEL. 713-483-6196
TECHNICAL SUMMARY

THE INCREASED AUTONOMY REQUIREMENTS FOR THE SPACE SHUTTLE HAVE SIGNIFICANTLY INCREASED THE ROLE OF ONBOARD COMPUTERS. THE RESULTANT INCREASED COMPLEXITY OF THE ONBOARD SYSTEMS REQUIRES THAT ADDITIONAL EMPHASIS BE PLACED UPON THE COMPUTER OPERATING SYSTEM DESIGN AND VERIFICATION TO ASSURE DELIVERY WITHIN SHUTTLE SCHEDULES AND COST OBJECTIVES. THIS OBJECTIVE CAN ONLY BE ACHIEVED BY RECOGNIZING THE INTER-DEPENDENCE OF HARDWARE, THE COMPUTER SYSTEM AND FUNCTIONAL SYSTEM APPLICATIONS. THE OBJECTIVE OF THIS EFFORT IS TO PROVIDE THE NECESSARY EMPHASIS ON THE TOTAL SYSTEM DESIGN AND VERIFICATION TO ASSURE THAT THIS INTER-DEPENDENCE IS ACCOUNTED FOR IN THE FINAL SHUTTLE SYSTEM. THE STUDY APPROACH INCLUDES THE UTILIZATION OF FY-70 AND FY-71 TECHNOLOGY EFFORTS. THIS WILL BE ACCOMPLISHED BY EVALUATING THE TWO EXECUTIVE DESIGNS PROVIDED UNDER FY-71 FUNDING AND SELECTING THE OPTIMUM APPROACH WHICH IS CONSISTENT WITH THE AVIONICS HARDWARE CONFIGURATION AT THE TIME OF CONTRACT AWARD. DETAILED SPECIFICATIONS WILL BE ESTABLISHED. USING THE FY-71 VERIFICATION STUDIES AS A BASELINE, A MASTER VERIFICATION PLAN WILL BE GENERATED WHICH WILL INCLUDE VERIFICATION PHASES, HARDWARE, FACILITIES AND CONFIGURATION MANAGEMENT PLANNING.

RTOP NO. 115-24-01 TITLE: HIGH TEMPERATURE SENSORS
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: GRAVES, G. B. TEL. 703-827-3745
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP MEASUREMENT TECHNIQUES AND INSTRUMENTATION TO DETERMINE THE EFFECT OF THE REENTRY ENVIRONMENT ON STRUCTURES USED IN THE SPACE SHUTTLE. SPECIFIC EFFORTS WILL BE MADE TO DEVELOP HEAT TRANSFER SENSORS, STRAIN MEASUREMENTS WITH EXTENDED UPPER TEMPERATURE PERFORMANCE, AND DYNAMIC DISPLACEMENT MEASUREMENT TECHNIQUES FOR ANALYZING THE PERFORMANCE OF VARIOUS PANEL DESIGNS UNDER BOTH VIBRATION AND THERMAL LOADS. THIS WORK IS ESSENTIAL TO THE DEVELOPMENT OF EFFICIENT LOAD BEARING STRUCTURES WHICH MEET AERODYNAMIC REQUIREMENTS AND CAN WITHSTAND REPEATED HIGH-TEMPERATURE EXPOSURE WITHOUT IMPOSING SEVERE WEIGHT PENALTIES ON THE VEHICLE.

RTOP NO. 115-24-02 TITLE: SPACE SHUTTLE: HIGH SPECIFICITY GAS ANALYSIS
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: ROBERTS, L.TES TEL. 415-961-2286
TECHNICAL SUMMARY

INSTRUMENTATION WILL BE DEVELOPED TO DETECTGASEOUS CONTAMINATS IN SPACE SHUTTLE CABINATMOSPHERES WITH THE REQUIRED SENSITIVITY ANDSPECIFICITY. A PROGRAM HAS BEEN UNDERWAY AT AMESBOTH IN-HOUSE AND THROUGH A CONTRACTOR, TODEVELOP ONE TYPE OF SUCH INSTRUMENTATION

BASED ONNEW CONCEPTS IN THE AREA OF NON-DISPERSIVEINFRARED ANALYSIS (NDIR). IN ADDITION TODEVELOPING A FLIGHT-QUALIFIED INSTRUMENT,FUNDAMENTAL STUDIES OF THE TECHNIQUE WILLCONTINUE WITH THE AIM OF INCREASING SENSITIVITYAND APPLICABILITY. THE SPACE SHUTTLE WILL INVOLVEA CLOSED SYSTEM IN WHICH HUMAN BEINGS MUST LIVE ININTIMATE CONTACT WITH A NUMBER OF COMPLEX CHEMICALCOMPOUNDS. YEARS OF EXTENSIVE TESTING HAVEELIMINATED, HOPEFULLY, ALL OF THE HAZARDOUSCOMPOUNDS WHICH COULD BE EXPECTED IN THESPACECRAFT STRUCTURE AND SYSTEMS UNDER NORMALCONDITIONS. HOWEVER, NORMAL CONDITIONS CANNOT BEGUARANTEED IN SPACE MISSIONS. FOR THIS REASON ANUMBER OF POSSIBILITIES ARE BEING EXPLORED TOEXAMINE THE TOXIC HAZARDS TO BE EXPECTED IN ACONDITION OF MALFUNCTION. SEVERAL CHEMICALCOMPOUNDS HAVE BEEN IDENTIFIED AS BEING----

RTOP NO. 115-24-03 TITLE: STUDY OF A VEHICLE STATUS AND MONITORING SYSTEM CONCEPT
ORGANIZATION: FLIGHT RESEARCH CENTER P. O. BOX 273 EDWARDS,
MONITOR: LOVE, J. E. TEL. 805-258-3311
TECHNICAL SUMMARY

A STATE-OF-THE-ART SYSTEM DESIGNED FOR MONITORING AND CONTINUOUS INFLIGHT RECORDING OF PARAMETERS WHICH DETERMINE THE OPERATIONAL STATUS OF A VEHICLE WILL BE FLIGHT TESTED IN A HIGH PERFORMANCE JET AIRCRAFT. AFTER EACH FLIGHT, A QUICK ANALYSIS IS PERFORMED BY COMPUTER PROCESSING OF THE DIGITIZED MAGNETIC FLIGHT TAPE. OPERATIONAL DISCREPANCIES ARE DETECTED AND IDENTIFIED WHEN SENSED QUANTITIES EXCEED PREDETERMINED THRESHOLDS AS INSERTED INTO THE COMPUTER FOR ANALYSIS. THE TAPE ALSO SERVES AS A HISTORY OF OPERATION FROM WHICH PREDICTIONS OF MALFUNCTION OR FAILURE CAN BE MADE FROM LONG-TERM (SEVERAL HUNDRED HOURS OF FLIGHT) PARAMETRIC TREND ANALYSIS. THE FLIGHT EXPERIENCE AND DATA ACCUMULATED WILL PROVIDE BASIC INFORMATION FOR SYSTEM REQUIREMENTS FOR THE SPACE SHUTTLE VEHICLE TO ACHIEVE SHORT TURNAROUND TIME BY AUTOMATIC SYSTEM TESTING, FAULT LOCATION, AND CHECKOUT. THE OBJECTIVE IS ALSO TO DEMONSTRATE THE ABILITY TO REFLY THE ENGINE-INLET SYSTEM BASED UPON DATA FROM THE LAST FLIGHT WITH LITTLE OR NO FORMAL GROUND PREFLIGHT OF THAT SYSTEM.

RTOP NO. 115-24-04 TITLE: INSTRUMENTATION/SENSORS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: ALEXANDER, J. D. TEL. 713-483-3466
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO DEVELOP THE TECHNOLOGY, DESIGN, AND FABRICATE A PROTOTYPE SYSTEM, AND TO PERFORM EVALUATION TESTS OF A ZERO G LIQUID QUANTITY GAUGING SYSTEM THAT IS SUITABLE FOR USE ON THE SPACE SHUTTLE. THE PROBLEM OF GAUGING A LIQUID IN ZERO G IS ONE OF EITHER PRODUCING AN ARTIFICIAL GRAVITY BY ACCELERATION AND USING MORE CONVENTIONAL METERING, WHICH USES MORE PROPELLANT, OR USAGE CALCULATIONS WHICH CANNOT ACCOUNT FOR LOSSES DUE TO FAILURE OR MALFUNCTION. AN INHOUSE STUDY AND EVALUATION OF GAUGING SYSTEM TECHNIQUES CONCLUDED THAT THE NUCLEAR ABSORPTION TECHNIQUE WAS THE MOST PROMISING. THIS METHOD WILL INHERENTLY PROVIDE TOTAL MASS

MEASUREMENT OF ANY SUBSTANCE REGARDLESS OF ITS PHYSICAL PHASE (SOLID, LIQUID, OR GAS). FOR THE SPACE SHUTTLE, THE MAXIMUM TANK SIZE THAT CAN BE METERED BY THIS TECHNIQUE IS DETERMINED BY THE ABSORPTION COEFFICIENTS OF THE PROPELLANT, DETECTOR DYNAMIC RANGE, AND SOURCE STRENGTH CONSIDERATIONS. LIQUID OXYGEN (LOX) TANKS ARE RESTRICTED TO A DIAMETER OF 10 FEET OR LESS WITH PRESENT TECHNIQUES AND SOURCE STRENGTH LIMITATIONS. FURTHER, THE TEMPERATURE RANGE OVER WHICH THE DETECTORS MUST PERFORM MAKES PRESENT MATERIALS MARGINAL IN THEIR PERFORMANCE. RECENTLY COMPLETED MATERIALS RESEARCH INDICATES THAT THE MATERIALS AND TECHNIQUES ARE AVAILABLE, AND A NEAR OPTIMUM DETECTOR CAN BE DEVELOPED WITHIN THE TIME SCHEDULES. AT LEAST TWO METHODS OF DEVELOPING VARIABLE INTENSITY SOURCES ARE AVAILABLE TO SOLVE THE PROBLEM OF HIGH DENSITY PROPELLANT PENETRATION WITHOUT EXCEEDING THE DETECTOR'S DYNAMIC RANGE OR POSING A RADIATION HAZARD TO THE CREW OR SERVICE PERSONNEL WHEN THE TANKS ARE EMPTY.

RTOP NO. 115-24-05 TITLE: SHUTTLE SENSORS & INSTRUMENTATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: ESCUE, W. T. TEL. 205-453-4626
TECHNICAL SUMMARY

THE TECHNOLOGY BEING CONDUCTED IN THE AREAS OF AIR DATA SENSORS, ZERO "G" QUANTITY MEASUREMENT AND PROPELLANT UTILIZATION/LOADING SENSORS IS AN EXTENSION OF WORK BEING CONDUCTED UNDER RTOP 125-24-19, SHUTTLE SENSORS AND INSTRUMENTATION. THIS TECHNOLOGY HAS THE OBJECTIVE OF MEETING THE SHUTTLE OPERATING REQUIREMENTS FOR THESE VITAL MEASUREMENTS. GAS ANALYSIS INSTRUMENTATION FOR THE SHUTTLE ENVIRONMENTAL CONTROL SYSTEM WILL BE PURSUED FOR 02 AND C02 ALONG WITH TOXIC GAS DETECTION AND ABORT SITUATIONS FOR H2, NO, CO, CH4 ETC. THE APS ENGINE TESTING WILL REQUIRE A MASS FLOW DEVICE CAPABLE OF MEASURING 02 AND H2 FLOW FOR PULSE WIDTHS OF 50 MILLISECONDS. THIS INSTRUMENT IS VERY VITAL TO APS ENGINE AND CONTROL SYSTEM EVALUATION.

RTOP NO. 908-42-05 TITLE: SPACE POWER DEVICES
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: EASTMAN, F. E. TEL. 713-483-3171
TECHNICAL SUMMARY

THE SPACE ELECTRICAL POWER SYSTEM MUST PERFORM IMPORTANT FUNCTIONS, SUCH AS: (1) ACCEPT POWER FROM THE PRIMARY POWER SOURCE AND PROVIDE POWER PROCESSING; (2) DISTRIBUTE THIS POWER FROM THE SOURCE TO THE VARIOUS LOADS THROUGH BUSES, LOAD CENTERS, AND FEEDER CIRCUITS; AND (3) PROVIDE THE REQUIRED CIRCUIT PROTECTION AND CONTROL. THREE CLASSES OF HARDWARE NEEDED FOR PERFORMING THESE FUNCTIONS ARE: (1) POWER PROCESSING EQUIPMENT (CONVERTERS, INVERTERS, VOLTAGE REGULATORS, ETC.); (2) WIRING, CONNECTORS, AND ASSOCIATED EQUIPMENT; AND (3) CIRCUIT CONTROL AND PROTECTION DEVICES (CIRCUIT BREAKERS, FUSES, POWER DISCONNECT, SWITCHES, ETC.). AS DETERMINED FROM AN EVALUATION OF THE SHUTTLE CONSTRAINTS, GUIDELINES, AND REQUIREMENTS, THIS EFFORT INVOLVES TWO SUBTASKS WHICH WILL SUPPORT THE ABOVE SYSTEM FUNCTIONS. THESE TASKS ARE AS FOLLOWS: 01 DYNAMIC LOAD SIMULATOR - THIS DEVELOPMENT WILL ENABLE ELECTRICAL

POWER SYSTEM LOADS TO BE SIMULATED TO ALLOW EVALUATION OF REALISTIC TRANSIENT CONDITIONS. THE SYSTEM IS DIVIDED INTO TWO AREAS: (1) DYNAMIC LOAD INTERROGATOR AND (2) DYNAMIC LOAD SIMULATOR. MSC CAN PROVIDE SOME LOAD INTERROGATION AND FUNCTIONAL SUPPORT EQUIPMENT AS AN APPROACH TO REDUCE COST. THE DYNAMIC LOAD SIMULATOR APPROACH INCLUDES A STUDY PHASE, ENGINEERING MODEL PHASE, AND PROTOTYPE/PRODUCTION PHASE. 02 SWITCHING DEVICES (SOLID STATE REMOTE POWER CONTROLLERS) - DEVELOPMENT OF SOLID STATE REMOTE POWER CONTROLLERS IS NEEDED TO MEET THE OPERATIONAL AND UNIQUE ENVIRONMENTAL REQUIREMENTS OF THE SHUTTLE. THE APPROACH INCLUDES A DESIGN STUDY, EVALUATION OF SELECTED COMPONENT DESIGN, AND THE DEVELOPMENT, FABRICATION, AND TESTING OF AN ENGINEERING MODEL.

RTOP NO. 908-42-10 TITLE: SPACE SHUTTLE - GUIDANCE AND NAVIGATION
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: CHEVERS, E. TEL. 713-483-2851
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO PROVIDE FEASIBLE GN&C SYSTEM DESIGNS AND FUNCTIONAL SOFTWARE ROUTINES (EQUATIONS AND ALGORITHMS) IN THE AREAS OF SHUTTLE ENTRY NAVIGATION, ENTRY GUIDANCE AND CONTROL, AND _IN-ORBIT DELTA-V GUIDANCE. THIS PROGRAM WILL BE A CONTINUATION OF SIMILAR ANALYTICAL ACTIVITIES FUNDED UNDER FY71 PROGRAMS 908-42-08 AND 908-41-10. THE VEHICLE CONFIGURATIONS AS DEVELOPED UNDER THE PHASE _B PROGRAM STUDIES WILL BE ANALYZED TO DETERMINE THE GN&C SYSTEM REQUIREMENTS FOR THE ABOVE STATED FLIGHT MODES. THE REQUIREMENTS WILL BE TRANSLATED INTO SYSTEM CONCEPTS AND EQUATION DESIGNS WHICH WILL SATISFY THE MISSION AND VEHICLE REQUIREMENTS FOR THESE FLIGHT MODES. THE OBJECTIVE OF THIS TASK IS TO PROCEED WITH THE FABRICATION OF LABORATORY PROTOTYPES OF A VOTER COMPARATOR SWITCH (VCS) DEVICE. THIS DEVICE, CONCEIVED AND DESIGNED UNDER FY70 908-41-10 AND FY71 908-41-08 PROGRAMS, IS AN ADAPTIVE VOTER ELEMENT WHICH CAN INTERFACE UP TO FOUR COMPUTERS IN A REDUNDANT RECONFIGURABLE SYSTEM. IT IS INTENDED THAT THE FABRICATION USE STATE-OF-THE-ART LARGE SCALE INTEGRATION. THE PROTOTYPE DEVICES WILL BE DELIVERED TO MSC AND INTERFACED WITH CANDIDATE _FLIGHT-TYPE COMPUTERS FOR LABORATORY EVALUATION OF VOTING AND RECONFIGURATION OF REDUNDANT SYSTEMS.

RTOP NO. 908-42-18 TITLE: SPACE SHUTTLE - CHECKOUT
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: MARLOWE, G. D. TEL. 713-483-6196
TECHNICAL SUMMARY

THE INTERDEPENDENCE OF HARDWARE, COMPUTER SYSTEMS AND FUNCTIONAL _APPLICATIONS MUST BE RECOGNIZED AS A SIGNIFICANT AREA SINCE ANY ONE MAY INFLUENCE THE DESIGN OF THE OTHER DURING THE DEVELOPMENT PHASES. THIS EFFORT WILL ASSURE EMPHASIS ON CRITICAL COMPUTER SYSTEM CONSIDERATIONS OF CHECKOUT, REDUNDANCY CONTROL, ERROR RECOVERY, VERIFICATION TECHNIQUES, AND DESIGN OF A BASIC DATA MANAGEMENT OPERATING SYSTEM FOR THE SPACE SHUTTLE. THIS EFFORT BUILDS UPON AND INTEGRATES THE FY-70 AND FY-71 TECHNOLOGY ACTIVITIES. THE STUDIES

AND RECOMMENDATIONS OF THE FY-70 STUDIES WILL BE UTILIZED IN THE FY-71 TECHNOLOGY DEVELOPMENT OF THE DETAILED EXECUTIVE DESIGN AND PROCEDURES. THE DETAILED SPECIFICATIONS AND PROCEDURES DELIVERED UNDER THE FY-71 EFFORT WILL BE UTILIZED TO SPECIFY, DELIVER AND DOCUMENT A DATA MANAGEMENT OPERATING _SYSTEM WHICH WILL BE UTILIZED WITH AN MSC SUBSYSTEM BREADBOARD SYSTEM. THIS SYSTEM WILL INCLUDE A FLIGHT COMPUTER (4 PI), DATA BUS, REDUNDANT POWER DISTRIBUTION SYSTEM, SIMULATED ENVIRONMENTAL CONTROL SYSTEM AND A GENERAL PURPOSE SIMULATION COMPUTER (360/44). THE DEVELOPMENT AND TESTING OF REAL APPLICATIONS BASED UPON PAST TECHNOLOGY EFFORTS IS EXPECTED TO DRIVE CRITICAL PROBLEM AREAS WHICH WOULD NOT OTHERWISE BE UNCOVERED UNTIL LATE IN THE SHUTTLE PROGRAM.

RTOP NO. 908-42-42 TITLE: SIMULATION GUIDELINES AND TECHNIQUES FOR MULTIPLEX DATA SYSTEMS FOR SHUTTLE
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: NOLTING, A. G. TEL. 713-483-5121
TECHNICAL SUMMARY

THE GOAL OF THIS RESEARCH AND TECHNOLOGY OPERATING PLAN IS TO PROVIDE A COMPREHENSIVE SET OF AVIONICS SIMULATION REQUIREMENTS FOR AN INTERIM FUNCTIONAL SIMULATION AND THE SHUTTLE MISSION SIMULATOR. EFFORTS WILL BE DIRECTED TOWARD EVALUATING ALTERNATIVES, E.G., SIMULATION TECHNIQUES, SIMULATION COMPUTER COMPLEX CONFIGURATION, AND ESTABLISHING THE REQUIREMENTS FOR THE COMPUTER SYSTEMS AND PROGRAMS FOR THE SHUTTLE MISSION SIMULATOR. THE DATA GENERATED IS REQUIRED EARLY DURING THE SHUTTLE PHASE C EFFORT TO INFLUENCE CREW STATION DESIGN AND FOR _THE EARLY DEVELOPMENT OF SIMULATORS AND SOFTWARE PROGRAMS TO BE USED FOR CREW TRAINING.

RTOP NO. 908-52-08 TITLE: CONTROL SYSTEM TECHNOLOGY FOR SHUTTLE VEHICLES
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: LOVINGOOD, J. A. TEL. 205-453-0436
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DETERMINE THE BEST (OPTIMUM) CONTROLLER WHICH WILL ADEQUATELY STABILIZE AND CONTROL THE ATTITUDE MOTION OF A SPACE SHUTTLE VEHICLE FOR THE VARIED FLIGHT ENVIRONMENTS: (1) LAUNCH/ATMOSPHERIC FLIGHT, (2) REENTRY FLIGHT, AND (3) LANDING. THE APPROACHES WILL EMPHASIZE AUTOMATIC CONTROL SYSTEMS WITH MAN SERVING AS BACKUP FOR EMERGENCIES. CONSIDERATION WILL BE GIVEN TO IMPLEMENTING THE CONTROL BY CONVENTIONAL, ADAPTIVE, AND/OR OPTIMAL CONTROL TECHNIQUES WITH RELIABILITY AND SIMPLICITY AS THE DESIGN CRITERIA. THE CONTROL SYSTEM INTERFACES WITH THE GUIDANCE AND NAVIGATION FUNCTIONS WILL BE REVIEWED TO ESTABLISH REQUIREMENTS AND COMMONGUIDELINES. THE OBJECTIVE OF THE ANALYSES WILL REQUIRE THE DEVELOPMENT OF FLEXIBLE ANALYSIS TECHNIQUES CAPABLE OF MEETING THE WIDE RANGE OF SHUTTLE VEHICLE MISSIONS THAT ARE UNDER CONSIDERATION. THE RECENT ADVANCES IN APPLYING MODERN CONTROL THEORY TO COMPLEX HIGH

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ORDER SYSTEMS HAVE CREATED THE OPPORTUNITY TO DEVELOP TECHNIQUES THAT WOULD GREATLY REDUCE THE TIME (BOTH ENGINEERING AND COMPUTER) AND EFFORT NECESSARY TO DESIGN EFFECTIVE CONTROLLERS FOR GIVEN SPACE APPLICATION. IN SOME INSTANCES, WORK HAS BEEN DONE IN FY-71. THESE CASES ARE SHOWN ON THE PERTINENT MILESTONE SCHEDULES (UNDER "NOTES").

RTOP NO. 908-52-18 TITLE: SHUTTLE SYSTEM STUDIES AND HARDWARE INVESTIGATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.
MONITOR: WOJTALIK, F. S. TEL. 205-453-1422
TECHNICAL SUMMARY

THIS WORK WILL PROVIDE TECHNOLOGY FOR DEVELOPING SPACE SHUTTLE VEHICLE (SSV) SYSTEMS REQUIREMENTS AND DESIGNS IN THE AREAS OF EMI SPECIFICATIONS TO ESTABLISH OPERATION AND ACCEPTANCE STANDARDS; DEVELOPMENT OF SOLID-STATE, AUTOMATIC, ELECTROMAGNETIC TEST EQUIPMENT FOR EMC _APPLICATIONS; DEVELOPMENT OF APPROACHES AND TECHNIQUES FOR GROUND VERIFICATION OF THE SSV DATA SYSTEM; IMPLEMENTATION OF ONBOARD CHECKOUT AND REDUNDANCY MANAGEMENT FOR THE REDUNDANT IMU SYSTEM; OPTIMUM BRAKING AND ANTI-SKID LANDING; AND DEVELOPMENT OF TECHNOLOGY FOR THE CHECKOUT MONITOR AND ONBOARD/GROUND ELECTRICAL SYSTEMS CONTROL. EMI SPECIFICATIONS REVIEW WILL INCLUDE SSV EQUIPMENT STUDIES, EQUIPMENT TEST DEFINITIONS, AND UPDATING OF PRESENT EMI TEST TECHNIQUES. EMC TEST EQUIPMENT RELIABILITY WILL BE IMPROVED AND PHYSICAL SIZE WILL BE REDUCED, UTILIZING LATEST STATE-OF-THE-ART TECHNIQUES. VERIFICATION OF THE _SSV DATA SYSTEM WILL USE EXISTING EQUIPMENT, CORRELATING PROPOSED TEST SPECIFICATIONS TO PROPOSED TEST TECHNIQUES AND MODIFYING EQUIPMENT FOR GREATEST FLEXIBILITY. THE IMU CHECKOUT SYSTEM WILL IMPLEMENT PREVIOUSLY DEVELOPED PLANS FOR HARDWARE AND SOFTWARE. PROPOSED BRAKING AND ANTI-SKID LANDING SYSTEM WILL BE ANALYZED AND SIMULATED BY COMPUTER.

RTOP NO. 908-62-13 TITLE: SPACE SHUTTLE INSTRUMENTATION SENSORS
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T. TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP IS FOR WORK ON SPACE SHUTTLE SENSORS TO DETECT HAZARDOUS CONDITIONS RESULTING FROM SPILL OR LEAKAGE OF SPACE SHUTTLE PROPELLANTS. HYDROGEN AND OXYGEN PRODUCE FIRE AND EXPLOSION HAZARDS IN A WIDE RANGE OF MIXTURE CONCENTRATIONS. SPACE SHUTTLE HYDROGEN AND OXYGEN SYSTEMS, BOTH GROUND AND FLIGHT, WILL BE LARGE AND COMPLEX AND WILL CONTAIN MANY PARTLY ISOLATED COMPARTMENTS AND OPERATIONALLY INACCESSIBLE COMPONENTS. THESE SYSTEMS WILL EXIST AND OPERATE IN AMBIENT CONDITIONS THAT RANGE ALL THE WAY FROM THE CLEAN QUIETNESS OF SPACE VACUUM TO THE DIRTY, NOISY, WINDY, SALT MOISTURE LADEN EARTH'S SURFACE ATMOSPHERE OF THE KENNEDY SPACE CENTER. SYSTEM FUNCTIONS WILL RANGE ALL THE WAY FROM THE STATIC STEADY STATE OF BULK STORAGE TO THE HIGHLY DYNAMIC OPERATING STATE OF LARGE PUMPS, VALUES, AND LINES GOING FROM NO-FLOW AMBIENT TEMPERATURES TO FLOWS UP TO 20 THOUSAND GALLONS PER MINUTE AT CRYOGENIC TEMPERATURES WITH START UP CHILLDOWN LOSSES BY CHANGE OF STATE FROM LIQUID TO GAS AT THOUSANDS

OF POUNDS PER MINUTE. THE SYSTEMS WILL BE MONITORED AND CONTROLLED BY REMOTELY LOCATED OPERATORS BOTH MANUAL AND AUTOMATIC. THE SAFE OPERATIONAL CONTROL OF THESE SYSTEMS WILL REQUIRE GOOD HYDROGEN FIRE SENSORS AND HYDROGEN AND OXYGEN GAS SENSORS. THE SENSORS MUST BE INDIVIDUALLY INEXPENSIVE TO ACQUIRE, OPERATE, AND MAINTAIN BECAUSE MANY WILL BE REQUIRED. THEY MUST BE RUGGED TO WITHSTAND THE OPERATING ENVIRONMENT. THEY MUST BE SENSITIVE, DEPENDABLE, AND ACCURATE TO PROVIDE THE INFORMATION NEEDED.

RTOP NO. 976-30-05 TITLE: SPACE SHUTTLE - ELECTRICAL POWER - MARK I FUEL CELL DEVELOPMENT
ORGANIZATION: MANNED SPACECRAFT CENTER NASA ROAD 1 HOUSTON,
MONITOR: RICE, W. E. TEL. 713-483-5273
TECHNICAL SUMMARY

THIS EFFORT REPRESENTS A 12-MONTH CONTINUATION OF EXISTING CONTRACTS WITH PRATT AND WHITNEY AIRCRAFT (NAS 9-11034) AND GENERAL ELECTRIC COMPANY (NAS 9-11033) WITH THE OBJECTIVE OF ADVANCING THE TECHNOLOGY OF THE BASIC ELECTROLYTE FUEL CELL AND ACID FUEL CELL RESPECTIVELY. PRIMARY OBJECTIVES OF BOTH PROGRAMS ARE TO IDENTIFY THE PROBLEMS AND FORMULATE THE SOLUTIONS REQUIRED TO DESIGN AND FABRICATE A FUEL CELL HAVING A LIFE CAPABILITY OF 5000 HOURS. THE APPROACH UTILIZED IN ACHIEVING THESE OBJECTIVES IS TO DEFINE A LOGICAL TECHNICAL EXTENSION OF THE PRESENT (FY71) EFFORT, A 2000-HR. OBJECTIVE, WHICH CONCENTRATES ON THE SPECIFIC LIMITING AREAS IDENTIFIED IN THE PREVIOUS PROGRAM. THE SPECIFIC TECHNICAL TASKS ARE FURTHER DIRECTED TOWARD DIRECT SUPPORT OF THE SPACE SHUTTLE REQUIREMENTS BY MAINTAINING AN ACTIVE LIAISON EFFORT BETWEEN THE FUEL CELL CONTRACTOR AND THE PRIME SHUTTLE CONTRACTOR.

RTOP NO. 113-31-17 TITLE: SPACE SHUTTLE - CRYOGENIC STORAGE SYSTEMS
ORGANIZATION: MANNED SPACECRAFT CENTER NASA ROAD 1 HOUSTON,
MONITOR: CHANDLER, W. A. TEL. 713-483-4771
TECHNICAL SUMMARY

THE SPACE SHUTTLE WILL REQUIRE CRYOGENIC STORAGE SYSTEMS FOR BOOST, MANEUVERING AND REACTION CONTROL PROPULSION, FUEL CELL AND AUXILIARY POWER, AND ENVIRONMENTAL CONTROL/LIFE SUPPORT FUNCTIONS. THE STORAGE SYSTEMS MUST SUPPLY CONDITIONED FLUIDS FOR UP TO 7 DAYS AND SATISFY THE SHUTTLE REQUIREMENTS OF COMPLETE REUSABILITY, LOW COST, MINIMUM MAINTENANCE AND MAXIMUM SAFETY. PRESENT TECHNOLOGY IS INADEQUATE TO MEET THESE REQUIREMENTS. THEREFORE, SELECTED CRITICAL PROGRAMS WERE INITIATED IN FY71 TO SATISFY THESE DEFICIENT TECHNOLOGICAL AREAS AND WILL BE CONTINUED WITH FY72 FUNDS. OTHER CRITICAL PROGRAMS WILL BE INITIATED BY THIS RTOP. THE OVERALL PROGRAM OBJECTIVE IS TO PROVIDE THE CRYOGENIC SYSTEM TECHNOLOGY NECESSARY TO MEET ALL THE OBJECTIVES FOR A LOW COST REUSABLE SHUTTLE VEHICLE.

RTOP NO. 908-52-37 TITLE: SPACE SHUTTLE CRYOGENIC TECHNOLOGY
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.
MONITOR: WORLUND, A. L. TEL. 205-453-3853
TECHNICAL SUMMARY

THIS PLAN WILL PROVIDE TECHNOLOGY TO PROVIDE CONSISTENT DESIGN CRITERIA AND CONCEPTS FOR EFFICIENT UTILIZATION AND CONTROL OF CRYOGENS ABOARD THE SPACE SHUTTLE VEHICLE. EFFORTS PERFORMED UNDER THIS RTOP WILL ESTABLISH THE DESIGN AND SUBSYSTEM INTEGRATION CRITERIA AND HARDWARE FEASIBILITY NECESSARY TO MINIMIZE PERFORMANCE DEVIATION WITH EXTENDED OPERATIONAL LIFE AND REUSE. THE EFFORTS PERFORMED UNDER THIS RTOP WILL SUSTAIN INVESTIGATIONS OF NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN, AND TESTING. NINE TASKS ARE IDENTIFIED WHICH HAVE THE POTENTIAL TO PROVIDE PROPELLANTS INDEPENDENT OF THE VEHICLE ACCELERATION FIELD, MINIMIZE PROPELLANT BOILOFF LOSSES, INCREASE COMPONENT PERFORMANCE AND LIFE, AND ASSURE MINIMUM CONSTRAINTS WHILE LOADING CRYOGENIC FEEDLINES. SPECIFICALLY, THESE TASK PROVIDE FOR INVESTIGATING ZERO G FLUID RETENTION DEVICES, REUSABILITY OF MULTILAYER INSULATION, LH2 INTERNAL TANK INSULATION, COMPONENT LIFE TEST METHODOLOGY, VACUUM JACKETED DUCTING, SPACE LOX VENT SYSTEM, LONG LIFE VALVE DESIGNS, "ZERO-LEAKAGE" SEALS, AND FEEDLINE GEYSER SUPPRESSION. CONTRACTED EFFORTS ARE PLANNED TO BE COMPLEMENTED BY IN-HOUSE EFFORTS. FY-72 FUNDING PLAN IS 1250K.

RTOP NO. 908-52-47 TITLE: UPPER ATMOSPHERE POLLUTION DUE TO SHUTTLE OPERATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: DEVRIES, L. L. TEL. 205-453-3108
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK ARE TO EXAMINE THE POTENTIAL OF SHUTTLE OPERATIONS TO CONTRIBUTE TO UPPER ATMOSPHERIC POLLUTION,

BOUND THE PROBLEMS IF ANY OF SIGNIFICANCE ARE FOUND, AND OUTLINE AN INVESTIGATIVE APPROACH IF NECESSARY. THROUGH EXPLORATORY STUDY AND ANALYSIS, POTENTIAL SOURCES OF UPPER ATMOSPHERIC POLLUTION DUE TO SHUTTLE OPERATIONS WILL BE IDENTIFIED AND POSSIBLE APPROACHES FOR ALLEVIATION OF SUCH POLLUTION WILL BE INVESTIGATED. THERE ARE A NUMBER OF POTENTIAL ENVIRONMENTAL EFFECTS WHICH COULD BE CAUSED BY SHUTTLE OPERATIONS, INCLUDING CLOUD FORMATION (ICE CRYSTALS) IN THE STRATOSPHERE, EXCESSIVE STRATOSPHERIC INCREASES IN CARBON DIOXIDE AND WATER VAPOR, CHANGES IN OZONE CONCENTRATION, EXCESSIVE DISPERSION OF PARTICULATE MATTER IN THE STRATOSPHERE, INTRODUCTION OF GASEOUS POLLUTANTS (CARBON MONOXIDE, NITROGEN OXIDES, SULPHER OXIDES, HYDROCARBONS) INTO THE ATMOSPHERE, AND INTRODUCTION OF POLLUTANTS INTO THE AIR IN THE AREA SURROUNDING LAUNCH SITES. THE FIRST PHASE OF THIS PROGRAM WILL BE TO IDENTIFY THE TOTAL QUANTITY AND PHYSICAL AND CHEMICAL PROPERTIES OF THE COMBUSTION PRODUCTS AS A FUNCTION OF ALTITUDE. ESTIMATES WILL BE MADE OF THE LIFE HISTORY OF EACH PRIMARY COMBUSTION BY-PRODUCT AND ANY SECONDARY PRODUCTS FROM THE TIME OF ATMOSPHERIC INJECTION UNTIL THEY ARE DEPOSITED ON THE EARTH'S SURFACE. THE ENVIRONMENTAL EFFECTS OF THIS POLLUTION WILL BE DETERMINED TO IDENTIFY POTENTIAL ENVIRONMENTAL HAZARDS AND TO DETERMINE POSSIBLE APPROACHES FOR ALLEVIATION OF SUCH HAZARDS.IF SIGNIFICANT PROBLEM AREAS ARE IDENTIFIED, AN INVESTIGATIVE PROGRAM WILL BE OUTLINED TO PROVIDE DEFINITIVE ANSWERS TO POSSIBLE ENVIRONMENTAL QUESTIONS.

RTOP NO. 908-52-47 TITLE: SHUTTLE - ENVIRONMENT FOR DESIGN, TEST AND MISSION ANALYSIS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: VAUGHAN, W. W. TEL. 205-453-3106
TECHNICAL SUMMARY

THE SHUTTLE WILL OPERATE IN THE EARTH'S ATMOSPHERE FROM NEAR THE SURFACE OF THE EARTH TO ORBITAL ALTITUDES. INITIAL ESTIMATES OF THE DESIGN CRITERIA HAVE BEEN FORMULATED, COORDINATED WITH MSC AND KSC, AND PUBLISHED AS A LEVEL II SHUTTLE SYSTEM REQUIREMENT FOR PHASE B WORK. CONTRACTORS AND NASA ITERATIONS, TRADE-OFF STUDIES, AND VARIATIONS ON THE DESIGN GUIDELINES HAVE CREATED A CONTINUOUS NEED FOR REDEFINITION AND FORMULATION OF ENVIRONMENTAL INFORMATION AND GUIDELINES IN CONSISTENT ENGINEERING TERMS. ALL ASPECTS OF THE SHUTTLE PROGRAM DEVELOPMENT DEPEND UPON THIS INTERFACE ACTIVITY IN THE NATURAL ENVIRONMENT AREA IN ORDER THAT TIMELY AND PROPER RESPONSE MAY BE MADE TO ALL INQUIRIES. IN MANY CASES THESE INPUTS MUST BE ANTICIPATED BASED ON AVAILABLE SHUTTLE DESIGN TEST AND OPERATIONAL PLANS TO PROVIDE ADEQUATE LEAD TIME TO ACQUIRE THE PROPER DATA. SCIENTIFIC-ENGINEERING TALENTS AT MSFC HAVE ESTABLISHED A RESPONSIVE RELATIONSHIP TO MSFC, MSC, AND KSC PLUS THEIR PRIME SHUTTLE CONTRACTORS ON THIS SUBJECT. THIS INCLUDES PROVIDING CONSISTENT MODELS, TEST SUPPORT PLANNING, OPERATIONAL ANALYSIS, SPECIFIC DESIGN STUDY INTERPRETATIONS AND DEFINITIONS. THIS IS A CONTINUING ENDEAVOR WHICH REQUIRES INHOUSE SCIENTIFIC-ENGINEERING INTERFACE TALENTS SUPPORTED BY PROVISIONS FOR DATA RESOURCE ACQUISITION PLUS SUPPORTING ANALYSIS USING OTHER GOVERNMENT AGENCIES AND CONTRACTOR TALENTS.

THIS WORK MUST BE CONTINUED TO AVOID COSTLY ERRORS ON ENVIRONMENT INPUTS TO THE SHUTTLE DEVELOPMENT AS REFLECTED BY ALL OTHER SHUTTLE RELATED RTOP'S, PRIME CONTRACTS, AND INHOUSE NASA EFFORTS.

RTOP NO. 908-62-09 TITLE: SPACE SHUTTLE ABORT AND SAFETY
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP IS FOR WORK RELATED TO SPACE SHUTTLE OPERATIONS SAFETY. BOTH THE GENERAL PUBLIC AND ITS PROPERTY AND GOVERNMENT PERSONNEL AND PROPERTY ARE INVOLVED. ENGINEERING INVESTIGATIONS WILL BE MADE TO IDENTIFY AND TECHNICALLY DEFINE THE HAZARDS ATTENDANT TO OPERATIONS OF PROPOSED SPACE SHUTTLE CONFIGURATIONS. THESE HAZARDS WILL BE EVALUATED AGAINST VARIOUS EXISTING RISK CRITERIA, DEVELOPMENT COSTS, OPERATING COSTS, AND SCHEDULES TO IDENTIFY THE OPTIMUM APPROACH (DESIGN CHANGE, OPERATION CHANGE, OR COMBINATION) TO BRING THE RISK WITHIN ACCEPTABLE LIMITS. WHERE EXISTING CRITERIA ARE INADEQUATE, THIS RTOP PROVIDES FOR ANALYSES AND TESTS TO PRODUCE DATA NECESSARY TO ESTABLISH THE NEW CRITERIA NEEDED. AMONG THE SPECIFIC AREAS OF SAFETY CONCERN FOR INVESTIGATION DURING FISCAL YEAR 1972 UNDER THIS RTOP ARE: (1) EMERGENCY EGRESS OF PERSONNEL FROM THE SPACE SHUTTLE AND ADJACENT WORK AREAS DURING ALL GROUND OPERATIONS, (2) SAFETY CRITERIA FOR DESIGN AND OPERATIONS OF FACILITIES AND EQUIPMENT FOR ALL GROUND MOVEMENTS AND HANDLING OF THE SPACE SHUTTLE, AND (3) OVERFLY SAFETY REQUIREMENTS FOR PROPOSED LAUNCH AND LANDING SITES.

RTOP NO. 908-62-17 TITLE: SHUTTLE FLIGHT PREPARATION
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

THIS RTOP ENCOMPASSES THOSE TECHNOLOGIES WHICH MUST BE ADVANCED TO ENABLE ATTAINMENT OF COST EFFECTIVE RAPID PREPARATION, TURNAROUND AND VERIFICATION OPERATIONS AT THE LAUNCH SITE AND FERRY LANDING SITES. IN ADDITION TO EFFICIENT HANDLING AND OPERATIONS TO CARRY OUT MORE ROUTINE TURNAROUND OPERATIONS, EFFICIENT FLIGHT READINESS VERIFICATION TECHNIQUES ARE ESSENTIAL FOR SUCCESSFUL LAUNCH AND MISSION OPERATIONS. MANY FACTORS CONTRIBUTE TO THE DIFFICULTY OF DETERMINING, WITH ASSURANCE, THAT SUB-SYSTEMS AND COMPONENTS WHICH MAKE UP THE SPACE SHUTTLE SYSTEM, ARE IN FACT IN A CONDITION ACCEPTABLE FOR USE/REUSE. SEVERAL AREAS OF TECHNOLOGY IN WHICH INVESTIGATION IN FY 72 IS PLANNED ARE: (1) MECHANICAL SYSTEMS READINESS ASSESSMENT, (2) STRUCTURAL INTEGRITY ASSESSMENT, (3) REDUNDANCY CHECKOUT TECHNIQUES, (4) FAILURE PREDICTION AND ANALYTICAL METHODS, AND (5) TEST AND FLIGHT ENGINEER ORIENTED COMPUTER LANGUAGE.

RTOP NO. 908-62-32 TITLE: GROUND OPERATIONS TECHNIQUES
ORGANIZATION: JOHN F. KENNEDY SPACE CENTER KENNEDY SPACE CENTER
MONITOR: BEDDINGFIELD, S. T.TEL. 305-867-5660
TECHNICAL SUMMARY

ENGINEERING AND OPERATIONS INVESTIGATIONS ARE TO BE MADE TO FURTHER DEVELOP GROUND OPERATIONS TECHNIQUES FOR SPECIFIC APPLICATION TO SPACE SHUTTLE TURNAROUND. THESE TECHNIQUES WILL BE EVALUATED AGAINST DESIRED CRITERIA AND TECHNIQUES ESTIMATED TO BE REQUIRED TO ACHIEVE THE RAPID TURNAROUND OF THE SHUTTLE, AND THE PRESENT TECHNIQUES WHICH HAVE BEEN DEVELOPED FOR NASA AND DOD SPACE VEHICLES. WHERE EXISTING ENGINEERING INFORMATION AND OPERATIONAL METHODS AND CRITERIA ARE INSUFFICIENT, THIS RTOP PROVIDES FOR INVESTIGATIONS, ANALYSES, AND TESTS TO ESTABLISH THE NEEDED METHODS AND CRITERIA. SPECIFIC AREAS OF GROUND OPERATIONS TECHNIQUES TO BE INVESTIGATED UNDER THIS RTOP INCLUDE: (1) LEAK DETECTION OF FLUIDS AND GASES, (2) HANDLING OF PROPELLANTS AND GASES, (3) PAYLOAD HANDLING, (4) AIRLINE OPERATIONS, MAINTENANCE AND SAFETY APPLICATIONS, AND (5) SCHEDULING AND CONTROL SYSTEMS.

RTOP NO. 908-72-47 TITLE: SHUTTLE SONIC BOOM STUDY
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE WORK UNDER THIS RTOP WILL PROVIDE A TECHNOLOGY BASIS FOR AN UNDERSTANDING OF SHUTTLE SONIC BOOM SIGNATURES. EXISTING SONIC BOOM TECHNOLOGY, AS DEVELOPED FOR AIRCRAFT, APPLIES PRIMARILY TO STEADY, LEVEL FLIGHT OF HIGH FINENESS RATIO VEHICLES AT LOW ANGLES OF ATTACK AT ALTITUDES OF LESS THAN 100,000 FEET AND AT MACH NUMBERS LESS THAN 3.0. THE SHUTTLE'S UNIQUE CHARACTERISTICSOF RELATIVELY LOW FINENESS RATIO VEHICLES AT LARGE ATTITUDES, STEADILY DECELERATING FROM AN ALTITUDE OF ABOUT 400,000 FEET WITH INITIAL MACH NUMBERS IN EXCESS OF 25 ESTABLISHES THE NEED FOR A CONCENTRATED TECHNOLOGY DEVELOPMENT PROGRAM TO PROVIDE THE MEANS OF OBTAINING REALISTIC PREDICTIONS OF SHUTTLE BOOM SIGNATURES. ONCE THIS CAPABILITY IS AVAILABLE, OPERATIONAL STUDIES WILL BE CONDUCTED TO DEFINE TECHNIQUES FOR ALLEVIATING THE OVERPRESSURE LEVELS AND/OR CONTROLLING THE LOCATION OF THE BOOM FOOTPRINT WITHIN RESTRICTED AREAS.

RTOP NO. 113-31-02 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF ENGINE COMPONENTS FOR THE AUXILIARY PROPULSION SYSTEM OF THE SPACE SHUTTLE. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE THRUSTER ASSEMBLY, INCLUDING THE INJECTOR, THRUST CHAMBER, IGNITER, AND VALVES. THE OPERATING CONDITIONS FOR THE EXPERIMENTAL WORK ARE SELECTEDTO FIT THE PARTICULAR REQUIREMENTS OF THE SPACE SHUTTLE. THIS INCLUDES OPERATION WITH GASEOUS HYDROGEN/GASEOUS OXYGEN PROPELLANTS AT THRUST LEVELS IN THE RANGE FROM 1500-2000 POUNDS, CHAMBER PRESSURES FROM 100-500 PSIA, AND APPROPRIATE RANGES OF PROPELLANT INLET PRESSURES AND TEMPERATURES. POINT DESIGN, NEAR-FLIGHT WEIGHT INTEGRATED THRUSTER ASSEMBLIES WILL BE FABRICATED AND TESTED TO PROVIDE AN EVALUATION OF OVERALL PERFORMANCE (BOTH PULSING AND STEADY-STATE), THRUSTER LIFE, AND OPERATING CHARACTERISTICS FOR TYPICAL DUTY CYCLES. OTHER PROGRAMS RELATING TO THE SUPPLY AND REGULATION OF THE PROPELLANTS FED TO THE ATTITUDE CONTROL ENGINES AS WELL AS MORE BASIC PROGRAMS TO EVALUATE CRITICAL PROBLEM AREAS IN COMBUSTION, VALVES AND IGNITION DEVICES ARE INCLUDED.

RTOP NO. 908-42-03 TITLE: SPACE SHUTTLE - PROPULSION
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: BUCHANAN, M. C. TEL. 713-483-5189
TECHNICAL SUMMARY

MANUFACTURE VARIOUS SEALS FROM MATERIALS WHICH HAVE BEEN SELECTED FROM PREVIOUS DEVELOPMENT CONTRACTS, ALSO FROM PROMISING NEW MATERIALS. IT ALSO SHOULD BE CONSIDERED TO SYNETHESIS ADDITIONAL NEW MATERIAL FOR SEAL TESTING. THESE SEALS WILL BE USED IN STATIC AND DYNAMIC _APPLICATIONS IN BOTH LIQUID OXYGEN AND LIQUID HYDROGEN. A SELECTION WILL BE MADE FROM PROMISING NEW MATERIALS FOR USE IN FURTHER TESTING. THESE MATERIALS WILL BE FABRICATED INTO DIFFERENT DESIGNS AND TESTED TO DETERMINE THEIR FUNCTIONAL CHARACTERISTICS.

RTOP NO. 908-72-14 TITLE: EVALUATION OF PYROTECHNIC SYSTEMS FOR SPACE SHUTTLE AND SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP AND EVALUATE TECHNOLOGY FOR NEW AND IMPROVED EXISTING PYROTECHNIC SYSTEMS FOR USE ON SPACE SHUTTLE AND SPACE STATION MISSION. THE STUDY WILL INCLUDE THE APPLICABILITY OF PYROTECHNIC SYSTEMS TO THE PERFORMANCE OF MANY FUNCTIONS ON SPACE SHUTTLE, AND POSSIBLY A FOLLOW-ON CONCEPT DEMONSTRATION PROGRAM.

RTOP NO. 976-30-04 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION SUBSYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, ALA., 35812
MONITOR: TEL. 205-453-3845
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS THE ESTABLISHMENT OFTHE TECHNOLOGY BASE COMPLEMENTARY OF THAT BEINGDEVELOPED UNDER RTOP 731-13-48 AND THE MANNEDSPACE FLIGHT CENTER AUXILIARY PROPULSION SYSTEMTECHNOLOGY PROGRAM. THE FY72 EFFORT WILL CONTINUETHE LIQUID HYDROGEN (LH2) AND LIQUID OXYGEN (LO2)TURBOPUMP ASSEMBLIES (TPA) TECHNOLOGY DEVELOPMENT.CONCEPT SCREENING, DETAIL DESIGN, FABRICATION,TESTING, HARDWARE DELIVERIES AND TECHNICAL SUPPORTFOR NASA INHOUSE APS TESTING WILL BE PROVIDED BYINDUSTRY UNDER MSFC CONTRACT. ADVANCEDDEVELOPMENT WILL PROVIDE AN EARLY IDENTIFICATIONAND SOLUTION OF POTENTIAL CRITICAL TPA PROBLEMAREAS.

RTOP NO. 976-30-04 TITLE: ATTITUDE CONTROL PROPULSION
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: POHL, H. O. TEL. 713-483-4971
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO IMPROVE THE REACTION CONTROL SYSTEM (RCS) DEVELOPMENT POSTURE FOR THE SPACE SHUTTLE BY ACQUIRING COMPONENT DESIGN AND OPERATING DATA WHICH WILL SUPPORT AND BE DIRECTLY APPLICABLE TO THE PHASE C AND EARLY PHASE D MAINSTREAM VEHICLE EFFORTS. THE PROGRAMS TO BE ACCOMPLISHED UNDER THIS RTOP WILL BE FOCUSED ON THE ANALYSIS, DESIGN, DEVELOPMENT AND FABRICATION OF REALISTIC AND REPRESENTATIVE PROPELLANT CONDITIONING COMPONENTS FOR A HIGH PRESSURE OXYGEN-HYDROGEN RCS BREADBOARD TEST SYSTEM. SPECIFIC PROGRAMS WILL BE INITIATED TO DEVELOP GAS GENERATOR/TURBOPUMP ASSEMBLIES, AND GAS GENERATOR/HEAT EXCHANGER ASSEMBLIES FOR BOTH OXYGEN AND HYDROGEN BASED UPON BEST CURRENT JUDGMENTS OF SHUTTLE RCS REQUIREMENTS. PROGRAMS WILL BE INITIATED TO DEVELOP PRESSURE REGULATORS AND MASS FLOW REGULATORS FOR BOTH HYDROGEN AND OXYGEN. A PROGRAM WILL ALSO BE INITIATED TO STUDY OVERALL PROPELLANT CONDITIONING SYSTEM CONTROLS, ESPECIALLY AS THEY RELATE TO CONTROL OF THE GAS GENERATORS. TO CONSOLIDATE THESE HARDWARE DEVELOPMENT AND FABRICATION PROGRAMS, A PROGRAM WILL BE UNDERTAKEN TO DESIGN AND BUILD UP A BREADBOARD TEST SYSTEM AT MSC IN WHICH THE PROPELLANT CONDITIONING ASSEMBLY COMPONENTS CAN BE OPERATED AND EVALUATED ON A SEPARATE COMPONENT OR COMPLETE ASSEMBLY BASIS. THE DATA AND INFORMATION FROM THESE SIX PROGRAMS WILL PERMIT EARLY IDENTIFICATION AND CONSIDERATION OF COMPONENT AND SYSTEM DESIGN PROBLEMS BY NASA AND THE PRIME VEHICLE CONTRACTOR, AND WILL INSURE THAT ASSIGNED OR IMPLIED COMPONENT AND SYSTEM FUNCTIONAL REQUIREMENTS ARE CONSISTENT WITH REALISTICALLY ACHIEVABLE GOALS.

RTOP NO. 114-03-30 TITLE: SPACE SHUTTLE: ENVIRONMENTAL TESTING OF THERMAL-PROTECTION MATERIALS
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THIS PROGRAM WILL ENCOMPASS A NUMBER OF WORK AREAS DEALING WITH THE EFFECTS OF THE ENTRY ENVIRONMENT ON CANDIDATE THERMAL-PROTECTION AND SKIN MATERIALS FOR SPACE SHUTTLE, WITH A COMMON GOAL OF EVALUATING THE OXIDATION SUSCEPTIBILITY AND RESULTING EFFECT ON THE MECHANICAL AND OPTICAL PROPERTIES OF THESE MATERIALS. OXIDATION EXPERIMENTS WILL BE RUN IN HIGH-TEMPERATURE ENVIRONMENTAL CHAMBERS WITH ATOMIC OXYGEN GENERATORS TO PROVIDE REACTIVE SPECIES APPROPRIATE FOR SHUTTLE THERMAL-ENVIRONMENT CONDITIONS. MECHANICAL PROPERTY EXPERIMENTS WILL BE RUN WHICH INCORPORATE ENVIRONMENTAL SIMULATION, TENSILE TESTS, AND APPROPRIATE METALLURGICAL, CHEMICAL AND PHYSICAL PROPERTY MEASUREMENTS.

RTOP NO. 114-03-30 TITLE: HIGH TEMPERATURE METALS FOR SPACE SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES CONTINUED DEVELOPMENT OF METALLIC MATERIALS FOR POSSIBLE USE IN THE HIGH TEMPERATURE REGIONS OF HEAT SHIELDS FOR SPACE SHUTTLE VEHICLES. THE PROGRAM INCLUDES THE DEVELOPMENT OF BOTH DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS (NI-CR-THO) AND COATED REFRACTORY METALS (COLUMBIUM AND TANTALUM ALLOYS). THE MAJOR OBJECTIVES OF THE PROGRAM ARE: 1. TO COMPLETE THE DEVELOPMENT AND SCALE-UP OF FABRICATION PROCESSES FOR AN ADVANCED NI-CR-THO ALLOY. 2. TO COMPLETE THE DEVELOPMENT OF RELIABLE FORMING AND JOINING PROCESSES FOR NI-CR-THO ALLOYS. 3. TO CONTINUE DEVELOPMENT OF IMPROVED OXIDATION-RESISTANT COATINGS AND PRODUCTION PROCESSES FOR BOTH COLUMBIUM AND TANTALUM ALLOY HEAT SHIELDS.

RTOP NO. 114-03-32 TITLE: SHUTTLE LUBRICATION, BEARINGS AND SEALS
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: JOHNSON, R. L. TEL. 216-433-4000
TECHNICAL SUMMARY

MATERIALS AND LUBRICANTS SELECTION, DEVELOPMENT, DESIGN, THEORY, ANALYSIS AND EXPERIMENTATION OF BEARINGS AND SEALS WILL BE PERFORMED UNDER EXTREME CONDITIONS ASSOCIATED WITH (A) ENGINE AND (B) VEHICLE COMPONENTS SUBJECT TO LUBRICATION, FRICTION, WEAR AND HYDRAULICS PROBLEMS. COMPONENTS MUST FUNCTION IN CRYOGENICS, AFTER EXPOSURE TO VACUUM, AND IN AIR AT EXTREME TEMPERATURES. ROLLING ELEMENT BEARINGS AND FACE TYPE SEALS FOR HYDROGEN PUMPS OF SHUTTLE ENGINES WILL BE OPERATED UNDER CONDITIONS SIMULATING PROBLEM AREAS. VEHICLE FRAME CONTROL BEARINGS, HYDRAULIC FLUIDS, AND SEALS FOR ACTUATION SYSTEMS OF FLIGHT CONTROL SURFACES WILL BE STUDIED. MINIMUM WEIGHT, EFFICIENCY AND EXTENDED LIFE ARE ESSENTIAL.

RTOP NO. 114-03-32 TITLE: BEARINGS, LUBRICANTS, AND SEALS FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL

MONITOR: DEMOREST, K. E. TEL. 205-453-3536
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO PROVIDE SOLUTIONS TO THE PROBLEMS OF LUBRICATING BEARING SYSTEMS AND OTHER COMPONENTS FOR LONG LIFETIMES IN THE VARIETY OF ENVIRONMENTS WHICH WILL BE ENCOUNTERED BY SHUTTLE SPACECRAFT. EARLY ORBITAL FLIGHTS OF BOTH SATELLITES AND MANNED SPACECRAFT HAVE HAD LUBRICATION SYSTEMS THAT WERE EITHER COMPLETELY SEALED OR THAT HAD RELATIVELY SHORT LIFE REQUIREMENTS. EVEN SUCH SPACECRAFT AS THE APOLLO TELESCOPE MOUNT AND THE ORBITAL WORKSHOP HAVE LIMITED LIFE REQUIREMENTS WHICH ARE WITHIN THE PRESENT STATE-OF-THE-ART. IT IS INTENDED TO ACCOMPLISH THE ABOVE OBJECTIVE BY THE CONTINUED DEVELOPMENT OF FLUID AND DRY LUBRICANTS AND BY THE DEVELOPMENT OF SPECIAL DESIGNS FOR SLIDING AND ROLLING ELEMENTS WHICH WILL MEET THE LIFE AND ENVIRONMENTAL REQUIREMENTS POSED BY THESE ADVANCED SYSTEMS.

RTOP NO. 114-03-33 TITLE: STRUCTURAL COMPOSITE MATERIALS FOR SPACE SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THE PRINCIPAL OBJECTIVE IS TO ESTABLISH THE CHARACTERISTICS OF AND TO OBTAIN DESIGN INFORMATION FOR CERTAIN ADVANCED FIBER/POLYMER MATRIX SYSTEMS THAT ARE APPLICABLE TO SPACE SHUTTLE STRUCTURES. THE HIGH STRENGTH TO WEIGHT RATIOS AND THE HIGH MODULUS TO WEIGHT RATIOS OF THESE SYSTEMS OFFER CONSIDERABLE PROMISE FOR REDUCING THE STRUCTURAL WEIGHT OF THE SHUTTLE SYSTEM AND THUS INCREASING THE PAYLOAD. A NEW HIGH STRENGTH, HIGH MODULUS ORGANIC FIBER WILL BE FURTHER INVESTIGATED AS A FILAMENT WINDING MATERIAL IN ADDITION TO A POLYIMIDE/GLASS FIBER SYSTEM FOR INCREASED TEMPERATURE CAPABILITY. IN ADDITION, ADHESIVE SYSTEMS WILL BE INVESTIGATED TO PROVIDE BETTER BOND STRENGTH OVER A WIDER TEMPERATURE RANGE.

RTOP NO. 114-03-33 TITLE: STRUCTURAL COMPOSITE MATERIALS FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: LAIACONA, F. P. TEL. 205-453-5516
TECHNICAL SUMMARY

THE OBJECT OF THIS PROGRAM IS TO DEVELOP TECHNIQUES FOR FABRICATING FIBER REINFORCED ALUMINUM COMPOSITES INTO STRUCTURAL SHAPES (TUBES, I-BEAMS, HAT SECTIONS, "T"-SECTIONS, Z SECTIONS, ETC.) BY MEANS OF A CONTINUOUS PROCESS. THE PRIMARY OBJECTIVE IS THE REDUCTION OF METALLIC COMPOSITE FABRICATION COSTS AS WELL AS DEVELOPING A MORE RELIABLE AND DESIRABLE METHOD OF FABRICATING METALLIC COMPOSITE COMPONENTS. THE APPROACH WILL BE TO EVALUATE PROCESSES FOR PRODUCING BORON-ALUMINUM COMPOSITES WHICH APPEAR ADAPTABLE FOR USE IN A CONTINUOUS PROCESS. NECESSARY PROCESSING PROCEDURES WILL BE INVESTIGATED AND TECHNIQUES DEVELOPED FOR PRODUCING A VARIETY OF STRUCTURAL SHAPES. A MECHANICAL EVALUATION WILL BE MADE OF THE DEVELOPED COMPOSITES SO THAT FINAL FABRICATING TECHNIQUES CAN BE ESTABLISHED AND EXPECTED MECHANICAL PROPERTIES OF

THE VARIOUS STRUCTURAL SHAPES CAN BE DEVELOPED. THE TECHNIQUES DEVELOPED SHALL ALSO BE INVESTIGATED FOR APPLICATION TO OTHER TYPE OF FIBER REINFORCED ALUMINUM COMPOSITES.

RTOP NO. 114-03-34 TITLE: DESIGN PROPERTIES OF MATERIALS (EVALUATION OF SOFTGOODS)
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: WOOD, T. E. TEL. 205-453-1231
TECHNICAL SUMMARY

TO STUDY THE PERFORMANCE OF RUBBER SOFT GOODS WHICH MUST BE USED FOR SEALS, BLADDERS, O-RINGS, DIAPHRAGMS, GASKETS, ADHESIVES, AND RELATED APPLICATIONS AS EFFECTED BY EXTREME CYCLIC VARIATIONS IN THE SHUTTLE VEHICLE FLIGHT ENVIRONMENT, COUPLED WITH THE REUSABILITY, RELIABILITY AND QUICK TURN-AROUND REQUIREMENTS. IT IS PROPOSED TO EXPOSE CANDIDATE RUBBER MATERIALS IN BOTH TYPICAL END-USE CONFIGURATIONS AND STANDARD TEST CONFIGURATIONS TO CYCLIC THERMAL AND PRESSURE ENVIRONMENTS COMPARABLE TO ANTICIPATED SHUTTLE ENVIRONMENTS AND MONITOR SUCHPARAMETERS AS COMPRESSION SET, STRESS RELAXATION, AGING BEHAVIOR, EMBRITTLEMENT, STRENGTH CHANGES, HARDNESS, AND OTHER ATTRIBUTES WHICH DICTATED THE SELECTION AND SUITABILITY OF THE MATERIALS FOR THE GIVEN APPLICATION.

RTOP NO. 114-03-35 TITLE: MATERIALS ENVIRONMENTAL COMPATIBILITY FOR SPACE SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: CATALDO, C. E. TEL. 205-453-1278
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY IS TO DETERMINE THE EFFECTS OF VARIOUS ENVIRONMENTS ANTICIPATED DURING FABRICATION, STORAGE AND FLIGHT OF THE SHUTTLE ON STRUCTURAL MATERIALS, BOTH WITH RESPECT TO SHORT TERM EFFECTS AND LONG LIFE EFFECTS. WHILE ALL ANTICIPATED ENVIRONMENTS CANNOT BE INVESTIGATED UNDER THE SCOPE OF THIS PROGRAM, SEVERAL SPECIFIC STUDIES ARE TO BE MADE WHEREIN MATERIALS PROBLEMS HAVE BEEN IDENTIFIED. THE STUDIES COVERED UNDER THIS RTOP INCLUDE THE EFFECTS OF HIGH PRESSURE GASEOUS HYDROGEN ON MATERIALS, THE FLAMMABILITY CHARACTERISTICS OF MATERIALS IN OXYGEN, CORROSION SUSCEPTIBILITY AND OUTGASSING CHARACTERISTICS OF NON-METALLIC MATERIALS. THREE STUDIES ALREADY UNDERWAY WILL BE CONTINUED WITH DIFFERENT EMPHASIS AND ONE ADDITIONAL TASK WILL BE IMPLEMENTED.

RTOP NO. 114-03-36 TITLE: SPACE SHUTTLE: EXTERNAL INSULATION
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROJECT IS TO DETERMINE: (1) THE MATERIAL PROPERTY CHANGES OF THE INGREDIENTS OF THIS CLASS OF MATERIALS AS THEY ARE PROCESSED AND SUBSEQUENTLY EXPOSED TO THE SHUTTLE ASCENT AND ENTRY ENVIRONMENT, AND (2) HOW THESE CHANGES RELATE TO THE THERMAL PERFORMANCE AND RELIABILITY OF THIS CLASS OF THERMAL PROTECTION SYSTEMS. SILICA, MULLITE AND ZIRCONIA SYSTEMS WILL BE STUDIED IN

THEIR CURRENT STATUS TO PROVIDE A BASELINE FOR ASSESSING THE EFFECTS OF FUTURE IMPROVEMENTS ON THEIR PERFORMANCE AND RELIABILITY. THIS WILL BE ACCOMPLISHED BY ASSESSING THE CHEMICAL AND MORPHOLOGICAL STATES OF THE MATERIAL INGREDIENTS BEFORE AND AFTER PROCESSING INTO THE INSULATION ITSELF. THE COATING WILL LIKEWISE BE STUDIED. AFTER CYCLIC EXPOSURE TO SIMULATED ENTRY ENVIRONMENTS, CHANGES IN THE MATERIALS WILL BE ASSESSED, RELATED TO THE THERMAL AND MECHANICAL PERFORMANCE OF THE MATERIALS AND RECOMMENDATIONS WILL BE MADE FOR IMPROVING THE MATERIAL COMPOSITION, PROCESSING AND COATING TO ACHIEVE HIGHER PERFORMANCE AND GREATER RELIABILITY.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATION FOR SHUTTLE
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: HALL, R. W. TEL. 216-433-4000
TECHNICAL SUMMARY

THIS RESEARCH AND DEVELOPMENT EFFORT IS RELATED TO THE GENERAL CLASS OF MATERIALS THAT MIGHT BE USED IN THE REUSABLE SURFACE INSULATION (RSI) CONCEPT FOR THE SHUTTLE THERMAL PROTECTION SYSTEM. THE OBJECTIVES OF THIS WORK MAY BE BRIEFLY SUMMARIZED AS FOLLOWS: 1) TO FULLY CHARACTERIZE THE RSI MATERIALS; 2) TO IMPROVE THE MECHANICAL BEHAVIOR OF RSI BODIES; 3) TO IMPROVE THE SURFACE CHARACTER OF RSI BODIES; 4) TO OPTIMIZE CURRENTLY USED FIBERS AND TO SEEK NEW AND IMPROVED FIBER COMPOSITIONS. THE FIRST THREE OBJECTIVES WILL BE PURSUED BY OBTAINING CURRENTLY USED RSI MATERIALS FROM NASA CONTRACTORS FOR IN-HOUSE STUDIES. MATERIAL CHARACTERIZATION WILL BE MADE AT ALL STAGES OF PROCESSING. IMPROVEMENTS IN MECHANICAL PROPERTIES AND SURFACE CHARACTERISTICS WILL BE SOUGHT BY THE INTRODUCTION OF OTHER SELECTED MATERIALS INTENDED TO BRING ABOUT THE DESIRED IMPROVEMENTS. THESE MATERIALS WILL BE COMPATIBLE WITH, BUT COMPLETELY INDEPENDENT OF, THE FABRICATION PROCESSING STEPS. OPTIMIZED AND IMPROVED FIBERS WILL BE SOUGHT BY CONTRACTUAL EFFORTS.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATIONS FOR SHUTTLE
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VA. 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE PROPERTIES OF CERAMIC MATERIALS WILL BE EVALUATED TO ESTABLISH THEIR SUITABILITY FOR USE AS SURFACE INSULATION THERMAL PROTECTION SYSTEMS. METHODS FOR IMPROVING THE THERMAL AND MECHANICAL PROPERTIES OF CURRENT LOW-DENSITY MATERIALS WILL BE INVESTIGATED. LOW-DENSITY RIGIDIZED FIBROUS MATERIALS SUCH AS SILICA, MULLITE, ZIRCONIA, AND ALUMINA WILL BE SUBJECTED TO CYCLIC HEATING. THERMAL AND MECHANICAL STABILITY WILL BE DETERMINED THROUGH MECHANICAL TESTS AND MICROSCOPIC EXAMINATION. IMPROVEMENTS IN PROPERTIES WILL BE PURSUED BY VARYING PROCESSING METHODS AND MATERIALS. COATINGS REQUIRED TO SEAL FIBROUS MATERIALS AGAINST EXCESSIVE MOISTURE ABSORPTION AND TO PROVIDE SUITABLE SURFACE EMITTANCE PROPERTIES WILL BE EVALUATED IN COMBINATION WITH THE VARIOUS FIBER SYSTEMS. THE THERMO-CHEMICAL INTERACTION OF COATINGS WITH FIBERS WILL BE STUDIED. THE STRUCTURAL BEHAVIOR OF THE COATING, FIBER, SUBSTRATE SYSTEM WILL BE STUDIED ANALYTICALLY AND THROUGH STRUCTURAL TESTS OF REPRESENTATIVE PANELS.

RTOP NO. 114-03-36 TITLE: EXTERNAL INSULATIONS FOR SHUTTLE
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: KING, H. M. TEL. 205-453-1227
TECHNICAL SUMMARY

THE OBJECTIVE IS TO EVALUATE THE PERFORMANCE OF REUSABLE SURFACE INSULATION (RSI) MATERIALS UNDER THERMAL AND DYNAMIC LOADS SIMULATING THE FLIGHT ENVIRONMENTS TO WHICH THE SHUTTLE BOOSTER IS EXPOSED IN ORDER TO ASSESS THE RELIABILITY OF THIS TYPE OF THERMAL PROTECTION SYSTEM FOR THIS APPLICATION, TO IDENTIFY OPTIMUM MATERIAL PROPERTIES, AND TO DEMONSTRATE ADEQUATE CYCLE LIFE FOR MULTI-FLIGHT REUSE WITH MINIMUM REFURBISHMENT. THE PERFORMANCE OF SEVERAL CURRENTLY AVAILABLE RSI MATERIALS WILL BE EVALUATED IN SUB-SCALE AND FULL SCALE PANEL CONFIGURATIONS USING BOOSTER PANEL DESIGNS AND SIMULATED BOOSTER ENVIRONMENTS. THE SUBSTRATE PANELS WILL BE OBTAINED FROM MARTIN-MARIETTA CORPORATION (MMC) IN THE SHUTTLE PHASE B BASELINE CONFIGURATION AND MATERIALS. THE RSI MATERIALS WILL BE OBTAINED FROM MSC AS A PORTION OF THE MATERIALS DELIVERABLE ON THEIR CONTRACTED DEVELOPMENT EFFORTS. AS IMPROVED RSI MATERIALS BECOME AVAILABLE FROM NASA IN-HOUSE OR SPONSORED CONTRACTUAL PROGRAM, ADDITIONAL MATERIALS WILL BE OBTAINED TO VERIFY IMPROVED MATERIAL RESPONSE TO BOOSTER ENVIRONMENTS. PARTICULAR EMPHASIS WILL BE PLACED ON THE EVALUATION OF REINFORCED RSI MATERIALS AS DEVELOPED UNDER EARLY WORK.

RTOP NO. 114-03-36 TITLE: HIGH TEMPERATURE ADHESIVES
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: SPIKER, I. K. TEL. 713-483-5539
TECHNICAL SUMMARY

RESEARCH IS REQUIRED TO: PROVIDE AN ADHESIVE SYSTEM THAT WILL PERFORM IN THE 600 DEG TO 700 DEG F RANGE; IS STRAIN-COMPATIBLE WITH SURFACE INSULATION UNDER THERMAL AND MECHANICAL CYCLING; HAVE MINIMUM DENSITY; AND HAVE REUSE CAPABILITY FOR 100 SHUTTLE MISSIONS. THIS WORK SHOULD INCLUDE STRUCTURAL ADHESIVES AND COMPOSITE RESINS, AND FLEXIBLE ADHESIVES SUCH AS THE SILICONE RUBBER SEALANTS.

RTOP NO. 114-03-37 TITLE: SPACE SHUTTLE: NONDESTRUCTIVE EVALUATION
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, GLEN TEL. 415-961-2265
TECHNICAL SUMMARY

EXISTING MICROWAVE CRACK-DETECTION TECHNOLOGY WILL BE USED TO DEVELOP DESIGN CRITERIA FOR CRACK-DETECTION SYSTEMS APPROPRIATE TO HIGH-SPEED NONDESTRUCTIVE EVALUATION OF SHUTTLE VEHICLES. IN THIS TECHNOLOGY, METAL SURFACES ARE EXAMINED FOR FLAWS BY USING MICROWAVES AS THE SCANNING MEDIUM. THE METAL SURFACE BEING EXAMINED ACTS AS A PARTIALLY REFLECTING PLANE TO INCIDENT MICROWAVE ENERGY AND, THEREFORE, HAS A CHARACTERISTIC REFLECTING SIGNATURE. WHEN THE MICROWAVE SIGNAL ENCOUNTERS A FLAW OR CRACK ON THE METAL SURFACE, THE SIGNAL IS DISTORTED OR CHANGED AND THIS CHANGE CAN BE USED AS AN INDICATION OF THE EXISTENCE OF AND, WITH PROPER CALIBRATION, THE SIZE OF THE FLAW OR CRACK. MICROWAVE CRACK-DETECTORS ARE NON-CONTACTING AND CAN BE USED TO LOCATE FLAWS BENEATH OR HIDDEN BY NON-METALLIC PAINTS AND FILMS. TESTS WILL BE CONDUCTED TO ADAPT EXISTING

TECHNOLOGY TO PROPOSED SPACE SHUTTLE SKIN AND STRUCTURE CONFIGURATIONS AND TO OBTAIN HIGH-SPEED NONDESTRUCTIVE EVALUATION CAPABILITY NECESSARY TO SPACE SHUTTLE MISSIONS.

RTOP NO. 114-03-37 TITLE: ADVANCED INSPECTION AND REPAIR TECHNIQUES
ORGANIZATION: GEO. C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: CATALDO, C. E. TEL. 205-453-1278
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ESTABLISH THE RE-USABILITY OF THERMAL PROTECTIONSYSTEM MATERIALS, INVESTIGATE METHODS OF INSPECTION OF SUCH SYSTEMS, AND STUDY METHODS OF REPAIR OF VARIOUS TYPES OF DEFECTS. A STUDY TO GAIN KNOWLEDGE OF MATERIALS DEGRADATION PHENOMENA UNDER LOW AND HIGH MASS FLOW CONDITIONS RELATIVE TO THE EFFECTS OF FLAWS WILL BE MADE. STUDIES WILL BE MADE OF THE EFFECTS OF SUCH DEGRADATION UPON THE STRUCTURAL OR FUNCTIONAL RELIABILITY OF THE COMPONENT OR SYSTEM. PERTINENT NDE EVALUATION WILL BE DEVELOPED FOR MONITORING AND EVALUATING THE INTEGRITY OF MATERIALS AND STRUCTURES, BOTH DURING GROUND TURN-AROUND AND WHERE FEASIBLE, ON-BOARD THE VEHICLE. MAJOR EMPHASIS WILL BE GIVEN TO THE TPS AND TO THE CRYOGENIC SYSTEM. IN THE PROPOSED STUDY TWO SEPARATE TASKS WILL BE INCLUDED.

RTOP NO. 114-08-01 TITLE: SPACE SHUTTLE STRUCTURAL DESIGN TECHNOLOGY
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE GOAL IS IDENTIFICATION OF CRITICAL STRUCTURAL PROBLEMS OF THE SPACE SHUTTLE, AND EXPERIMENTAL AND ANALYTICAL RESEARCH THAT WILL PROVIDE EFFICIENT SOLUTIONS TO THESE PROBLEMS AND AN ADEQUATE TECHNOLOGICAL BASE FOR STRUCTURAL DESIGN OF THE LEAST WEIGHT OR COST SHUTTLE VEHICLE. THE WORK WILL BE ACCOMPLISHED INHOUSE AND THROUGH NUMEROUS CONTRACTS PRIMARILY WITH THE AEROSPACE COMPANIES ACTIVELY ENGAGED IN DEVELOPMENT OF THE SHUTTLE. A MAJOR EFFORT IS THE PURCHASE OF SURFACE STRUCTURE PANELS FOR TESTING UNDER AERODYNAMIC, ACOUSTIC, AND VIBRATORY ENVIRONMENTS. DEVELOPMENT OF MORE EFFICIENT STRUCTURAL PANELS THAT SHOW PROMISE OF REDUCING PRIMARY STRUCTURE WEIGHT WILL BE CONTINUED. STUDIES OF THE MOST EFFICIENT STRUCTURAL ARRANGEMENTS WILL BE MADE. TESTING OF LIGHT WEIGHT COMPOSITE REINFORCED METAL STRUCTURES WILL BEGIN. EFFORTS IN IDENTIFYING MAJOR PROBLEM AREAS WITH SUCH SECONDARY STRUCTURES AS DOORS AND WINDOWS WILL CONTINUE AND WORKABLE DESIGN SOLUTIONS WILL BE DEVELOPED. STUDIES WILL CONTINUE ON DESIGN CRITERIA AREAS THAT PRESENT SPECIAL PROBLEMS TO THE SHUTTLE SUCH AS STRUCTURAL TEST REQUIREMENTS, ON BOARD PURGE SYSTEM REQUIREMENTS, AND STRUCTURAL INTERFACE COMPATIBILITY.

RTOP NO. 114-08-02 TITLE: SPACE SHUTTLE COMPOSITE TANK TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE THE TECHNOLOGY FOR APPLICATION OF FILAMENT WOUND COMPOSITES TO SPACE SHUTTLE VEHICLE TANKAGE. APPLICATIONS FOR THIS TECHNOLOGY WILL INCLUDE LARGE, LOW-PRESSURE, LOAD-CARRYING LIQUID PROPELLANT TANKS; NON-INTEGRAL (NON-LOAD CARRYING) LIQUID TANKS; AND SMALL, HIGH-PRESSURE GAS STORAGE VESSELS. FILAMENTS OF GLASS, BORON, GRAPHITE, AND HIGH MODULUS POLYMER WHICH OFFER SIGNIFICANT WEIGHT OR COST SAVINGS, WHILE MAINTAINING OR IMPROVING THE RELIABILITY ATTAINABLE WITH CONVENTIONAL METAL VESSELS, WILL BE EVALUATED. THE DEVELOPMENT OF THE ADVANCED CONCEPTS FOR FILAMENT-WOUND PRESSURE VESSELS ALREADY IN PROGRESS WILL BE CONTINUED. IN FY '72, ADDITIONAL ACTIVITIES WILL BE SPECIFICALLY DIRECTED TOWARD SPACE SHUTTLE SYSTEM COMPONENT DESIGN AND DEVELOPMENT.

RTOP NO. 114-08-03 TITLE: SPACE SHUTTLE FRACTURE CONTROL METHODS
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: NORED, D. L. TEL. 216-433-6916
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL PROVIDE TECHNOLOGY REQUIRED FOR ESTABLISHING EFFECTIVE FRACTURE CONTROL DESIGN AND OPERATIONAL METHODS FOR THE SPACE SHUTTLE VEHICLE STRUCTURES. TECHNOLOGY BENEFITS FOR OTHER SPACE VEHICLE AND SPACE STATION APPLICATIONS WILL ALSO RESULT. SPECIFIC AREAS OF CURRENT WORK INCLUDE: (1) DEVELOPMENT OF FRACTURE DATA ON MATERIALS USING FLAW GEOMETRIES AND LOADING CONDITIONS OF SPECIFIC INTEREST TO THE SPACE SHUTTLE VEHICLE INTEGRAL PROPELLANT TANKS; (2) DEVELOPMENT OF ANALYTICAL EVALUATIONS OF CRACK TIP STRESS INTENSITY FOR SPECIFIC SPACE SHUTTLE VEHICLE FLAW GEOMETRIES AND LOADING CONDITIONS; AND (3) DEFINITION OF FRACTURE CONTROL DESIGN APPROACHES SPECIFICALLY SUITED TO THE SPACE SHUTTLE VEHICLE STRUCTURES.FY '72 EFFORTS WILL CONTINUE IN THESE AREAS, WITH INCREASED EMPHASIS ON THE EFFECTS OF ENVIRONMENT ON FLAW PROPAGATION.

RTOP NO. 114-08-04 TITLE: SPACE SHUTTLE COMPOSITES FOR PRIMARY STRUCTURE
ORGANIZATION: GEORGE C. MARSHALL SPACE FLIGHT CENTER MARSHALL
MONITOR: ENGLER, E. E. TEL. 205-453-3958
TECHNICAL SUMMARY

THE OBJECTIVES OF THE STUDY ARE: TO INDICATE AREAS OF GROWTH POTENTIAL FOR THE SPACE SHUTTLE VEHICLE THROUGH THE USE OF ADVANCED FILAMENTARY COMPOSITE MATERIALS WHICH WOULD PROVIDE MAXIMUM STRENGTH TO WEIGHT CAPABILITIES AND RESULT IN INCREASED PAYLOAD; AND TO DEVELOP THRUST STRUCTURE CONCEPTS, INCLUDING MAJOR STRUCTURAL COMPONENTS, APPLICABLE FOR VARIOUS ENGINE ARRANGEMENTS BY NUMBER AND SIZE. EXISTING TECHNOLOGY COMPOSITE SYSTEMS WILL BE UTILIZED TO OBTAIN MINIMUM WEIGHT STRUCTURE. THE APPROACH UTILIZED IS TO PERFORM TECHNOLOGY INVESTIGATIONS IN THE AREAS OF STRUCTURAL DESIGN, STRUCTURAL ANALYSIS, MATERIALS EVALUATION, FABRICATION, QUALITY ASSURANCE, AND TESTING. THESE INVESTIGATIONS WILL INCLUDE BOTH IN-HOUSE AND CONTRACTED EFFORT. MAJOR STRUCTURAL COMPONENTS WILL BE DESIGNED, FABRICATED, AND TESTED. THESE MAJOR STRUCTURAL TEST COMPONENTS, APPLICABLE TO A SPACE SHUTTLE VEHICLE, WILL INCLUDE A SCALED THRUST STRUCTURE, SKIN PANELS, ENGINE SUPPORT BEAMS AND MINOR

COMPONENTS SUCH AS BEAM CAPS, STRINGERS, JOINTS, AND SHEAR WEBS. DESIGN CRITERIA STUDIES WILL ALSO BE CONDUCTED. THE MATERIALS TO BE EVALUATED WILL INCLUDE BORON/EPOXY, GRAPHITE/EPOXY, BORON/ALUMINUM, AND POLYIMIDE COMPOSITES. THE STUDY WAS INITIATED IN FY 1970 AND WILL EXTEND THROUGH FY 1975. THE MANPOWER REQUIREMENTS AVERAGE ABOUT 19 MAN-YEARS PER YEAR.

RTOP NO. 117-07-03 TITLE: SPACE SHUTTLE: THERMAL PROTECTION SYSTEMS
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

CANDIDATE MATERIALS FOR USE IN SPACE SHUTTLE THERMAL PROTECTION SYSTEMS WILL BE EVALUATED TO DETERMINE PERFORMANCE AND TO IDENTIFY FAILURE MODES. SAMPLES OF CANDIDATE MATERIALS (METALLIC AND NON-METALLIC) WILL BE TESTED IN ARC-JET FACILITIES CAPABLE OF DUPLICATING A NUMBER OF FULL-SCALE FLIGHT CONDITIONS. HEAT SHIELD MATERIALS TO BE INVESTIGATED INCLUDE THE NICKEL, COBALT AND COLUMBIAN ALLOYS, REUSEABLE SURFACE INSULATORS AND CARBONACEOUS AND POLYMERIC MATERIALS. EMPHASIS WILL BE ON THE EVALUATION OF MATERIALS THAT REQUIRE LITTLE OR NO REFURBISHMENT. PERFORMANCE EVALUATION WILL INCLUDE DETERMINATION OF THE EMITTANCE OF THE SURFACE AND ITS CATALYTIC BEHAVIOR REGARDING SURFACE RECOMBINATION OF DISSOCIATED BOUNDARY LAYER SPECIES. IN ORDER TO ACCOMPLISH THESE OBJECTIVES CONSIDERABLE IMPROVEMENTS IN ARC-JET OPERATION WILL BE MADE. THIS WILL INCLUDE INSTALLATION OF THE 2" X 9" SUPERSONIC DUCT IN A FACILITY BAY PREVIOUSLY OCCUPIED BY OTHER EQUIPMENT, INCREASING THE TOTAL POWER AND FLEXIBILITY OF THE D.C. POWER SUPPLY AND INCREASING THE LEVEL OF ENTHALPY OF THE ARC JET STREAMS.

RTOP NO. 117-07-03 TITLE: SPACE SHUTTLE THERMAL PROTECTION SYSTEMS
ORGANIZATION: LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO INVESTIGATE THERMAL PROTECTION SYSTEMS FOR THE SPACE SHUTTLE, TO ASSESS THE ADEQUACY OF EXISTING TECHNOLOGY, AND TO IDENTIFY AND IMPLEMENT REQUIRED DEVELOPMENT PROGRAMS. THIS WILL BE ACCOMPLISHED PRIMARILY BY CONTRACT WORK SUPPORTED BY IN-HOUSE STUDIES AND TESTING. THREE TYPES OF HEAT SHIELDS WILL BE CONSIDERED: LOW-COST ABLATIVE SHIELDS, NONMETALLIC RADIATIVE-INSULATIVE SHIELDS, AND METALLIC RADIATIVE SHIELDS. FIBROUS INSULATION MATERIALS, NON-DESTRUCTIVE TEST TECHNIQUES, AND SOME ASPECTS OF CONVECTION COOLING WILL ALSO BE INVESTIGATED. PARAMETRIC HEAT-SHIELD STUDIES WILL BE MADE TO PROVIDE RATIONAL AND UP-TO-DATE ESTIMATES OF THE WEIGHT AND COST OF SYSTEMS INVOLVING ABLATORS, RADIATORS, INSULATORS, AND ACTIVE COOLING. LARGE-SCALE THERMAL PROTECTION SYSTEMS WILL BE DESIGNED, FABRICATED, AND TESTED TO VALIDATE ANALYTICAL RESULTS, WEIGHTS, AND, POSSIBLY, COSTS. THE RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION WHICH WILL SERVE AS A BASIS FOR THE SELECTION AND DESIGN OF THERMAL PROTECTION SYSTEMS FOR THE SPACE SHUTTLE.

RTOP NO. 908-42-01 TITLE: STRUCTURES
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: ST. LEGER, L. G. TEL. 713-483-2626
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO EXPLORE TWO PROMISING NEW TOOLS OF NONDESTRUCTIVE EVALUATION (NDE), LASER HOLOGRAPHIC INTERFEROMETRY (LHI) AND ACOUSTIC EMISSION (AE), AND TO DEVELOP UNDERSTANDING IN ALL OF THE IMPORTANT ADVANCED TECHNIQUES OF NDE TO SUPPORT MSC'S ROLE OF MANAGING THE DEVELOPMENT OF THE SPACE SHUTTLE. HIGH-TEMPERATURE ADHESIVES WILL BE SURVEYED FOR THEIR SUITABILITY AS A BONDING AGENT FOR THE SPACE SHUTTLE EXTERNAL INSULATION SYSTEM. MECHANICAL AND THERMOELASTIC PROPERTIES OF CANDIDATE ADHESIVES WILL BE DETERMINED THROUGHOUT THE RANGE OF DESIGN TEMPERATURES AS WELL AS PROCESSING EFFECTS, THERMAL CYCLING EFFECTS, AND THICKNESS EFFECTS. A SEPARATE PROCUREMENT WILL BE MADE OF AN ANALYTICAL TOOL FOR THE ACCURATE PREDICTION OF BONDLINE STRESSES. PROVIDE STRUCTURAL DESIGN DATA TO ASSESS THE POTENTIAL USE OF BERYLLIUM FOR HOT STRUCTURE ON THE SPACE SHUTTLE. THE APPROACH IS FIRST TO DESIGN TYPICAL OPTIMUM WEIGHT PANELS REPRESENTATIVE OF THE ABOVE-MENTIONED APPLICATIONS FOR THE SPACE SHUTTLE. THE SECOND STEP INVOLVES THE MANUFACTURE AND TESTING OF A FEW OF THESE REPRESENTATIVE PANELS. THE TECHNICAL OBJECTIVE IS TO DEVELOP REUSABLE MECHANICAL FASTENERS FOR USE IN AN ENVIRONMENT OF 1800 DEGREES F, 2000 DEGREES F, 2500 DEGREES F. THE MATERIALS CORRESPONDING TO THESE CUT-OFF TEMPERATURES ARE HAYNES 188, TD-NICR, AND CB, RESPECTIVELY.

RTOP NO. 908-42-02 TITLE: SPACE SHUTTLE THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: SMITH, J. A. TEL. 713-483-3676
TECHNICAL SUMMARY

THE OVERALL VEHICLE THERMAL MANAGEMENT SYSTEMS FOR THE SHUTTLE MUST BE FLEXIBLE AND ADAPTABLE ENOUGH TO ACCOMMODATE CHANGES IN MISSIONS AND CONFIGURATIONS AND MUST EFFICIENTLY UTILIZE AVAILABLE HEAT SOURCES AND SINKS. THE MULTI-MISSION REQUIREMENT FOR THE SHUTTLE PRESENTS PARTICULAR DESIGN PROBLEMS IN THERMAL CONTROL DUE TO: (1) LIFE-CYCLE CONSIDERATIONS, AND (2) THE WIDE RANGE OF REQUIRED OPERATING CONDITIONS VARYING FROM THOSE SIMILAR TO CONVENTIONAL AIRCRAFT, TO SPACECRAFTS SUBJECTED TO BOOST, ORBITAL AND REENTRY THERMAL CONDITIONS. THE OBJECTIVE OF THIS RTOP IS TO DEVELOP CANDIDATE THERMAL CONTROL CONCEPTS WHICH OFFER POTENTIAL SOLUTIONS FOR SHUTTLE DESIGN PROBLEMS AND DEVELOP IMPROVED ANALYTICAL TECHNIQUES FOR MORE EFFECTIVE DESIGN AND EVALUATION. HEAT PIPE THERMAL CONTROL SYSTEMS OFFER THE POTENTIAL FOR LONG LIFE AND TROUBLE FREE HEAT TRANSPORT AND REJECTION AT LOW WEIGHTS FOR SPACE SHUTTLE EQUIPMENT COOLING APPLICATIONS. DESIGN AND TESTING OF PROTOTYPE THERMAL CONTROL SYSTEMS APPLICABLE TO THE UNIQUE SPACE SHUTTLE ENVIRONMENT AND REUSE APPLICATIONS WILL BE PURSUED TO PROVIDE THERMAL CONTROL DESIGN OPTIONS FOR THE SHUTTLE VEHICLE. VEHICLE COMPLEXITY AND USE OF ADVANCED COMPONENTS REQUIRES IMPROVED ANALYTICAL METHODS AND EXTENSIVE VEHICLE LEVEL ANALYSIS FOR DESIGN SUPPORT AND MISSION PLANNING. THE ANALYTICAL TECHNIQUES DEVELOPMENT PROGRAM IS DIRECTED TOWARDS DEVELOPING COMPUTER PROGRAMS FOR USE AS ANALYTICAL TOOLS FOR THE SHUTTLE PROGRAM.

RTOP NO. 908-42-38 TITLE: MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: STROUHAL, G. TEL. 713-483-3676
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE THE GENERATION OF DATA FOR PRELIMINARY DESIGN ACTIVITIES AND CONFIRMATION THAT APPROPRIATE PROCEDURES HAVE BEEN SELECTED FOR PROPERTY MEASUREMENTS, NONDESTRUCTIVE TESTING, AND DESIGN. PRELIMINARY DESIGN DATA WILL BE GENERATED FOR TWO CLASSES OF TPS MATERIALS - SURFACE INSULATION AND CARBON/CARBON COMPOSITES. PRELIMINARY PROPERTY AND PERFORMANCE SPECIFICATION WILL BE WRITTEN. THE OBJECTIVE OF THIS TASK IS TO DEVELOP THE ANALYTICAL METHODS NEEDED TO UNDERSTAND AND PREDICT THE THERMAL PERFORMANCE OF THE SPACE SHUTTLE THERMAL PROTECTION SYSTEM. THERMO-CHEMICAL, BOUNDARY-LAYER, AND MATERIAL RESPONSE ANALYSES AND COMPUTER PROGRAMS CURRENTLY IN USE AT MSC WILL BE MODIFIED AND UPDATED, AS REQUIRED, FOR APPLICATION TO THE SHUTTLE CONFIGURATION AND ENVIRONMENT. INVESTIGATION IS REQUIRED TO: PROVIDE AN ADHESIVE SYSTEM THAT WILL PERFORM IN THE 600 TO 700 F RANGE; IS STRAIN COMPATIBLE WITH SURFACE INSULATION UNDER THERMAL AND MECHANICAL CYCLING; HAVE MINIMUM DENSITY; AND HAVE REUSE CAPABILITY FOR 100 SHUTTLE MISSIONS. THIS WORK SHOULD INCLUDE STRUCTURAL ADHESIVES AND COMPOSITE RESINS, AND FLEXIBLE ADHESIVES SUCH AS THE SILICONE RUBBER SEALANTS.

RTOP NO. 976-30-01 TITLE: SPACE SHUTTLE STRUCTURAL DESIGN CRITERIA
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: KEY, J. E. TEL. 205-453-4349
TECHNICAL SUMMARY

DESIGN CRITERIA WERE DEVELOPED DURING PHASE A OF THE SHUTTLE DEVELOPMENT STUDIES; HOWEVER, THESE DESIGN CRITERIA WERE VERY GENERAL AND DID NOT CONTAIN DETAILS THAT APPLY TO SPECIFIC CONFIGURATIONS OR MISSIONS. ADDITIONAL CRITERIA WILL BE DEVELOPED FOR THE CONFIGURATIONS AND MISSIONS SELECTED DURING THE PHASE B STUDIES. IN ADDITION, STRUCTURAL CRITERIA PROBLEM AREAS IDENTIFIED IN THE PHASE A AND PHASE B EFFORTS WILL BE STUDIED IN DEPTH TO DETERMINE THE REQUIRED YIELD, PROOF, AND ULTIMATE FACTORS FOR STRUCTURES AND PROPELLANT TANKS, DETERMINE METHODS OF COMBINING LOADS AND ENVIRONMENTAL CONDITIONS, AND DETERMINE THE FAIL-SAFE APPROACH FOR STRUCTURES. THIS RTOP IS A CONTINUATION OF THE EFFORT INITIATED IN RTOP'S 908-52-01 AND 976-30-61. FY 72 FUNDS OF $300K AND A MANPOWER LEVEL OF .6 MANYEARS ARE REQUIRED TO CONTINUE THIS EFFORT.

RTOP NO. 976-30-38 TITLE: MATERIALS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: SMITH, J. A. TEL. 713-483-3676
TECHNICAL SUMMARY

INVESTIGATE THE UTILITY OF METAL MATRIX COMPOSITES FOR EXTERNAL USE ON THE SPACE SHUTTLE SUCH AS SKIN PANELS TO 800 F AND POLYMER MATRIX COMPOSITES TO 600 F. DATA CONCERNING STRENGTH, STIFFNESS, THERMAL CYCLING CAPABILITY, AND STABILITY WILL BE GENERATED. INVESTIGATE THE FEASIBILITY OF DIE-LESS PRODUCTION FOR LARGE METAL MATRIX PANELS.THE SURFACE INSULATION CLASS OF MATERIAL SHOWS PROMISE OF MEETING THE THERMAL PROTECTION SYSTEM REQUIREMENTS FOR LARGE AREAS

OF THE SPACE SHUTTLE ORBITER AND BOOSTER. UNDER THIS RTOP, FULL-SCALE PRODUCTION CAPABILITY OF AN OPTIMIZED SURFACE INSULATION MATERIAL WILL BE INITIATED AND DESIGN VERIFICATION TESTS ON FULL-SCALE TPS COMPONENTS WILL BE CONDUCTED. THE RESULTS OF THIS PROGRAM PHASE WILL LEAD TO SELECTION OF AN OPTIMIZED THERMAL PROTECTION SYSTEM FOR THE SHUTTLE PROGRAM. OXIDATION RESISTANT REINFORCED CARBON MATERIAL OFFER A WEIGHT COMPETITIVE SOLUTION AS A MULTIMISSION THERMAL PROTECTIVE SYSTEM FOR TEMPERATURES ABOVE 2000 F. TO INCREASE CONFIDENCE IN THIS THERMAL PROTECTION CONCEPT, FULL-SCALE STRUCTURAL DESIGNS WILL BE DEVELOPED AND VERIFICATION TESTS PERFORMED. DESIGN CONCEPTS WILL BE REFINED BY CONCENTRATION ON MINIMIZING STRUCTURAL WEIGHT, INDUCED STRESSES, EASE OF MANUFACTURING, ATTACHMENT METHODS, AND COST EFFECTIVENESS.

RTOP NO. 976-30-43 TITLE: SPACE SHUTTLE MISSION SIMULATION TESTS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: ENGLER, E. E. TEL. 205-453-3958
TECHNICAL SUMMARY

THIS STUDY WILL DEVELOP OPTIMUM STRUCTURAL SYSTEMS, PRIMARILY THERMAL PROTECTION SYSTEMS, FOR VARIOUS TEMPERATURE REGIMES FOR THE SPACE SHUTTLE VEHICLE. THE PROGRAM OBJECTIVES ARE: TO ESTABLISH DESIGN, FABRICATION, INSPECTION TECHNIQUES, AND HARDWARE EXPERIENCE NECESSARY TO MINIMIZE DEVELOPMENT RISKS; TO PROVIDE SOUND THERMAL PROTECTION SYSTEM (TPS)/PRIMARY LOAD-CARRYING STRUCTURE RECOMMENDATIONS; TO PROVIDE REALISTIC STRUCTURAL WEIGHT AND COST DATA; TO DEMONSTRATE THE VALIDITY OF DESIGN AND ANALYSIS METHODS, FABRICATION METHODS, INSPECTION METHODS, REFURBISHMENT METHODS; AND REUSABILITY. THE APPROACH WILL INCLUDE STUDIES, INVESTIGATIONS, AND MISSION SIMULATION TESTS ON COMPONENTS AND LARGE STRUCTURAL TEST ITEMS OF MAJOR STRUCTURAL PORTIONS OF A TYPICAL SPACE SHUTTLE VEHICLE. THERMAL/ACOUSTIC TEST PANELS OF A DESIGN SIMILAR TO THE LARGE TEST ITEM DESIGNS WILL BE DESIGNED, FABRICATED, AND TESTED. THE LARGE TEST ITEMS WILL INCLUDE: TEST ITEM NO. 1, BOOSTER SECTION; AND TEST ITEM NO. 2, ORBITER SECTION. CONTRACTED AND IN-HOUSE TECHNOLOGY INVESTIGATIONS WILL BE PERFORMED IN THE AREA OF STRUCTURAL DESIGN AND ANALYSIS, THERMAL ENGINEERING, MATERIAL EVALUATION, FABRICATION, AND QUALITY ASSURANCE. THE PROGRAM WAS INITIATED IN FY 1970 AND WILL EXTEND THROUGH FY 1975. MANPOWER REQUIREMENTS AVERAGE ABOUT 41 MANYEARS PER YEAR.

RTOP NO. 976-30-43 TITLE: SPACE SHUTTLE THERMAL PROTECTION SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: KING, H. M. TEL. 205-453-1127
TECHNICAL SUMMARY

THIS EFFORT WILL SELECT OR DEVELOP AND EVALUATE OPTIMUM INSULATION MATERIALS FOR USE UNDER THE RERADIATIVE PANELS OF A SHUTTLE THERMAL PROTECTION SYSTEM. THE INVESTIGATIONS WILL INCLUDE PANEL INSULATIONS, WITH APPROPRIATE PACKAGING OR CONFIGURATION FOR REQUIRED HANDLING, INSTALLATION AND MOISTURE RESISTANCE, AND LOAD BEARING INSULATIONS TO TRANSMIT MECHANICAL LOADS FROM THE PANEL TO PRIMARY STRUCTURE WITH MINIMUM HEAT LEAK. THE EVALUATION SHALL PROVIDE DATA FOR DESIGN PURPOSES AND FOR ASSESSMENT OF THE RELIABLE

REUSE LIFETIME UNDER SHUTTLE OPERATING ENVIRONMENTS. ACTIVE AND PASSIVE STRUCTURAL COOLING SYSTEMS CONCEPTS AND SYSTEM DESIGNS WILL BE DEVELOPED TO INCLUDE WEIGHT, COST, RELIABILITY, AND REDUNDANCY. CONCEPTS TO BE STUDIED ARE ACTIVE COOLING, HEAT SINK, HEAT PIPE, AND PHASE CHANGE MATERIAL AND PASSIVE SYSTEMS.

EARTH ORBITAL SYSTEMS TECHNOLOGY (OART/OMSF)

RTOP NO. 113-34-22 TITLE: NICAD BATTERY DEVELOPMENT FOR SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

INITIAL FABRICATION AND TEST OF BALANCED GEOMETRY 100-AH NICAD CELLS HAS SHOWN SIGNIFICANT GAINS IN PERFORMANCE OVER CONVENTIONAL CELLS. INFORMATION GAINED TO DATE INDICATES THAT A 200-AH CELL CAN BE DESIGNED USING SIMILAR TECHNIQUES. SINCE THESE CELLS ARE DESIGNED FOR SPACE STATION APPLICATIONS, LONG RELIABLE LIFE EXPECTANCIES BECOME A PRIME REQUIREMENT. THIS RTOP WILL COVER THE CONTINUANCE OF 100-AH CELL LIFE TESTS ALREADY IN PROGRESS, AND WILL PROVIDE INITIATION OF 200-AH LIFE TESTS. IT WILL ALSO COVER THE IN-HOUSE DEVELOPMENTAL WORK REQUIRED TO SUPPLEMENT THE CONTRACTS.

RTOP NO. 113-60-20 TITLE: SPACE STATION/BASE ELECTRICAL POWER PROCESSING AND DISTRIBUTION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: SCHWARZ, F. C. TEL. 216-433-6131
TECHNICAL SUMMARY

ESTABLISH THE NEEDED TECHNOLOGY FOR THE ELECTRIC POWER PROCESSING AND DISTRIBUTION SYSTEM FOR THE SPACE STATION/BASE WITH AN ESTIMATED TOTAL POWER CAPACITY OF 30 TO 100 KW. ELECTRONIC POWER PROCESSORS WITH POWER HANDLING CAPACITIES OF 10 KW AND BEYOND WILL BE BREADBOARDED. THE PROCESSORS WILL OPERATE WITH INPUT VOLTAGES OF FROM 100 TO 500 VOLTS. ELECTRICAL SWITCHGEAR WILL BE DEVELOPED CAPABLE OF CONTROLLING THE POWER FLOW IN THE POWER DISTRIBUTION LINES OF THE STATION/BASE. CERTAIN GENERAL ASSUMPTIONS CONCERNING THE STATION/BASE/ELECTRICAL SYSTEMS WILL BE MADE TO PERMIT AN EARLY START ON CRITICAL LONG LEAD TIME TECHNOLOGY. THIS WORK WILL ATTACK PROBLEMS WHICH ARE OF SIGNIFICANCE TO THE FORESEEABLE POWER SYSTEM CONFIGURATIONS. THE IMPORTANT ELEMENTS OF THIS WORK SHOULD BE APPLICABLE TO THE TECHNOLOGY REQUIREMENTS AS THEY WILL EMERGE FROM SYSTEM STUDIES.

RTOP NO. 112-27-10 TITLE: ISOTOPE BRAYTON CONVERSION TECHNOLOGY
ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD
MONITOR: PACKE, D. R. TEL. 216-433-4000
TECHNICAL SUMMARY

THE ISOTOPE BRAYTON CONVERSION TECHNOLOGY PROGRAM IS TO PROVIDE A BROAD TECHNOLOGY BASE FOR A HIGHLY RELIABLE, LONG LIVED, AND VERY EFFICIENT SPACE POWER CONVERSION SYSTEM WITH ELECTRICAL POWER CAPABILITY UP TO THE MULTIPLE KILOWATTS AND WHICH ARE SUITABLE FOR OPERATION WITH ISOTOPE HEAT SOURCES. TYPICAL MISSIONS FOR THIS TYPE OF POWER SYSTEM WOULD INCLUDE MANNED SPACE STATIONS, MANNED LUNAR MISSIONS, AND UNMANNED MISSIONS. DEVELOPMENT UNDER THIS RTOP, UNDER RTOP 112-27-11, AND ISOTOPE HEAT SOURCE DEVELOPMENT UNDER AEC COGNIZANCE WILL PROVIDE A TECHNOLOGY BASE FOR ISOTOPE BRAYTON TO MEET A SPECTRUM OF FUTURE MISSION POWER NEEDS UP TO THE MULTIPLE KILOWATT LEVEL. THE TECHNOLOGY PROGRAM PRESENTLY INVESTIGATES A POWER CONVERSION SYSTEM WHICH PRODUCES 2-15 KILOWATTS OF ELECTRIC POWER. THIS SYSTEM IS PRESENTLY UNDERGOING PERFORMANCE AND ENDURANCE TESTING

IN THE PLUM BROOK SPACE POWER FACILITY USING AN ELECTRICALLY HEATED HEAT SOURCE. DURING CY 1972 THE SYSTEM WILL BE INSTALLED AT THE MARSHALL SPACE FLIGHT CENTER FOR TESTING FROM A "USER" VANTAGE AGAINST "USER" REQUIREMENTS. LATER, WHEN THE ISOTOPE HEAT SOURCE (RTOP 112-27-11) IS READY, IT WILL BE MATED TO THE SYSTEM AND TESTED IN THE PLUM BROOK SPACE POWER FACILITY. IN ADDITION TO THE POWER CONVERSION SYSTEM TEST ITSELF, THE IBCT PROGRAM INCLUDES PERFORMANCE AND ENDURANCE TESTING OF INDIVIDUAL COMPONENTS AND SUBSYSTEMS. AS A MINIMUM GOAL FOR ENDURANCE DEMONSTRATION, MOST COMPONENTS WILL BE TESTED FOR 20,000 HOURS AND THE COMPLETE POWER CONVERSION SYSTEM WILL ACCUMULATE 5000 HOURS.

RTOP NO. 112-27-11 TITLE: ISOTOPE BRAYTON THERMAL ENERGY SUBSYSTEM TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD

MONITOR: WINTUCKY, W. T. TEL. 216-433-6844

TECHNICAL SUMMARY

THE ISOTOPE BRAYTON (THERMAL) ENERGY SUBSYSTEM TECHNOLOGY PROGRAM IS TO DEVELOP THE TECHNOLOGY FOR LONG-LIFE HIGHLY RELIABLE AND EFFICIENT COMPONENTS NECESSARY TO THE GENERATION AND TRANSFER OF THERMAL ENERGY TO THE WORKING GAS OF THE BRAYTON POWER CONVERSION SYSTEM. THIS PROGRAM DOES NOT INCLUDE THE ISOTOPE-FUELED HEAT SOURCES (CAPSULES) WHICH ARE THE SUBJECT OF AN AEC PROGRAM. THE THERMAL ENERGY SUBSYSTEM LESS THE HEAT EXCHANGER IS TO PROVIDE FOR INTACT REENTRY OF THE ISOTOPE HEAT SOURCES IN CASE OF A FLIGHT ABORT. DEVELOPMENT UNDER THIS RTOP, UNDER RTOP 112-27-10, AND ISOTOPE HEAT SOURCE DEVELOPMENT UNDER AEC COGNIZANCE WILL PROVIDE THE TECHNOLOGY BASE FOR ISOTOPE BRAYTON SYSTEMS TO MEET A SPECTRUM OF FUTURE MISSION POWER NEEDS UP TO THE MULTIPLE KILOWATT POWER LEVEL. THE ISOTOPE BRAYTON THERMAL ENERGY SUBSYSTEM TECHNOLOGY PROGRAM AT LEWIS RESEARCH CENTER IS AN IN-HOUSE EFFORT. A PRELIMINARY DESIGN WAS OBTAINED FROM A CONTRACTED STUDY. THE PRESENT TECHNOLOGY PROGRAM INCLUDING THE HEAT SOURCE REENTRY VEHICLE, HEAT SOURCE HEAT EXCHANGER AND ASSOCIATED DUCTING IS TO IDENTIFY AND ADDRESS AS EARLY AS PRACTICAL THOSE TASKS WHICH ARE ESSENTIAL TO VERIFYING THE THERMAL ENERGY SUBSYSTEM. A THERMAL PROTOTYPE 25 KW THERMAL ENERGY SUBSYSTEM WILL BE FABRICATED IN-HOUSE FOR TECHNOLOGY TESTING WITH EITHER A BRAYTON ENGINE SIMULATOR OR THE BRAYTON POWER CONVERSION SYSTEM IN THE PLUM BROOK SPACE POWER FACILITY USING ELECTRICALLY SIMULATED ISOTOPE HEAT SOURCES.

RTOP NO. 114-03-51 TITLE: SPACE STATION - VEHICLE THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: GUY, W. W. TEL. 713-483-2351
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO DEVELOP GENERALIZED RADIATOR/FLUID SYSTEM THERMAL ANALYSIS TECHNIQUES FOR: (1) RADIATOR/FLUID SYSTEM THERMAL SCALE MODELING, (2) AUTOMATICALLY GENERATING AND CORRECTING LARGE THERMAL NETWORKS, AND (3) CHARACTERIZATION OF ADVANCED ACTIVE THERMAL CONTROL COMPONENTS (I.E., HEAT PIPE-RADIATORS, HEAT PIPE-THERMAL TRANSPORT SYSTEMS, ETC. IN ADDITION, THE FEASIBILITY OF USING HEAT PIPES FOR ADVANCED THERMAL CONTROL CONCEPTS WILL BE EXPERIMENTALLY DEMONSTRATED. THE APPROACH WILL EXTEND WORK INITIATED IN FY 1970-71. ANALYTICAL TECHNIQUES WILL BE FORMULATED INTO COMPUTER PROGRAMS FOR THERMAL SCALE MODELING, ERROR CORRECTION AND CHARACTERIZATION OF THERMAL CONTROL COMPONENTS. VALIDATION OF THESE ANALYTICAL TECHNIQUES WILL BE ACCOMPLISHED WITH THERMAL-VACUUM TESTING. THE SPACE STATION HEAT PIPE APPLICATIONS ACTIVITY WILL INVOLVE SOME INITIAL CONCEPTUAL DESIGN OF PROMISING SYSTEMS, COMPONENT TESTING, AND THERMAL VACUUM TESTING OF A COMPOSITE SYSTEM WITH MULTIPLE HEAT SOURCES. ANALYTICAL TRADE STUDIES WILL ALSO BE CONDUCTED TO EVALUATE RELATIVE DIFFERENCES BETWEEN A HEAT PIPE APPROACH AND MORE CONVENTIONAL SYSTEMS.

RTOP NO. 114-03-51 TITLE: SPACE STATION THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: GATES, D. W. TEL. 205-453-3100
TECHNICAL SUMMARY

AS A CONTINUATION OF OUR WORK IN THE THERMAL CONTROL FIELD, OUR EFFORTS WILL BE DIRECTED TOWARD SEVERAL METHODS OF IMPROVING NASA'S CAPABILITIES OF CONTROLLING SPACECRAFT TEMPERATURES. ONE EFFORT WILL _BE DIRECTED TOWARD IMPROVEMENT OF THE WHITE PAINTS AND THEIR RELIABILITY FOR EXTENDED MISSION REQUIREMENTS. WHILE MAINTAINING THE 0.9 REQUIRED IN THE PRESENT THERMAL DESIGNS FOR SPACE STATION, THE DELTA A _SUB S MUST BE A MINIMUM TO OBTAIN THE REQUIRED TOTAL LIFE OR THE LEAST EVA REQUIRED TO RESTORE THE THERMAL-CONTROL SURFACES. THIS IS BEING DONE BY IMPROVING THE BINDERS AND PIGMENTS, AND PROTECTION OF THE _COATING AFTER APPLICATION, TO ITS EVENTUAL MISSION REQUIREMENT. INTEGRATION OF EFFICIENT HEAT PIPES INTO ELECTRONIC AND ELECTROMECHANICAL HARDWARE IS BEING DEVELOPED FOR THERMAL CONTROL NECESSARY FOR EXTENDED LIFE OF THESE COMPONENTS. THIS IS NOT BROAD COVERAGE OF HEAT PIPE APPLICATIONS, ONLY THE SPECIFIC USE. DEVELOPMENT OF LARGE SCALE THIN FILM SEMICONDUCTORS IS PROPOSED FOR THERMAL CONTROL DEVICES WITH LONG LIFE AND FLEXIBLE CONTROL OF SURFACE AND INTERIOR SURFACES. IN ORDER TO PROVIDE NECESSARY BACKUP KNOWLEDGE FOR THESE DEVELOPMENT EFFORTS, LABORATORY STUDIES OF COATINGS, HEAT PIPES AND SEMICONDUCTORS WILL CONTINUE, AND SPECIAL EFFORT IS NOW DIRECTED TOWARD MEASUREMENT DESIGN PARAMETER DATA (THERMAL CONDUCTIVITY, RESISTIVITY AND RADIATION _FIELD VARIATION FOR THE SEMICONDUCTORS), MINIATURE HEAT PIPE ANALYSIS, AND PROPERTIES AND LONG LIFE TIMES OF COATINGS AND THEIR SUBSTRATES AT CRYOGENIC TEMPERATURES.

RTOP NO. 114-03-46 TITLE: METEOROIDS (SPACE STATION)
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

STUDIES AIMED AT MAXIMIZING THE EFFECTIVENESS OF MULTIPLE-WALL STRUCTURES IN PROVIDING METEOROID PROTECTION OF SPACE STATION/SPACE BASE ARE IN PROGRESS. STRESS CONCENTRATIONS IN PANELS, RESULTING FROM PARTIAL-PENETRATION IMPACTS, ARE BEING STUDIED TO DETERMINE THE DEGRADATION IN STRUCTURAL INTEGRITY AND EFFICIENCY, AND THE IMPLICATIONS WITH RESPECT TO DESIGN CRITERIA. HIGH-EXPLOSIVE DRIVER TECHNIQUES ARE BEING DEVELOPED FOR ACCELERATING LABORATORY PROJECTILES TO METEORIC SPEEDS. THE OVERALL OBJECTIVE IS TO DEVELOP COMPREHENSIVE DESIGN CRITERIA WHICH CAN BE USED BOTH TO DESIGN IMPACT-RESISTANT STRUCTURES FOR PROTECTION OF THE SPACE STATION/BASE, AND TO ASSESS THE LONG-TERM PERFORMANCE OF IMPACTED STRUCTURAL ELEMENTS.

RTOP NO. 114-03-46 TITLE: METEOROIDS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: CLIFTON, K. S. TEL. 205-453-0943
TECHNICAL SUMMARY

(A) LOW LIGHT LEVEL TELEVISION SYSTEMS WILL BE USED IN GROUND-BASED OBSERVATIONS OF METEORS IN ORDER TO DEFINE THE MASS DISTRIBUTION OF THE NEAR-EARTH METEOROID ENVIRONMENT. SPECIFICALLY, DATA WILL BE RECORDED TO DETERMINE THE SLOPE OF THE MASS-FLUX CURVE IN THE MASS RANGE BETWEEN THAT DEFINED PHOTOGRAPHICALLY AND THAT MEASURED BY THE PEGASUS SATELLITES, A REGION OF CRITICAL IMPORTANCE TO LONG-TERM ORBITING SPACECRAFT. IN ADDITION, THE TEMPORAL AND OTHER VARIATIONS IN METEOR INFLUX RATES WILL ALSO BE INVESTIGATED. WITH THE USE OF VIDEO PROCESSORS, FILTERS, AND SPECTRAL GRATINGS METEOR PARAMETERS SUCH AS LUMINOSITY, COLOR, AND SPECTRA WILL ALSO BE EXAMINED. FURTHERMORE, TWO STATION OBSERVATIONS CAN ALLOW THE CALCULATION OF METEOR HEIGHTS, VELOCITIES, AND ORBITAL PARAMETERS.
(B) THE METEOROID SIMULATION PROGRAM IS CONDUCTED USING LIGHT GAS AND PLASMA ACCELERATORS. AT THE PRESENT TIME THEY ARE UTILIZED IN SUPPORT OF FOUR OBJECTIVES: (1) TO VERIFY AND SUPPORT AN ACCURATE THEORETICAL MODEL OF THE HYPERVELOCITY IMPACT PHENOMENA. (2) TO DEFINE DAMAGE TO SUCH STRUCTURES AS SKYLAB BUMPER AND HULL, MDA INSTRUMENTATION CABLES, PROPOSED LUNAR TUG FUEL TANKS, SOLAR CELLS, IU PANELS, ETC., FROM HYPERVELOCITY IMPACT. (3) TO SIMULATE METEOR PHENOMENA IN SUPPORT OF THE GROUND-BASED WORK. (4) INCREASE THE ACCELERATION VELOCITY OF PROJECTILES.

RTOP NO. 114-03-45 TITLE: METEORS AND METEOROIDS
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: GOODWIN, G. TEL. 415-961-2265
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE UNDERSTANDING OF HYPERVELOCITY IMPACT REQUIRED TO DESIGN FUTURE SPACECRAFT HAVING ADEQUATE METEOROID PROTECTION. EFFECTS OF MATERIAL, PROJECTILE DENSITY, SIZE, AND SHAPE, AND PROJECTILE VELOCITY ON PENETRATION AND

CRATERING PHENOMENA WILL BE STUDIED EXPERIMENTALLY AND ANALYTICALLY. IMPROVEMENTS IN LAUNCHER PERFORMANCE RESULTING FROM HIGH-EXPLOSIVE DRIVER DEVELOPMENT CARRIED OUT UNDER RTOP 114-03-46 WILL BE EXPLOITED TO THE MAXIMUM POSSIBLE EXTENT. RESULTS OF THIS WORK WILL BE NEEDED FOR THE DESIGN OF METEOROID BUMPERS FOR LONG-LIVED SPACECRAFT AND PARTICULARLY FOR SPACECRAFT TRAVERSING THE ASTROID BELT.

RTOP NO. 114-08-07 TITLE: SPACE STATION DAMAGE CONTROL AND DYNAMICS
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: BROOKS, G. W. TEL. 703-827-2042
TECHNICAL SUMMARY

THE RESEARCH CONDUCTED UNDER THIS RTOP WILL BE DIRECTED INTO 2 AREAS. FIRST AREA DEALS WITH METHODS TO PROVIDE AND MAINTAIN LARGE ENCLOSED VOLUMES FOR MANNED SPACE STATIONS. RESEARCH WILL BE DIRECTED TOWARD THE DEVELOPMENT OF A DAMAGE CONTROL SYSTEM THAT WILL DETECT, LOCATE, AND REPAIR HOLES OR LEAKS IN THE PRESSURIZED CABINS OF SPACE STATIONS. THE SECOND AREA DEALS WITH THE DEVELOPMENT OF ANALYTICAL AND EXPERIMENTAL TECHNIQUES FOR PREDICTING THE DYNAMIC RESPONSE AND RESULTING STRESSES OF FLEXIBLE MODULAR AND ROTATING SPACE STATIONS. COMPUTER SIMULATIONS OF A STATION CONSISTING OF SEVERAL MODULES AND A STATION WITH A COUNTERWEIGHT CONNECTED BY CABLES OR OTHER EXTENDIBLE MEMBERS WILL BE DEVELOPED. THE ANALYSIS WILL BE USED TO DETERMINE THE THREE-DIMENSIONAL STATION DYNAMICS AND ELASTIC RESPONSE DURING NORMAL OPERATION, EXTENSION, STEADY SPIN, AND RETRACTION.

RTOP NO. 746-03-47 TITLE: METEOROID TECHNOLOGY SATELLITE
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DETERMINE THE METEOROID ENVIRONMENT IN SPACE AND TO DETERMINE THE EFFECTIVENESS OF METEOROID PROTECTION STRUCTURES FOR FUTURE SPACE FLIGHTS. THE WORK INCLUDES THE FOLLOWING AREAS: THE METEOROID TECHNOLOGY SATELLITE (MTS) IS A SCOUT LAUNCHED NEAR-EARTH EXPERIMENT TO OBTAIN BASELINE DATA ON THE EFFECTIVENESS OF BUMPERS OR MULTI-WALL STRUCTURES AND THE VELOCITY DISTRIBUTIONS OF METEOROIDS. MEASUREMENT WILL ALSO BE MADE OF THE FLUX OF VERY SMALL MASS METEOROIDS. THE VELOCITY MEASUREMENT IS A JOINT LANGLEY RESEARCH CENTER/MANNED SPACECRAFT CENTER EXPERIMENT. THE INTERPLANETARY METEOROID PENETRATION EXPERIMENT WILL BE FLOWN ON THE PIONEER F AND ON THE PIONEER G FLIGHTS THROUGH THE ASTEROID BELT TO OBTAIN METEOROID FLUX DATA IN INTERPLANETARY SPACE ENVIRONMENT. AN EARTH ORBITAL SISYPHUS EXPERIMENT WILL BE STUDIED. THE SISYPHUS SYSTEM IS AN OPTICAL METEOROID DETECTOR WHICH UTILIZES THREE OVERLAPPING REFLECTIVE TELESCOPES TO DETERMINE THE MASS, VECTOR VELOCITY, AND RANGE FROM SPACECRAFT OF METEOROIDS.

RTOP NO. 746-03-48 TITLE: RADIATION TECHNOLOGY SATELLITE
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: MCALLUM, W. E. TEL. 713-483-3734
TECHNICAL SUMMARY

A SCIENTIFIC INSTRUMENT PACKAGE WAS LAUNCHED SIMULTANEOUSLY WITH THE ORBITING FROG OTOLITH SPACECRAFT ON NOVEMBER 7, 1970. THE INSTRUMENT PACKAGE CONSISTED OF TWO EXPERIMENTS: (1) A RADIATION EXPERIMENT COMPOSED OF THREE SOLID-STATE SPECTROMETERS, A REAL-TIME SPECTRUM-TO-DOSE CONVERTER, AND THREE IONIZATION CHAMBERS, AND (2) A METEOROID EXPERIMENT CAPABLE OF MEASURING PARTICLE FLUX AND PARTICLE VELOCITY WITH THIN FILM CAPACITOR SENSORS. THE WORK TO BE ACCOMPLISHED IS THE REDUCTION, ANALYSIS, AND PUBLICATION OF 90 DAYS OF FLIGHT DATA FROM THE RADIATION AND METEOROID EXPERIMENTS. THE EXISTING MAGNETIC TAPES WILL BE PROCESSED TO STRIP THE APPROPRIATE DATA AND CORRELATE THE EXPERIMENT DATA WITH SPACECRAFT POSITION OBTAINED FROM THE STADAN EPHEMERIS DATA. THE RESULTING INFORMATION WILL PROVIDE EVALUATION OF SPECTRUM-TO-DOSE CONVERSION PERFORMANCE; DOSE AND POSSIBLE SPECTRUM MAPS OF THE SOUTH ATLANTIC ANOMALY; EVALUATION OF METEOROID INSTRUMENT PERFORMANCE; AND METEOROID FLUX AND VELOCITY DATA POINTS.

RTOP NO. 115-23-30 TITLE: CENTRAL MULTIPROCESSOR AND MAN/MACHINE TECHNIQUES
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: WELDON, J. W. TEL. 713-483-4065
TECHNICAL SUMMARY

THE PRESENT CONCEPT OF A SPACE STATION/BASE AS A PERMANENT FACILITY (10 YEAR LIFE) IMPLIES SELF-CONTAINED AUTONOMOUS OPERATIONS. THIS REQUIRES PERFORMING ONBOARD FUNCTIONS WHICH WERE PREVIOUSLY PERFORMED ON THE GROUND SUCH AS STATUSING OPERATIONS, INTEGRATED SUBSYSTEM CHECKOUT, PROCESS CONTROL, AND SCIENTIFIC DATA EDITING AND PROCESSING. THE ONBOARD COMPUTATIONAL CAPABILITY REQUIRED TO ACCOMPLISH THESE FUNCTIONS ONBOARD GREATLY EXCEEDS ANY PREVIOUS FLIGHT COMPUTATIONAL REQUIREMENTS. THE DESIGN AND DEVELOPMENT OF A HIGH CAPACITY, HIGH SPEED, FAULT TOLERANT, SPACE FLIGHT MULTIPROCESSOR COMPUTER SYSTEM TO PERFORM THE ONBOARD COMPUTATIONS IS RECOGNIZED AS A CRITICAL TECHNOLOGY AREA. TO ASSURE THE AVAILABILITY OF THIS CRITICAL TECHNOLOGY, THIS EFFORT WILL RESULT IN THE DEVELOPMENT OF MAN/MACHINE M/P COMMUNICATIONS TECHNIQUES, THE DESIGN OF AN AEROSPACE MULTIPROCESSOR, AND THE AVAILABILITY OF MULTICOMPUTER SYSTEM FOR IN-HOUSE EVALUATION OF PRELIMINARY MULTIPROCESSOR CONCEPTS AND APPLICATIONS. THIS RTOP (115-23-30) IS A CONTINUATION OF RTOP (125-23-15) ACTIVITY STARTED IN FY-71. THE MAN/MACHINE COMMUNICATIONS TECHNIQUES STUDY WILL PROVIDE A DISPLAY DEVICE CAPABLE OF PRESENTING THE WIDE VARIETY OF ALPHANUMERIC/GRAPHIC DATA REQUIRED ON A SPACE STATION. THE ADDITIONAL MEMORY REQUIRED FOR FULL GRAPHIC CAPABILITIES AND THE SOFTWARE NECESSARY TO COMMUNICATE WITH THE CENTRAL MULTIPROCESSOR. THE BUFFER I/O SYSTEM WHICH WILL INTERFACE WITH EXTERNAL MEMORY OF THE MULTIPROCESSOR/MULTICOMPUTER SYSTEM IS TO BE EVALUATED IN ITS ABILITY TO DETECT ERROR, RECOVER FROM FAULTS AND HANDLE SYNCHRONOUS/ASYNCHRONOUS COMPUTER I/O OPERATIONS.

RTOP NO. 115-23-40 TITLE: SPACE STATION OPTICAL MASS MEMORY SYSTEM
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.
MONITOR: BAILEY, G. A. TEL. 205-453-3770
TECHNICAL SUMMARY

A MASS MEMORY SYSTEM IS REQUIRED FOR THE SPACE STATION/SPACE BASE SYSTEM OF 1976 THAT COMPLETELY DWARFS EXISTING SYSTEMS IN TERMS OF CAPACITY, SPEED, POWER REQUIREMENTS, SIZE, ETC. IT WOULD BE A RANDOM ACCESS, READ-WRITE MEMORY OF 10 TO THE 12TH POWER BITS CAPACITY WITH NO MOVING PARTS. IT HAS LONG BEEN KNOWN THAT FOR MEMORIES OF THIS CAPACITY, TO KEEP OTHER PARAMETERS REASONABLE, EITHER SOME OPTICAL OR ELECTRON BEAM TECHNIQUE WOULD BE EMPLOYED. THE READ-WRITE REQUIREMENT OBVIATES THE USE OF E-BEAM TECHNOLOGY SINCE THERE IS NO KNOWN MEANS OF STORING BY E-BEAMS IN AN ERASABLE MEDIUM. ADDITIONALLY, THE SUCCESS OF AN OPTICAL SYSTEM WOULD DEPEND UPON THE EFFICIENT INTERACTION OF THE LIGHT SOURCE, THE ACCESSION SYSTEM, THE INPUT-OUTPUT SYSTEM, AND THE STORAGE MEDIUM. OPTICAL MEMORY SYSTEMS IN THE PAST HAVE FAILED DUE TO ONE OR MORE OF THE ABOVE FACTORS. FOR INSTANCE, THE STORAGE MEDIUM MUST HAVE VERY HIGH DATA STORAGE DENSITY IF VERY LARGE CAPACITIES ARE STORED WITHIN REASONABLE DIMENSIONS. PAST SYSTEMS HAVE REQUIRED A PERFECT STORAGE MEDIUM TO KEEP BIT ERROR RATES LOW. HOWEVER, IF STORAGE IS IMPLEMENTED BY HOLOGRAPHIC MEANS, A PERFECT MEDIUM IS NOT REQUIRED.

IN ADDITION, BY STORING THE INFORMATION IN TWO STEPS (COMPOUND ADDRESSING) THE HIGH RESOLUTION OF HOLOGRAPHIC RECORDING CAN BE MAINTAINED. SEVERAL YEARS OF EFFORT HAVE BEEN DEVOTED BY INDUSTRY ON THE DEVELOPMENT OF LASER SYSTEMS, BEAM DEFLECTION SYSTEMS, HOLOGRAPHIC TECHNIQUES, RECORDING MATERIALS, LARGE PHOTODETECTOR ARRAYS, AND LIGHT MODULATORS. MOST OF THIS WORK WAS DONE INDEPENDENTLY ON EACH OF THESE COMPONENTS AND ONLY RECENTLY HAS IT BEEN POSSIBLE TO DISCUSS THE FEASIBILITY OF COMBINING TECHNIQUES TO OBTAIN ALARGE STORAGE/FAST ACCESSION SYSTEM----

RTOP NO. 115-23-10 TITLE: AUTOMATED DATA HANDLING TECHNIQUES AND COMPONENTS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
MONITOR: SCHAEFER, D. H. TEL. 301-982-5184
TECHNICAL SUMMARY

OPERATIONAL EARTH RESOURCE MISSIONS WILL SENSE A VERY LARGE NUMBER OF IMAGES IN MANY SPECTRAL REGIONS. IT HAS BEEN ESTIMATED THAT SENSORS MAY BE RECEIVING INPUTS AT A TOTAL RATE EQUIVALENT TO 10 TO THE 12TH POWER BITS PER SECOND. IN ORDER TO EFFECTIVELY UTILIZE THIS AVALANCHE OF INFORMATION, DATA REDUCTION ON-BOARD THE ANALYSIS OF DATA GENERATED IN EARTH RESOURCE MISSIONS. THE DEVELOPMENT OF THESE METHODS SHOULD ALSO ASSIST OTHER NASA MISSIONS INCLUDING MISSIONS AROUND PLANETS OTHER THAN THE EARTH. THREE PRINCIPAL AREAS WILL BE INVESTIGATED. THE FIRST AREA IS THE DEVELOPMENT OF HYBRID OPTICAL-DIGITAL METHODS OF PERFORMING DATA ANALYSIS. THIS WILL ALLOW THE ANALYSIS OF IMAGES IN A "PARALLEL" MANNER (I.E., WHERE NO SCANNING IS INVOLVED). THE SECOND AREA IS THE DEVELOPMENT OF ADVANCED DIGITAL METHODS OF PROCESSING DATA. THIS INCLUDES THE DEVELOPMENT OF MINIMAL PROGRAMMABLE COMPUTING DEVICES AS WELL AS THE DEVELOPMENT OF A MICRO-PROCESSOR COMPUTER.

RTOP NO. 115-21-21 TITLE: MICROWAVE COMMUNICATION FOR THE SPACE STATION BASE
ORGANIZATION: JET PROPULSION LABORATORY CALIFORNIA INSTITUTE OF
MONITOR: POWELL, R. V. TEL. 213-354-6586
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO DEVISE A TECHNOLOGY TO SATISFY THE REQUIREMENTS OF THE MANNED SPACE STATION UNIFIED MICROWAVE COMMUNICATION SYSTEM. THE REQUIREMENTS ARE PRIMARILY LONG TERM RELIABILITY (10 YEARS OR MORE) WITH A CAPABILITY OF EFFICIENTLY HANDLING 100 MEGABITS/SECOND OF DATA COMING TO AND FROM MANY DIFFERENT SOURCES, INCLUDING EARTH RESOURCES MODULES AND THE TRACKING DATA RELAY SATELLITE NETWORK (TDRSN). WORK IS BEING DONE TO DEVELOP AN EXTENSIVE TECHNOLOGY FOR THE K SUB U BAND REGION OF THE FREQUENCY SPECTRUM WHICH IS A MAJOR NASA SPACE STATION FREQUENCY. THIS INCLUDES THE DEVELOPMENT AND TESTING OF HIGH GAIN FURLABLE CONICAL K SUB U BAND ANTENNAS, AS WELL AS THE INVESTIGATION OF OTHER K SUB U BAND ANTENNA CONCEPTS. ALSO, RELIABLE LONG-LIFE WIDEBAND TRANSMITTERS WITH CATHODE REPLACEMENT ARE BEING DEVELOPED. THE TRANSMITTER WORK INCLUDES THE MULTIPLE ELECTRON GUN (MEG) CONCEPT FOR

HIGH-POWER HIGH-RATE COMMUNICATION TO EARTH VIA THE TDRSN. NEW MODULATION/DEMODULATION/DETECTION TECHNIQUES SUCH AS INTERPLEX FOR EFFICIENT MULTIPLE SUBCARRIER TELEMETRY SYSTEMS ARE BEING DEVELOPED AND EVALUATED IN THE LIGHT OF THE VERY HIGH DATA RATE REQUIREMENTS. OPTIMUM MODULATION INDEX SELECTION RULES TO MINIMIZE CROSS-MODULATION AND WAVEFORM DISTORTION LOSS ARE UNDER INVESTIGATION. INCLUDED ARE STUDIES OF MULTIPLE SUBCARRIER SCHEMES FOR SUPPRESSED CARRIER SYSTEMS AND DEVELOPMENT OF METHODS OF EXTRACTING THE SUBCARRIER FROM THE MODULATION SIDEBANDS.

RTOP NO. 115-21-10 TITLE: MICROWAVE NEAR EARTH COMMUNICATIONS AND TRACKING
ORGANIZATION: GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
MONITOR: SIMAS, V. R. TEL. 301-982-4936
TECHNICAL SUMMARY

THE OBJECTIVE OF THE WORK UNDER THIS RTOP IS TO ACHIEVE TECHNOLOGICAL ADVANCES IN COMMUNICATION AND TRACKING SYSTEMS IN ORDER TO SATISFY THE DEMANDING COMMUNICATION REQUIREMENTS FOR FUTURE SPACE FLIGHT PROJECTS, SUCH AS SPACE STATION, EARTH OBSERVATION SATELLITE (EOS) PROGRAM AND TDRS. THE CAPABILITY AND PERFORMANCE REQUIREMENTS ON THE COMMUNICATION LINKS FOR THESE ADVANCED PROJECTS ARE CHARACTERIZED BY HIGH DATA RATES (100 MHZ BANDWIDTH), SIMULTANEOUS MULTI-LINK OPERATION AND RELIABLE LONG LIFE OPERATION. THE ATTAINMENT OF THESE PARAMETERS WILL REQUIRE TECHNOLOGICAL ADVANCES IN BOTH SPACECRAFT AND GROUND TERMINAL TECHNIQUES AND HARDWARE. 1) HIGH POWER (10 WATT) EFFICIENT SOLID STATE SIGNAL SOURCES AT K SUB U BAND WILL BE DEVELOPED. THIS WILL CIRCUMVENT THE LIABILITIES ASSOCIATED WITH VACUUM TUBE TWTS, NAMELY LIMITED LIFE, SIZE AND WEIGHT, AND HIGH VOLTAGES. 2) INCREASED ACCURACY AND SENSITIVITY OF TRACKING AND DATA SYSTEMS WILL BE ATTAINED BY IMPROVING SPACECRAFT AND NETWORK PRIMARY FREQUENCY STANDARDS. THE WORK HERE INVOLVES THE DEVELOPMENT OF RUBIDIUM FREQUENCY STANDARDS AND A MINIATURE, ULTRA-STABLE, FREQUENCY/PHASE STANDARD ATOMICALLY CONTROLLED USING ADVANCED CONCEPTS OF ELECTRO DYNAMIC STORAGE OF REFERENCE IONS. 3) THE PRESENTLY ENVISIONED SPACE STATION COMMUNICATIONS SYSTEM HAS ANTENNA REQUIREMENTS THAT MAY BE BEST FILLED BY THE USE OF PHASED ARRAYS. THESE ANTENNA REQUIREMENTS WILL BE DETERMINED THROUGH TRADE-OFF STUDIES AND AN APPROPRIATE PHASED ARRAY TECHNIQUE DEVELOPED WHICH BEST SUITS THE STATION-TO-MODULE AND STATION-TO-GROUND COMMUNICATION LINKS.

RTOP NO. 115-21-50 TITLE: CODING FOR SPACE COMMUNICATIONS
ORGANIZATION: AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA
MONITOR: FOSTER, J. V. TEL. 415-961-2267
TECHNICAL SUMMARY

DEVELOP ERROR DETECTION AND CORRECTION CODING TECHNIQUES APPLICABLE TO TELEMETRY LINKS FOR A SPACE STATION/BASE, WITH REQUIREMENTS FOR DATA RATES GREATER THAN 15 MBPS. INVESTIGATE METHODS FOR EXTENDING THESE TECHNIQUES TO DATA RATES OF 50 MBPS. STUDY THE APPLICABILITY OF CODING METHODS FOR COMMAND LINKS

ASSOCIATED WITH A SPACE STATION. INVESTIGATE HYBRID CODING TECHNIQUES TO EXTEND PRESENT CODING GAINS FOR LOW DATA RATE PLANETARY MISSIONS. THEORETICAL STUDIES OF HIGH DATA RATE CODING HAVE BEEN COMPLETED. DESIGN AND DEVELOPMENT OF PHOTOTYPE DECODING, ENCODING, AND DATA SIMULATION EQUIPMENT, WITH AN OPERATIONAL CAPABILITY OF AT LEAST 20 MBPS, IS UNDERWAY. DETAILED DESIGN OF PROMISING HYBRID CODING TECHNIQUES WILL BE UNDERTAKEN FOR EVALUATION OF MOST EFFECTIVE APPROACH.

RTOP NO. 115-25-02 TITLE: DESIGN, PROCESSING AND TESTING OF LSI ARRAYS FOR SPACE STATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: ANDERSON, D. L. TEL. 205-453-3770
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS DIRECTED TOWARD DEVELOPING THE TECHNOLOGY AND TECHNIQUESFOR THE DESIGN, FABRICATION AND TESTING OF LARGE SCALE INTEGRATED CIRCUIT ARRAYS. THIS ENCOMPASSES THE DESIGN, DEVELOPMENT AND IMPLEMENTATION OF AUTOMATIC TEST EQUIPMENT INCLUDING COMPUTER SOFTWARE TO PERFORM DYNAMIC AS WELL AS FUNCTIONAL TESTS ON LSI ARRAYS. INHERENT IN THESE BROAD OBJECTIVES IS THE MAXIMUM USE OF AN IN-HOUSE XDS SIGMA 5 COMPUTER FACILITY TO DEVELOP AND APPLY CAD (COMPUTER AIDED DESIGN) TECHNIQUES TO SUCH LSI PROBLEMS AS LOGIC SIMULATION, CIRCUIT LAYOUT AND SYSTEM ANALYSIS. SPECIAL EMPHASIS WILL BE GIVEN TO FACILITATE THE COMPUTER OPERATIONS FOR THE USER AND INTERACTIVE GRAPHICS WILL BE EMPLOYED WHEREVER FEASIBLE. PROCESS TECHNOLOGY DEVELOPMENT WILL BE PURSUED IN THE PROMISING AREAS WHERE NEED EXISTS. FOR INSTANCE, THE APPLICATION OF BEAM LEADS TO MOS DEVICES IS AN IMMEDIATE SOLUTION TO THE PASSIVATION AND INTERCONNECTION PROBLEM. SIMILARLY THE SILICON-ON-SAPPHIRE INTEGRATED CIRCUITS AND MNOS DEVICES PROVIDE A GREAT AMBIENT OF POTENTIAL. THE GENERAL APPROACH TO IMPLEMENTING THIS PROGRAM WILL BE BASED FIRST ON DEVELOPING AND UTILIZING NEW LSI TECHNOLOGY THAT PROMISES TO BE USEFUL IN FUTURE NASA MISSIONS. COMPUTER AIDED DESIGN AND TESTING PROGRAMS WILL BE DEVELOPED TO COMPLEMENT NEW LSI TECHNOLOGY.

RTOP NO. 115-19-02 TITLE: CONTROL AND STABILIZATION SYSTEMS AND COMPONENTS FOR SPACE STATION
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365RIN
MONITOR: TEL. 703-827-3745
TECHNICAL SUMMARY

TECHNOLOGY WILL BE DEVELOPED TO PERMIT THE DESIGN OF SPACE STATION ATTITUDE CONTROL AND STABILIZATION SYSTEMS FOR AN 8-10 YEAR OPERATIONAL LIFETIME. SIMULATIONS WILL BE MADE CONSIDERING FLEXIBLE, VARIABLE-INERTIA, MULTIBODY, SPINNING AND NON-SPINNING MODULAR CONFIGURATIONS IN ORDER TO DETERMINE THE REQUIRED SYSTEM AND COMPONENT PERFORMANCE. CONTROL SOFTWARE AND HARDWARE NEEDS BEYOND THE PRESENT STATE-OF-THE-ART WILL BE DEFINED AND DEVELOPMENT EFFORTS UNDERTAKEN TO PROVIDE SOLUTIONS. CRITICAL HARDWARE ELEMENTS WILL BE CARRIED THROUGH PROTOTYPE DEVELOPMENT TO ESTABLISH FEASIBILITY. THIS EFFORT IS DIRECTLY COORDINATED WITH MSFC AND GSFC, AND GSFC-DEVELOPED COMPONENTS WILL BE INTEGRATED INTO SIMULATIONS AT LANGLEY. TECHNOLOGY FOR SEPARATE EXPERIMENT-ISOLATION AND FINE-POINTING SYSTEMS WILL BE DEVELOPED IN A SIMILAR MANNER.

RTOP NO. 113-26-13 TITLE: RESISTOJET SYSTEM TECHNOLOGY FOR MANNED SPACE STATION REACTION CONTROL
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VA 23365
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE APPLICATION OF BIOWASTE RESISTOJETS ON THE SPACE STATION TO PROVIDE THE IMPULSE REQUIRED FOR CONTROL MOMENT GYRO (CMG) DESATURATION AND ORBIT MAINTENANCE. THESE UNITS SHALL HAVE HIGH PERFORMANCE, LONG LIFE AND MINIMUM POWER CONSUMPTION. A HIGH THERMAL EFFICIENCY AMMONIA - HYDROGEN RESISTOJET WAS DEVELOPED AS PART OF THE MORL PROGRAM. THE BIOWASTE RESISTOJET CURRENTLY UNDER DEVELOPMENT IS AN EVOLUTION OF THE MORL DESIGN, WITH THE INCORPORATION OF HEATER MATERIALS COMPATIBLE WITH THE OXIDIZING BIOWASTE GASES AT THE HIGH TEMPERATURE REQUIRED FOR GOOD PERFORMANCE. THE MORL AND ALTERNATE RESISTOJET CONCEPTS ARE BEING EVALUATED FOR PROPELLANT PERFORMANCE, LIFE, POWER CONSUMPTION AND SYSTEM SUITABILITY. A PROGRAM HAS BEEN INITIATED TO DEVELOP THE PROPELLANT COLLECTION AND MANAGEMENT SYSTEM REQUIRED TO INTERFACE THE RESISTOJET WITH THE LIFE SUPPORT SYSTEM. STUDIES CONDUCTED BY THE PRIME SPACE STATION CONTRACTORS HAVE PROVIDED INFORMATION REGARDING THRUSTER DUTY CYCLES, THRUST LEVELS, PROPELLANT AVAILABILITY, ETC. THIS INFORMATION WILL BE USED IN FUTURE THRUSTER EVALUATION PROGRAMS AND IN THE DEVELOPMENT OF A PROTOTYPE PROPELLANT COLLECTION AND SUPPLY SYSTEM. THE COMBINED THRUSTER AND PROPELLANT COLLECTION SYSTEM WILL THEN BE TESTED AT LRC TO REVEAL SYSTEM OPERATIONAL CHARACTERISTICS, RESISTOJET-LIFE SUPPORT SYSTEM INTERFACE PROBLEMS AND TO DEMONSTRATE THE TOTAL SYSTEMS CAPABILITY TO PROVIDE THE IMPULSE REQUIRED ON A DUTY CYCLE DICTATED BY CMG AND ORBIT MAINTENANCE REQUIREMENTS.

RTOP NO. 113-31-01 TITLE: ZERO GRAVITY PROPELLANT TRANSFER TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER 21000 BROOKPARK ROAD

MONITOR: OTTO, E. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THIS RTOP OUTLINES A TECHNOLOGY PROGRAM THAT REVIEWS AND AUGMENTS THE PRESENT ZERO GRAVITY FLUID BEHAVIOR AND THERMAL PROTECTION TECHNOLOGY AND CULMINATES IN A FUNCTIONALLY AND ENVIRONMENTALLY TESTED ENGINEERING MODEL OF A LIQUID HYDROGEN TRANSFER FLIGHT EXPERIMENT. THE OBJECTIVE OF THE FLIGHT EXPERIMENT WOULD BE TO EVALUATE ONE OR MORE PROPELLENT TRANSFER SYSTEMS THUS PROVIDING TECHNOLOGY AND DESIGN DATA FOR PREDICTABLE AND EFFICIENT ZERO-G PROPELLANT TRANSFER OPERATIONS IN SPACE. THE PROGRAM IS TO BE CONDUCTED IN TWO PHASES - AN EXPERIMENT DEFINITION PHASE AND AN EXPERIMENT DEVELOPMENT PHASE. THE EXPERIMENT DEFINITION PHASE WILL CONSIST OF TWO PARALLEL STUDY CONTRACTS AUGMENTED BY IN-HOUSE RESEARCH. THE TWO MAIN OBJECTIVES OF THIS PHASE ARE (1) TO DEFINE AND CONDUCT THOSE ITEMS OF RESEARCH THAT FILL GAPS IN DATA NECESSARY FOR EXPERIMENT DEFINITION AND FOR DESIGN AND FABRICATION TECHNOLOGY, AND (2) TO DEFINE THE EXPERIMENT. THE FIRST PHASE LASTS UNTIL LATE CY 1973. THE EXPERIMENT DEVELOPMENT PHASE WILL CONSIST OF A CONTRACT FOR THE DESIGN, FABRICATION, AND TEST OF AN ENGINEERING MODEL OF THE FLIGHT EXPERIMENT TOGETHER WITH THE NECESSARY GROUND SUPPORT EQUIPMENT. IT IS TO BE CONDUCTED OVER A PERIOD OF TWO AND ONE HALF YEARS AND IS CONCLUDED IN LATE CY 1975.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER - SPACE STATION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: GRAFF, C. B. TEL. 205-453 4560
TECHNICAL SUMMARY

THIS RTOP SETS FORTH A SERIES OF TEST THAT PURSUE TECHNOLOGY DEVELOPMENT AND ESTABLISHES TECHNOLOGY REQUIREMENTS NEEDED TO INTEGRATE NUCLEAR POWER CONVERSION UNIT INTO THE SPACE STATION/SPACE BASE. PERFORMANCE TESTING WILL BE CONDUCTED INHOUSE TO SOLVE INTERFACE REQUIREMENTS AND TO DEVELOP AUTOMATIC CONTROL EQUIPMENT, AUXILIARY POWER EQUIPMENT, ALSO DEVELOP CIRCUITRY AND POWER CONVERSION COMPONENTS AS RELATED TO NUCLEAR POWER. THE TEST RESULTS WILL BE USED TO INFLUENCE THE PROGRAMS FOR THE RESPECTIVE TECHNOLOGIES ADMINISTERED BY MSFC, MSC AND LERC. THIS IS A CONTINUATION OF THE PRESENT PROGRAM. NECESSARY COMPONENTS FOR THE CONSTRUCTION OF THE GAS MANAGEMENT LOOPS AND HEAT REJECTION LOOP HAVE BEEN PURCHASED. THIS PROPOSAL IS FOR THE FUNDING TO COMPLETE THE PURCHASE OF THE TEST SUPPORT EQUIPMENT AND THE SPECIAL INTERFACE EQUIPMENT.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER - SPACE STATION PART II
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MONITOR: MILLER, J. L. TEL. 205-453-4567
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO INVESTIGATE THE NATURE OF CELL TO CELL AND CELL TO SUBSTRATE PROBLEMS KNOWN TO EXIST THROUGH PREVIOUS EXPERIENCE AND TO DEVELOP CELL STACK TECHNOLOGY FOR SPACE STATION APPLICATION WITH HIGHEST RELIABILITY AND LONGEST LIFETIME. PROBLEM AREAS TO BE ADDRESSED SPECIFICALLY INCLUDE INTERCELL CONNECTION TECHNIQUES, BONDING TECHNIQUES AND MATERIALS COMPATIBILITY, HOT SPOT PHENOMENON RELATING TO NON-PRODUCING CELLS, REVERSE LEAKAGE AND AVALANCHE BREAKDOWN, THERMAL MASS EFFECTS OF VARIOUS CELL STACK AND SUBSTRATE DESIGNS. THE OBJECTIVES WILL BE ACCOMPLISHED THROUGH A COMBINATION OF IN-HOUSE AND CONTRACTED EFFORTS BROKEN DOWN INTO INDIVIDUAL TASKS. IN GENERAL, EACH TASK AREA WILL BE WORKED IN THREE PHASES AS FOLLOWS: (1) ANALYSIS OF THE MATERIALS PROPERTIES RELATING TO THE PROBLEM, (2) DESIGN AND FABRICATION OF CELL STACK MATRIX TEST ARTICLES, AND (3) TEST AND EVALUATION. IT IS INTENDED THAT MAXIMUM COST EFFECTIVENESS BE REALIZED THROUGH APPROPRIATE USE OF MSFC TEST FACILITIES AND EXPERIENCE GAINED ON EARLIER PROGRAMS INCLUDING SKYLAB.

RTOP NO. 908-51-02 TITLE: SPACE STATION THERMAL CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALABAMA
MONITOR: VANIMAN, J. L. TEL. 205-453-3821
TECHNICAL SUMMARY

THE TASKS COVERED BY THIS RTOP ARE DIRECTED TOWARD PROVIDING TECHNOLOGICAL SOLUTIONS TO THERMAL CONTROL PROBLEMS INTRODUCED BY NEW SPACECRAFT REQUIREMENTS FOR LONG TERM HIGH RELIABILITY OPERATION IN SPACE FOR PERIODS UP TO TEN YEARS. LONG TERM TESTS OF THERMAL CONTROL SURFACES AND STUDIES OF ACTIVE THERMOELECTRIC SURFACE COATINGS AND DEPLOYABLE AND ORIENTABLE RADIATORS WILL BE PERFORMED TO PROVIDE RESOLUTION AND CIRCUMVENTION OF LIMITED HEAT REJECTION CAPABILITY IMPOSED BY RADIATION BLOCKAGE OF CONTIGUOUSLY DOCKED MODULES AND BY SURFACE OPTICAL PROPERTY DEGRADATION/CONTAMINATION RESULTING FROM PROLONGED EXPOSURE TO THE SPACE ENVIRONMENT. THERMAL CAPACITOR, LONG LIFE CIRCULATION PUMP, HEAT MANAGEMENT, HEAT PIPE SYSTEM, AND THERMAL CONTACT CONDUCTANCE STUDIES WILL BE PERFORMED TO ASSURE EFFICIENT HIGHLY RELIABLE LONG LIFE THERMAL CONTROL SYSTEM TECHNOLOGY IS AVAILABLE FOR MODULE DESIGN. SCALE MODELING TECHNIQUES WILL BE DEVELOPED FOR MAKING THERMAL VACUUM DESIGN VERIFICATION TESTS OF FULL SYSTEMS PRACTICAL AND ECONOMICAL. PROJECTED TIME TO COMPLETE THE OBJECTIVES OF THIS RTOP IS 6 YEARS. FY 72 RESOURCE GUIDELINE IS 250K. FY 72 DIRECT MAN-YEARS REQUIREMENT IS 3.

RTOP NO. 908-41-02 TITLE: SPACE STATION - THERMAL CONTROL
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: GUY, W. W. TEL. 713-483-2351
TECHNICAL SUMMARY

THE OBJECTIVE OF THE PROPOSED EFFORT IS TO DEVELOP AN ADVANCED SPACE RADIATOR CONFIGURATION WHICH IS APPLICABLE FOR A VARIETY OF SPACECRAFTS AND MISSIONS, PROVIDES INCREASED SYSTEM RELIABILITY, MINIMIZES METEOROID PROTECTION REQUIREMENTS, AND IMPROVES HEAT LOAD RANGE CAPABILITY. THE APPROACH WILL INCLUDE AN ANALYTICAL INVESTIGATION AND EXPERIMENTAL VERIFICATION OF CANDIDATE MODULAR HEAT-PIPE RADIATOR PANEL DESIGN CONCEPTS. CANDIDATE PANEL CONCEPTS WILL BE IDENTIFIED FOR BOTH INTEGRAL SKIN AND FLEXIBLE OR RIGID DEPLOYABLE CONFIGURATIONS. WORK INITIATED IN FY 1971 WILL SERVE AS THE TECHNOLOGY BASE FOR THIS EXTENSION ACTIVITY.

RTOP NO. 908-51-21 TITLE: MANUFACTURING AND INSPECTION
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: HOLLAND, J. G. TEL. 205-453-5085
TECHNICAL SUMMARY

ONE OBJECTIVE FOR THIS EFFORT WILL BE TO PROVIDE TECHNOLOGY BY THE DEVELOPMENT OF METHODS, TECHNIQUES, PROCEDURES, TOOLS AND EQUIPMENT AND TO MAKE THIS TECHNOLOGY AVAILABLE FOR THE FABRICATION, PROCESS INSPECTION, ASSEMBLY, MAINTENANCE, AND SIMULATION TESTING OF SYSTEMS AND COMPONENTS APPLICABLE TO THE SKYLAB, SPACE STATION, SPACE BASE, AND/OR OTHER ADVANCED MANNED MISSIONS. IN-HOUSE WORK WILL CONTINUE TO BE PERFORMED TO ASSURE THE AVAILABILITY OF TECHNOLOGY NECESSARY FOR THE MANUFACTURE AND SIMULATION TESTING OF CRITICAL

STRUCTURAL SYSTEMS, SUBSYSTEMS, AND COMPONENTS; AUTOMATION OF WELDING EQUIPMENT; MAINTENANCE; ELECTRONIC CIRCUITRY; ELECTRICAL NETWORK SYSTEMS; ETC. ALSO, THE OBJECTIVES OF THIS EFFORT ARE TO EVOLVE, THROUGH RESEARCH, DEVELOPMENT, AND TECHNOLOGY APPLICATIONS STUDIES, NEW INSPECTION TECHNIQUES REQUIRED FOR EFFECTIVE INSPECTION OF SPACE STATION HARDWARE, STRUCTURES, AND SYSTEMS. IN-PROCESS INSPECTION AND END ITEM INSPECTION TECHNIQUES EMPLOYING NONDESTRUCTIVE TESTING CONCEPTS, PROCESS CONTROL CONCEPTS, AND VISUAL INSPECTION CONCEPTS ARE TO BE STUDIED AND DEVELOPED TO PROVIDE THE TECHNIQUES REQUIRED BY THE PROGRAM. THROUGH STUDIES OF THE STRUCTURES, MATERIALS, SYSTEMS, AND HARDWARE PROPOSED FOR THE PROGRAM, THE INSPECTION REQUIREMENTS AND TECHNIQUES NECESSARY TO ASSURE QUALITY, PER PRESCRIBED DESIGN, WILL BE IDENTIFIED. THESE REQUIREMENTS WILL BE COMPARED TO EXISTING TECHNIQUES AND, WHERE EXISTING TECHNIQUES ARE FOUND INSUFFICIENT, NEW TECHNIQUES WILL BE DEVELOPED OR FURTHER DEVELOPMENT PERFORMED TO ADVANCE EXISTING TECHNIQUES.

RTOP NO. 908-51-33 TITLE: INFORMATION MANAGEMENT SYSTEMS DATA MANAGEMENT
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.
MONITOR: GARRETT, H. TEL. 205-453-4070
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO PERFORM RESEARCH AND DEVELOPMENT OF ADVANCED SPACE COMPUTER HARDWARE, SOFTWARE, AND COMPUTER PERIPHERAL DEVICE TECHNOLOGY. ALSO RESEARCH AND DEVELOPMENT OF COMPUTER/SCIENTIST LANGUAGES AND INTERACTIONS WILL BE PERFORMED. THIS EFFORT _WILL LEAD TO THE DEVELOPMENT OF AN ADVANCED SPACE MULTIPROCESSOR, A GENERALIZED SOFTWARE EXECUTIVE, ADVANCED PERIPHERAL DEVICES AND PROGRAMING TECHNIQUES YIELDING HIGH RELIABILITY PROGRAMS. INCLUDED UNDER THIS EFFORT ARE: RESEARCH AND DEVELOPMENT OF ADVANCED SPACE COMPUTERS, MULTIPROCESSORS, AND MULTICOMPUTER SYSTEMS, AND THE ASSOCIATED SOFTWARE; RESEARCH AND DEVELOPMENT OF ADVANCED COMPUTER PERIPHERAL DEVICES SUCH AS DISPLAYS, HISTORY PLOTTERS, KEYBOARDS, HARDCOPY DEVICES WILL BE PERFORMED; RESEARCH AND DEVELOPMENT OF HIGH LEVEL COMPUTER/SCIENTIST LANGUAGES TO FACILITATE MAN-MACHINE INTERACTION. THE RESEARCH AREAS SUPPORT FUTURE INFORMATION MANAGEMENT SYSTEMS AND DATA MANAGEMENT SYSTEMS SUCH AS THOSE ANTICIPATED FOR THE SPACE STATION.

RTOP NO. 908-51-07 TITLE: COMMUNICATIONS
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: LOWREY, D. O. TEL. 205-453-1578
TECHNICAL SUMMARY

TO DEVELOP AN ELECTRONICALLY STEERABLE MICROWAVE PHASED ARRAY AT S-BAND CAPABLE OF OPERATING ON THE SPACE STATION AND OTHER SPACE VEHICLES. THE ARRAY WILL PROVIDE A HIGH DATA RATE, TELECOMMUNICATIONS CAPABILITY WITH SIMULTANEOUS OR SEPARATE TRANSMIT, RECEIVE AND TRACKING FUNCTIONS. THE NARROW BEAM, HIGH GAIN SIGNAL WILL AUTOMATICALLY SCAN AND TRACK WITHIN A 120 DEGREE CONE. IT WILL BE CAPABLE OF OPERATING IN EITHER THE RETRODIRECTIVE SELF-FOCUSING OR PROGRAMMED MODE. THE ACTIVE ELECTRONICS MODULES OF THE ARRAY WILL UTILIZE 100 PERCENT MICROWAVE AND DIGITAL INTEGRATED CIRCUITRY, AND MICROCIRCUITRY TECHNIQUES TO ACHIEVE HIGH EFFICIENCY, WIDE BANDWIDTH, LONG OPERATING LIFETIME, SMALL SIZE, AND LIGHT WEIGHT SYSTEM. THE ARRAY WILL CONTAIN ALL THE ELECTRONIC CIRCUITRY AND ANTENNA ELEMENTS IN AN INTEGRAL PACKAGE TO PERFORM THE TRANSMIT, RECEIVE AND BEAMPOINTING CONTROL FUNCTIONS. HIGH REDUNDANCY AND GRACEFUL PERFORMANCE DEGRADATION WILL BE ACHIEVED THROUGH THE USE OF THE INDIVIDUAL ELECTRONIC MODULES, EACH OF WHICH CONTAINS COMPLETE TRANSMIT, RECEIVE AND LOGIC ELECTRONICS THAT ARE FREQUENCY COHERENT WITH A MASTER FREQUENCY CONTROL MODULE. LOW POWER LEVELS GENERATED BY EACH MODULE ARE RADIATED BY THEIR INDIVIDUAL ASSOCIATED ANTENNA ELEMENT TO FORM THE COMPOSITE RADIATED SIGNAL. TECHNIQUES WILL BE DEVELOPED FOR PRODUCTION OF MICROELECTRONIC CIRCUITRY TO ACHIEVE LOW COST MODULES. EMPIRICAL DESIGN EQUATIONS DEVELOPED FOR THE ACTIVE ELECTRONICALLY STEERED PHASED ARRAY WILL BE MADE AVAILABLE TO AID IN THE DESIGN AND DEVELOPMENT OF ACTIVE ELECTRONICALLY STEERED PHASED ARRAYS AT HIGHER FREQUENCIES.

RTOP NO. 908-41-07 TITLE: SPACE STATION COMMUNICATIONS
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: CHICOINE, E. L. TEL. 713-483-2128
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO PROVIDE THE RF SUBSYSTEMS TECHNICAL GUIDELINES FOR AN INTEGRATED ANTENNA SYSTEM APPROACH AND FUNCTIONAL REQUIREMENTS FOR COMMUNICATIONS DEVELOPMENT AND TECHNOLOGY PROGRAMS BEING UNDERTAKEN FOR SPACE STATION. SPECIFICALLY, THE FOLLOWING OBJECTIVE WILL BE MET: PROVIDE THE OVERALL TECHNICAL GUIDELINES FOR AN INTEGRATED RF AND ANTENNA SUBSYSTEM TO MEET SPACE STATION REQUIREMENTS, MAKING MAXIMUM UTILIZATION OF STATE-OF-THE-ART TECHNOLOGY IN THE COMMUNICATIONS AREA AND CONTINUING DEVELOPMENTS ALREADY IN PROGRESS. THIS WILL RESULT IN RF SUBSYSTEMS PARAMETRIC DATA THAT WILL AID IN ATTAINING BROADER OBJECTIVES AS FOLLOWS: (1) ESTABLISH THE OVERALL COMMUNICATION FUNCTIONAL REQUIREMENTS AND SUBSYSTEM CRITERIA NECESSARY FOR A VIABLE ONBOARD COMMUNICATION SYSTEM FOR AUTONOMOUS OPERATION AND LONG LIFE, (2) PROVIDE CRITERIA FOR ANTENNA DESIGN AND COMMUNICATION LINK PERFORMANCE, (3) OUTLINE TECHNICAL REQUIREMENTS FOR THE SPACE STATION COMMUNICATION SYSTEM TEST BED, COMMUNICATION SUBSYSTEM INTEGRATION, AND AN OVERALL TEST AND EVALUATION PROGRAM (SPACE-GROUND), (4) ESTABLISH ENGINEERING INTERFACE AND COMPATIBILITY CRITERIA FOR THE VARIOUS SPACE STATION COMMUNICATION LINKS WITH: OTHER SPACE VEHICLES; VIA RELAY SATELLITE; OR DIRECT TO GROUND AND (5) PROVIDE CRITERIA FOR INTERFACING COMMUNICATION SUBSYSTEMS WITH OTHER SUBSYSTEMS. PROVIDE COMMUNICATION SYSTEM ANALYSIS AND EVALUATION OF DIGITAL COMMUNICATIONS SYSTEMS DESIGN CONFIGURATION AND FUNCTIONAL REQUIREMENTS OF THE SPACE STATION. MAXIMIZE THE EFFECTIVENESS OF EXISTING SYSTEMS AND APPLY NEW TECHNOLOGY FOR SOLUTIONS TO SPECIFIC----

RTOP NO. 908-41-10 TITLE: SPACE STATION - GUIDANCE AND NAVIGATION
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: KENNEDY, R. C. TEL. 713-483-4384
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A TECHNICAL FOUNDATION FOR THE SELECTION AND DEVELOPMENT OF AN ORBITAL NAVIGATION SYSTEM FOR THE SPACE STATION. THE NAVIGATION SYSTEM MUST HAVE PERFORMANCE CAPABILITIES APPROACHING THAT OF THE MSFN GROUND TRACKING NETWORK IN ORDER TO PROPERLY SUPPORT THE SPACE STATION PLANNED SCIENTIFIC EXPERIMENTS PROGRAM. FURTHER, A HIGH DEGREE OF AUTONOMY WILL BE REQUIRED TO REDUCE, OR ELIMINATE, THE NEED FOR GROUND SUPPORT THEREBY PROVIDING A COST EFFECTIVE NAVIGATION CAPABILITY. TO ACHIEVE THIS END THIS TASK WILL EXAMINE THE VARIETY OF POSSIBLE TECHNIQUES WHICH CAN POTENTIALLY MEET THE PERFORMANCE REQUIREMENTS. ERROR ANALYSES WILL BE CONDUCTED AS REQUIRED TO FORM A BASIS FOR PERFORMANCE COMPARISON. SYSTEM MECHANIZATION ANALYSES WILL BE CONDUCTED TO DEVELOP THE HARDWARE AND SOFTWARE ASPECTS OF THE CANDIDATE SYSTEMS INCLUDING LEVELS OF REDUNDANCY AND OPERATING PROCEDURES. COST DATA WILL BE COMPILED AND, TOGETHER WITH THE TECHNICAL TRADE FACTORS DEVELOPED IN THE PERFORMANCE AND SYSTEM ANALYSIS WORK, WILL BE EVALUATED TO SELECT A BEST SYSTEM APPROACH FOR CONTINUING ANALYSIS.

RTOP NO. 908-41-18 TITLE: CHECKOUT
ORGANIZATION: MANNED SPACECRAFT CENTER HOUSTON, TEXAS 77058
MONITOR: WELDON, J. W. TEL. 713-483-4065
TECHNICAL SUMMARY

THE PRESENT CONCEPT OF A SPACE STATION/BASE AS A PERMANENT FACILITY (10 YEAR LIFE) IMPLIES SELF-CONTAINED AUTONOMOUS OPERATION. THIS REQUIRES PERFORMING ONBOARD DATA MANAGEMENT AND CHECKOUT FUNCTIONS WHICH ON PRESENT SPACECRAFTS ARE PERFORMED ON THE GROUND. THE DESIGN AND DEVELOPMENT OF THE HARDWARE AND SOFTWARE TO PERFORM THE ONBOARD COMPUTATION, PROCESS CONTROL AND SYSTEM CHECKOUT IS RECOGNIZED AS A CRITICAL TECHNOLOGY AREA. TO ASSURE THE AVAILABILITY OF THIS CRITICAL TECHNOLOGY, AN ONBOARD DATA MANAGEMENT/CHECKOUT SYSTEM WILL BE INTERFACED WITH THE ENVIRONMENTAL THERMAL CONTROL/LIFE SUPPORT SYSTEM. THE OBJECTIVE OF THIS TASK IS THE DEVELOPMENT OF ONBOARD CHECKOUT HARDWARE DEVICES AND SOFTWARE PROGRAMS REQUIRED TO INTERFACE THE SPACE STATION DATA MANAGEMENT SYSTEM BREADBOARD WITH THE ENVIRONMENTAL THERMAL CONTROL/LIFE SUPPORT SYSTEM (ETC/LSS) (RTOP 975-11-06). EMPHASIS WILL BE GIVEN TO PROVIDING AUTOMATED STATUS MONITORING, DIAGNOSTICS, CONTROL AND CHECKOUT OF THE ETC/LSS DURING THE IN-HOUSE OPERATION AND EVALUATION OF THE ETC/LSS. THIS TASK WILL PROVIDE VALIDATION OF THE TECHNIQUES AND CONCEPTS DEVELOPED BY RTOP 125-23-14 AND 125-23-15.

RTOP NO. 908-51-08 TITLE: STABILIZATION AND CONTROL
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.
MONITOR: SELTZER, S. M. TEL. 205-453-4713
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP BETTER DESIGN TECHNOLOGY SO THAT THE COMPUTER CONFIGURATION FOR THE ON-BOARD DIGITAL CONTROL SYSTEM CAN BE DETERMINED. THIS OBJECTIVE CONSISTS OF: (1) CONTINUING THE DEVELOPMENT OF COMPUTATIONAL PROGRAMS AND TECHNIQUES TO ANALYZE VARIABLE, MULTIRATE AND NONSYNCHRONOUS SAMPLED DATA CONTROL SYSTEMS PERFORMED UNDER CONTRACT NAS8-21377; (2) APPLYING PROMISING NEW TECHNIQUES THAT HAVE BEEN OR ARE NOW BEING DEVELOPED WITHIN THE BODY OF MODERN CONTROL THEORY. AN ADDITIONAL OBJECTIVE IS TO CONTINUE DEVELOPMENT EFFORT ON RELIABLE, LONG-LIFE CMG'S BY ADVANCING THE STATE-OF-THE-ART PAYING PARTICULAR ATTENTION TO "SIGNATURE ANALYSIS". THIS WOULD BE ACCOMPLISHED BY DEVELOPING A BEARING CONDITION DIAGNOSTIC SYSTEM FOR INCORPORATION INTO THE ADVANCED CONTROL MOMENT GYRO.

RTOP NO. 908-71-08 TITLE: CONTROL COMPONENTS FOR SPACE STATION/BASE SUBSYSTEMS
ORGANIZATION: GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
MONITOR: EVANS, H. E. TEL. 301-982-5194
TECHNICAL SUMMARY

THIS TASK COVERS DESIGN, TEST AND EVALUATION OF PROTOTYPE DRIVE MOTORS AND SPEED REDUCER SYSTEMS FOR SPACE STATION SUPPORT. WORK INCLUDES ESTABLISHING RELIABILITY THRU LIFE TESTING PROGRAMS. WHERE APPROPRIATE, NEW DESIGNS WILL BE UNDERTAKEN TO MEET SPACE STATION CONTROL SYSTEM REQUIREMENTS. GOALS FOR THIS PROGRAM ARE COMPONENT AND SYSTEMS DESIGN THAT MEET 10 YEARS OPERATION IN THE SPACE ENVIRONMENT. INITIAL EFFORTS COVER DESIGN, DEVELOPMENT, AND EVALUATION OF COMPONENTS FOR CMG SPIN MOTOR AND GIMBAL TORQUERS UTILIZING BRUSHLESS DC MOTOR DRIVES AND UNIQUE SPEED REDUCING ASSEMBLIES. TEST PROGRAMS WILL INCLUDE SIMULATED CMG LOADS; DUTY CYCLES, AND LOAD DISTURBANCES. ELECTRONIC CIRCUITRY REQUIRED TO PROVIDE CONTROL OVER THE DUTY CYCLE RANGE WILL BE DESIGNED AND EVALUATED IN A SIMULATED SPACE ENVIRONMENT. CLOSE COORDINATION WILL BE MAINTAINED WITH RELATED EFFORTS AT LRC, MSFC AND MSC TO INSURE PROGRAM COMPATIBILITY.

RTOP NO. 908-74-35 TITLE: A SOLAR CELL ENERGY WHEEL SYSTEM
ORGANIZATION: LANGLEY RESEARCH CENTER HAMPTON, VIRGINIA 23365
MONITOR: NELSON, C. H. TEL. 703-827-2893
TECHNICAL SUMMARY

THIS WORK WILL ESTABLISH THE FEASIBILITY OF A SOLAR CELL ENERGY WHEEL SYSTEM (SCEWS) THAT CAN PERFORM THE DUAL FUNCTION OF POWER GENERATION AND ATTITUDE CONTROL FOR MANNED SPACECRAFT. INITIAL EFFORTS WILL DEFINE SCEW SYSTEM AND COMPONENT DESIGN GOALS AND WILL INVESTIGATE THE IMPACT OF SPACECRAFT INTEGRATION ON SCEW SYSTEM DESIGN. ANALYSES AND SIMULATIONS WILL BE CONDUCTED TO DETERMINE THE SYSTEM POWER GENERATE COMPONENT PERFORMANCE SPECIFICATIONS COMPATIBLE

WITH MISSION REQUIREMENTS. SYSTEM HARDWARE WHICH CANNOT BE DEVELOPED WITHIN STATE-OF-THE-ART TECHNOLOGY WILL BE IDENTIFIED, AND DESIGN AND BREADBOARD HARDWARE DEVELOPMENT EFFORTS WILL BE CARRIED OUT TO ASSURE THE SCEWS CONCEPT FEASIBILITY AND PRACTICABILITY. IF THE SCEWS CONCEPT PROVES VIABLE, LABORATORY PROTOTYPE SCEWS HARDWARE WILL BE BUILT AND EVALUATED USING EXISTING LRC STATIC AND DYNAMIC TEST SETUPS. ASSOCIATED DEVELOPMENT PROGRAMS WILL BE DIRECTLY COORDINATED WITH LERC, CSFC, AND MSC. PRIMARY PROBLEM AREAS INCLUDE THE IMPACT OF RELIABILITY, SAFETY, MAINTAINABILITY, FAILURE MODES, AND SYSTEM INTEGRATION ON SCEWS WEIGHTTRADE-OFFS; PERFORMANCE LIMITS OF COMPOSITE MATERIALS UNDER CYCLIC STRESSES AND EXTENDED-DURATION VACUUM; DEVELOPMENT OF BEARINGS AND SEALS CAPABLE OF LONG LIFE UNDER LARGE CYCLIC LOADS; DEVELOPMENT OF HIGH-POWER, EFFICIENT SPIN MOTORS AND GENERATORS; DEVELOPMENT OF HIGH-TORQUE, LOW-RATE GIMBAL ACTUATORS; AND DEVELOPMENT OF GIMBAL SENSORS WITH HIGH RESOLUTION AND ACCURACY. SOLUTIONS TO THESE PROBLEMS WILL BE VERIFIED THROUGH SIMULATION AND HARDWARE TESTS, WHICH WILL DETERMINE POWER GENERATION CAPABILITY, CONTROL EFFECTIVENESS, AND SPINUP-SPINDOWN CYCLING EFFECT ON SYSTEM PERFORMANCE. SUCCESSFUL COMPLETION OF THIS

RTOP NO. 908-51-04 TITLE: SPACE STATION ATTITUDE CONTROL PROPULSION SYSTEMS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALA.

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TECHNICAL SUMMARY

THIS PLAN IS TO ESTABLISH THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) DESIGN OPERATIONAL METHODOLOGY AND COMPONENT REQUIREMENTS TO SATISFY THE MANNED SPACE STATION REQUIREMENTS AND DEMONSTRATE THE NECESSARY COMPONENT, SYSTEM AND OPERATIONAL TECHNOLOGY. THIS EFFORT IS NECESSARY TO PROVIDE THE CAPABILITY TO MEET THE LONG DURATION AND LARGE IMPULSE NEEDS OF THE SPACE STATION WITH A MINIMUM OF CREW ACTIVITY FOR REFURBISHMENT AND RESUPPLY. THESE OBJECTIVES WILL BE ACCOMPLISHED BY A LOGICAL SEQUENCE OF REQUIREMENTS DEFINITION AND ANALYSIS, COMPONENT AND SYSTEM DESIGN AND TRADEOFF STUDIES, AND EXPERIMENTAL DEMONSTRATION OF BREADBOARD COMPONENTS AND SYSTEMS. THE ACPS REPAIR, RESUPPLY AND MAINTENANCE CONTRACTS BEGUN IN PREVIOUS FISCAL YEARS HAVE BEEN COMPLETED. THE "EVALUATION OF THE TRASH ROCKET CONCEPT" TASK WILL COMMENCE IN CY-71 AND CONTINUE FOR TEN MONTHS. IT IS A SOLE-SOURCE CONTRACT TO UNITED TECHNOLOGY CENTER, DIVISION OF UNITED AIRCRAFT CORP. WHICH WILL PROVIDE SOME FUNDAMENTAL DATA RELATIVE TO THE POTENTIAL OF THE HYBRID SYSTEM USING TRASH AS THE FUEL.

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