Aeronautics Research and Technology Program and Specific Objectives

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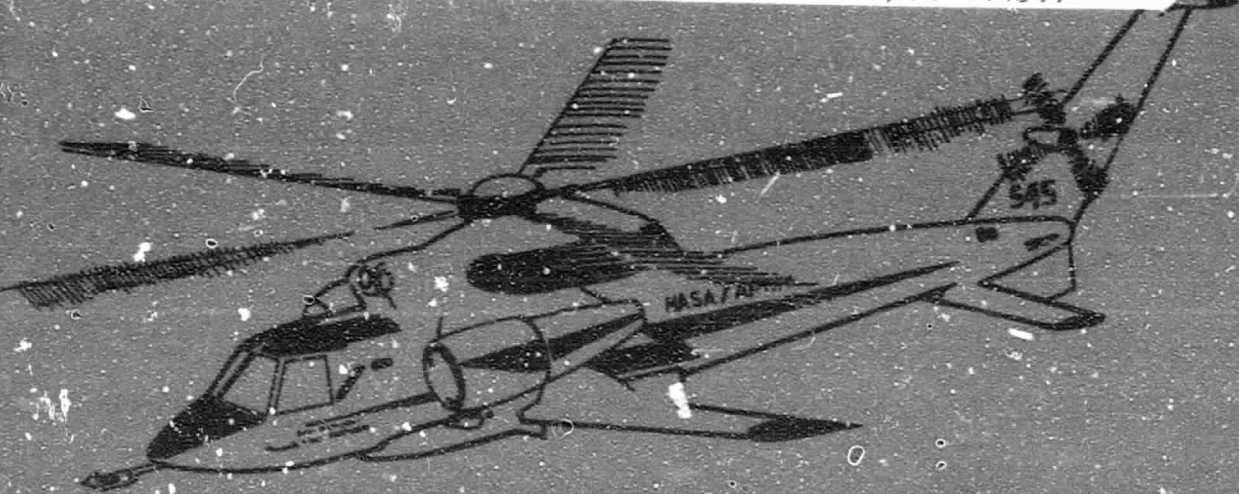

Office of Aeronautics and Space Technology

Fiscal Year 1982

NASA
National Aeronautics and Space Administration

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICS RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM AND SPECIFIC OBJECTIVES
DOCUMENT APPROVAL

Walter B. Olstad

Walter B. Olstad
Acting Associate Administrator for
Aeronautics and Space Technology

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Date

PREFACE

The Office of Aeronautics and Space Technology (OAST) is responsible for planning and managing NASA's Aeronautics and Space Research and Technology programs and Energy Technology program. Broad goals have been established for these programs to assure that they are aligned toward providing the technology required to meet national needs in aviation, space and energy.

The OAST Program and Specific Objectives documents set forth a much more detailed set of objectives (that derive from these broad program goals) which form the basis for planning specific research and technology activities. A separate Program and Specific Objectives document has been developed for each of these OAST programs, i.e., the Aeronautical Research and Technology program, the Space Research and Technology program, and the Energy Technology program.

The Program and Specific Objectives documents are intended to meet the following management goals:

- To effectively communicate and describe the OAST programs;
- To provide management with an integrated viewpoint of an inherently complex and multifaceted R&T program, thereby facilitating the decision process;
- To force a disciplined approach on near-term detailed planning;
- To provide a framework from which an orderly evolution of the program can be planned;
- To facilitate evaluation of the technical feasibility of programs, and to facilitate judgment of the adequacy of our planning;
- To make the program more result- and accomplishment-oriented;
- To improve program control by providing each level of management with a clear set of objectives and targets to be accomplished, as well as a set of standards against which progress can be measured;

- To make individual researchers/technologists aware of the significance of their output to broad objectives, goals and needs, and to stimulate their imaginations with challenging targets; and

- To provide a vehicle for implementing the program via solicitation of Research and Technology Objectives and Plans (RTOP) documents from the NASA Field Installations, while allowing the Field Installations maximum flexibility in developing innovative RTOP approaches toward meeting stated objectives and targets.

  (The RTOP is the vehicle by which an agreement or contract is reached between OAST and a Field Installation concerning the performance and funding of a specific research and technology activity.)

These documents are tools which should be utilized by everyone engaged in planning, managing and performing the OAST programs, to insure that they are fully aware of the purpose of their efforts. It is important, therefore, that these documents, or appropriate parts thereof, be distributed to all levels of the NASA organization involved in the OAST programs.

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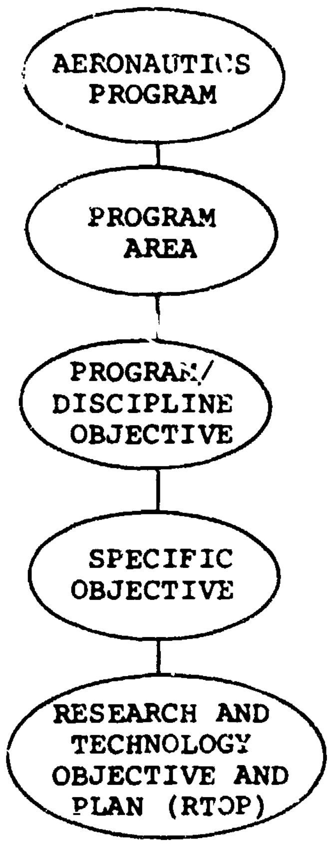
INTRODUCTION

INTRODUCTION

The Aeronautics Research and Technology program is broken down into two Program Areas:

- o Research and Technology Base
- o Systems Technology Programs

which are further broken down into succeedingly more detailed activities to form a Work Breakdown Structure for the Aeronautics program, as shown in the following chart.



This document provides a detailed view of this Work Breakdown Structure down to the Specific Objective level, and sets forth goals or objectives at each of these levels. It addresses what is to be accomplished and why, but does not address how. The latter falls within the domain of the RTOP, as well as other program documents.

AERONAUTICS RESEARCH AND TECHNOLOGY

PROGRAM GOAL

TITLE: Aeronautics Research and Technology

PROGRAM GOAL:

To advance aeronautics technology to make possible safer, more economical and environmentally acceptable air transportation systems which are responsive to current and future national needs; to maintain the strong competitive position of the United States in the international aviation marketplace; and to support the military in maintaining the superiority of the nation's military aircraft. The program is directed at advancing technology to (1) maintain a solid foundation of aeronautical technology in all the relevant disciplines to meet the future needs of civil aviation; (2) to reduce aircraft energy consumption; (3) to reduce the undesirable environmental effects of noise and pollution; (4) to improve aircraft terminal-area operations and safety; (5) to provide the technology for advanced long-haul and short-haul air transportation system concepts for the future; and (6) to support the military by providing an advanced technology base which may be uniquely applicable to military aircraft or applicable as well to civil aircraft, and by providing technical problem-solving support for current military aircraft development.

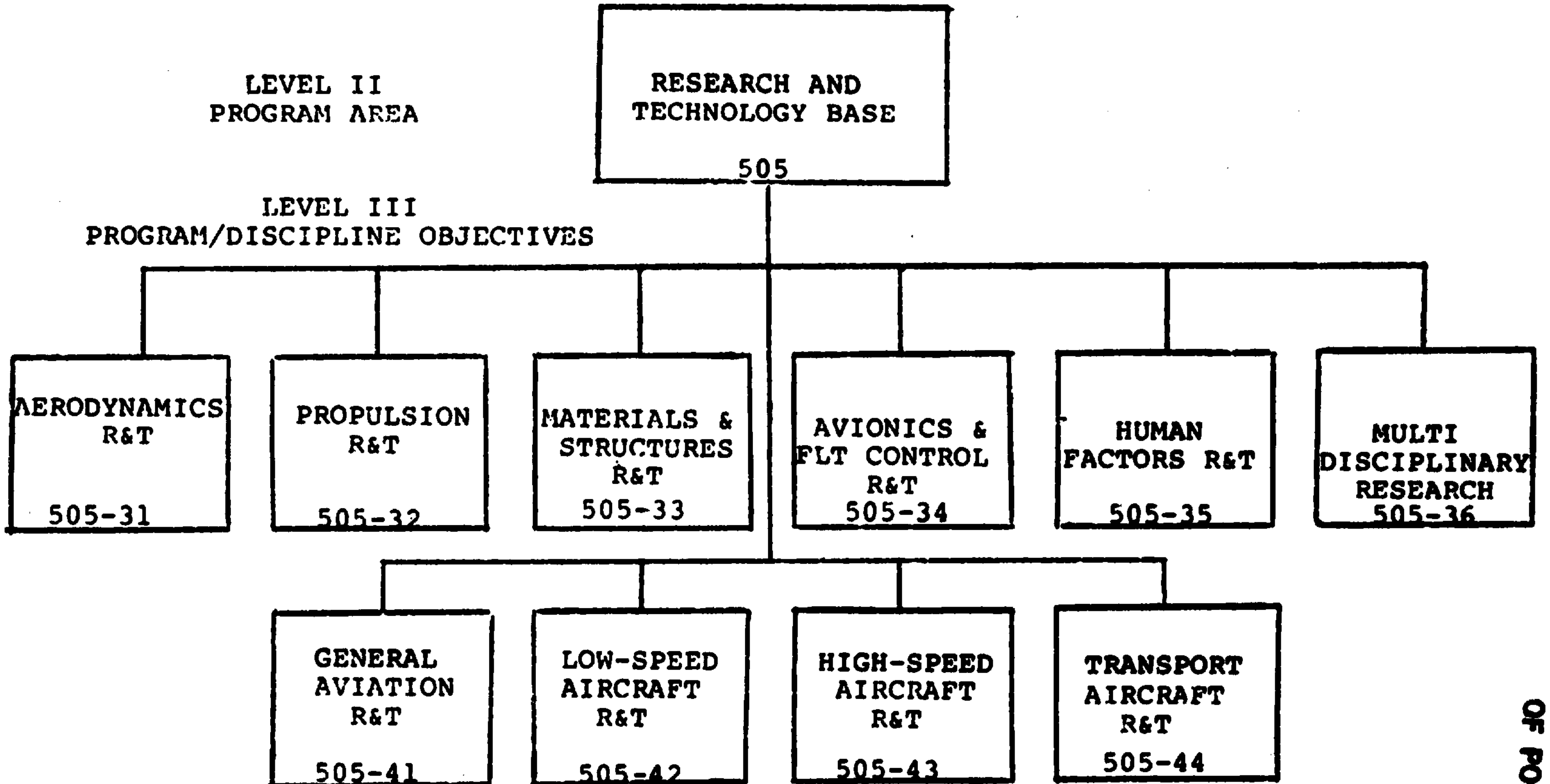
PROGRAM AREA GOALS:

- Research and Technology Base: To establish and maintain a solid foundation of aeronautical technology embracing all of the relevant disciplines, and to provide a wellspring of ideas for advanced aeronautical concepts.

- Systems Technology Programs: To provide technology demonstration/proof of concept for systems which have matured under the Research and Technology Base,

RESEARCH AND TECHNOLOGY BASE

AERONAUTICS R&T BASE WORK BREAKDOWN STRUCTURE
LEVELS II & III



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PROGRAM AREA GOAL

TITLE: Research and Technology Base

Program Goal Title: Aeronautics Research and Technology

PROGRAM AREA GOAL:

To establish and maintain a solid foundation of aeronautical technology embracing all of the relevant disciplines associated with aeronautics and to provide a wellspring of ideas for advanced concepts.

PROGRAM/DISCIPLINE OBJECTIVES:

- o Aerodynamics R&T: To advance the understanding and predictive capability of aerodynamic phenomena to permit aerodynamic optimization of advanced aircraft in early design stages.

- o Propulsion R&T: To provide through basic research, applied technology, and experimental engineering, the knowledge, understanding, and technology base necessary to achieve safer and more energy efficient, economical, reliable, and environmentally acceptable propulsion systems for future aircraft of all types ranging from small general aviation aircraft and helicopters to commercial transports to military aircraft.

- o Materials and Structures R&T: To provide a materials and structures technology that will permit the aerospace industry to develop new and improved, safe and reliable metals, polymers, and ceramics and the application of these materials to advanced structures that will result in significant improvements in the performance, safety, durability, and economy of commercial, military and general aviation aircraft.

- o Avionics and Flight Control R&T: To develop technology for the advanced aviation electronic systems necessary to reduce costs and increase safety, performance and efficiency in the military and civil aircraft fleets of the late 1980's and early 1990's.

- **Human Factors R&T:** To provide the research and technology base for solutions to the human problems impeding the growth or safety of air transportation.

- **Multidisciplinary Research:** To conduct basic research of a multidisciplinary nature related to the field of aeronautics technology.

- **General Aviation R&T:** To develop and demonstrate the feasibility of new technologies for improving general aviation aircraft and to promote early transfer of these technologies to industry. These objectives include improvements in safety, energy efficiency, utility and environmental impact based on advanced technology in aerodynamics and flight dynamics, propulsion, structures and materials, avionics and human factors.

- **Low-Speed Aircraft R&T:** To provide, through state-of-the-art advances, improvements in 1) the technology areas of rotorcraft structures, dynamics, aerodynamics, flight dynamics, controls, avionics, and man-system integration, 2) the understanding of hybrid rotor/airship feasibility, and 3) the technology areas of V/STOL aircraft propulsion, aerodynamics, and flight dynamics.

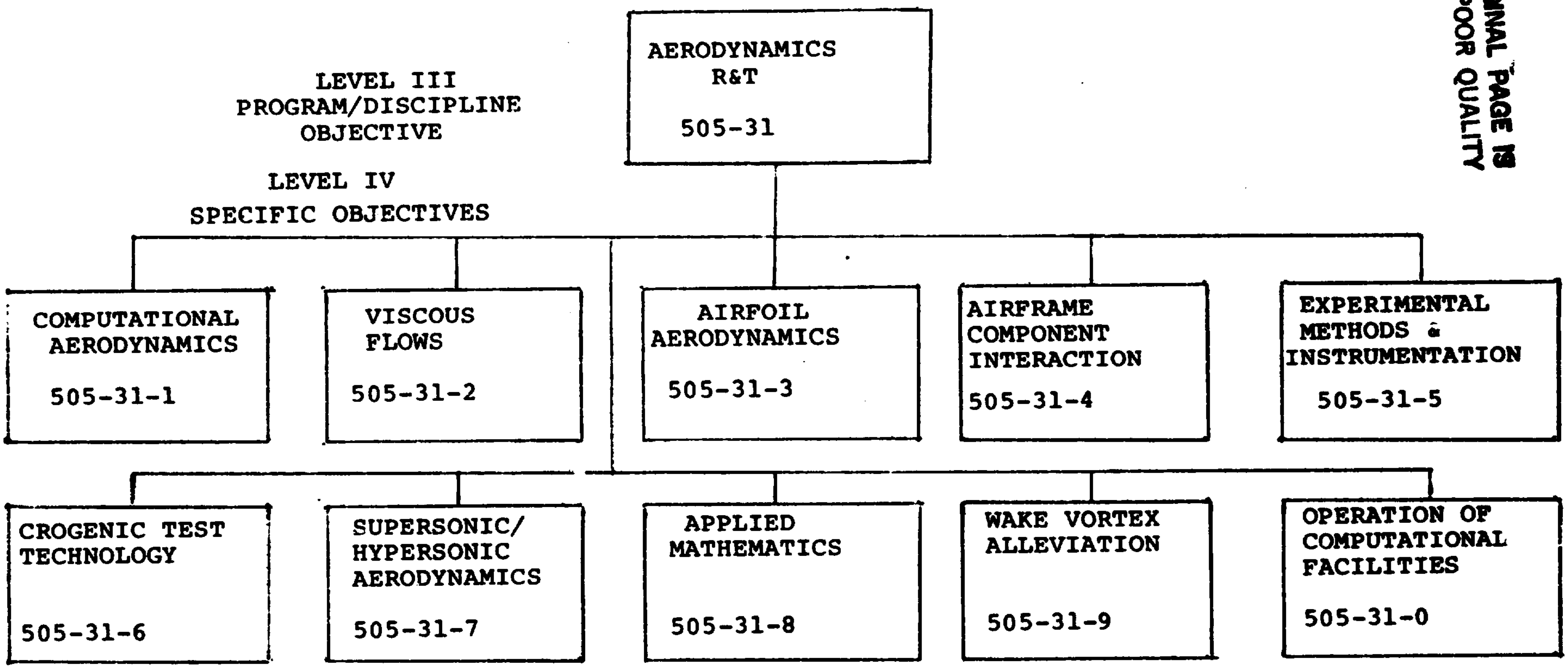
- **High-Speed Aircraft R&T:** To generate technology advancements needed to achieve improve high-speed aircraft, including economic, safe and reliable civil aircraft and technologically superior military vehicles and systems.

- **Transport Aircraft R&T:** To provide, through a continuing program of research and concept development, improved knowledge of aviation meteorology, a technology base for improved safety, and improved aircraft systems operating reliability and efficiency.

AERODYNAMICS R&T

AERODYNAMICS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Aerodynamics R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Research and Technology Division/Clinton Brown

PROGRAM/DISCIPLINE OBJECTIVE:

To advance the understanding and predictive capability of aerodynamic phenomena to permit aerodynamic optimization of advanced aircraft in early design stages.

SPECIFIC OBJECTIVE:

- o Computational Aerodynamics: To develop the computational analyses required to investigate and understand basic aerodynamic flow phenomena and to use these analyses to provide the capability for calculating the aerodynamic characteristics of individual aircraft components, given aircraft shapes, and for defining new shapes aerodynamically optimized by numerical methods for various classes of aircraft.

- o Viscous Flows: To extend the experimental data base for turbulent flows to acquire improved understanding of turbulent flow. Evaluate turbulence models, predict and control boundary-layer transition, reduce turbulent skin friction drag; predict and reduce airframe aerodynamic noise.

- o Airfoil Aerodynamics: To provide analytical and computational analyses coupled with experimental procedures and test facilities to advance the understanding of airfoils and airfoil systems in both steady and non-steady flows and to employ these tools in the development of advanced technology single- and multi-element airfoils for rotary and fixed wing aircraft.

- Airframe Component Interaction: To explore the aerodynamic phenomena associated with the interaction of airframe components at subsonic and supersonic speeds; and to expand the technology base that provides for the development of advanced wing/body/nacelle configurations.

- Experimental Methods and Instrumentation: To provide the technology for the increased aerodynamic experimental research capability required to improve prediction of performance and aircraft missile designs and to explore advanced aerodynamic concepts.

- Cryogenic Test Technology: To develop the test technology required to fully exploit the unique capabilities of the pressurized cryogenic wind tunnels such as the National Transonic Facility (NTF) in the performance of research and development studies related to advanced aerodynamic design concepts at full scale Reynolds numbers.

- Supersonic/Hypersonic Aerodynamics: To provide the experimental techniques, the analytical methods and the fundamental aerodynamic data base needed to permit the efficient aerodynamic design of future supersonic/hypersonic vehicles.

- Applied Mathematics: To provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments.

- Wake Vortex Alleviation: To reduce the hazard potential of wake vortices shed by transport aircraft through aerodynamic techniques without significant detrimental effects on aircraft performance.

- Operation of Computational Facilities: To provide the operational and maintenance resources necessary for the advanced computer facilities needed to support the computational needs of the research and technology programs in the areas of Aerodynamics, Aerothermodynamics, and Materials and Structures.

SPECIFIC OBJECTIVE

TITLE: Computational Aerodynamics

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Randolph Graves

SPECIFIC OBJECTIVE:

To develop the computational analyses required to investigate and understand basic aerodynamic flow phenomena and to use these analyses to provide the capability for calculating the aerodynamic characteristics of individual aircraft components, given aircraft shapes, and for defining new shapes aerodynamically optimized by numerical methods for various classes of aircraft.

- Develop methods for solving the fluid flow equations of aerodynamics with emphasis on improving computational efficiency through construction of new algorithms, improving computer languages, and improving geometric modeling and grid generation.

- Develop the computational procedures needed to investigate and analyze the full range of basic aerodynamic flow interactions common to all classes of aircraft.

- Determine the ranges of applicability and accuracy of the analyses and provide guidance for improving these analyses by conducting suitable experiments, performing companion calculations, and comparing results.

- Develop the computational analyses required to investigate turbulence, to model turbulent transport phenomena, and to simulate the development and propagation of turbulent flows.

- Demonstrate use of new technology by applying codes to selected problems of interest to private industry and the Department of Defense.

TARGETS:

- Make detailed comparisons with experiments to be performed over a wide range of Reynolds number and angle of attack to verify the predictive capability of two-dimensional viscous airfoil codes using improved turbulence models by the end of FY 82.

- Determine the utility and accuracy of the Navier-Stokes codes for predicting unsteady transonic flows such as buffet through comparison with experimental data from the new leg of the Ames High Reynolds number Channel and other available data by the end of FY 1982.

- Provide an experimental data base that will assess the ability of three-dimensional viscous codes to predict flows over wings, bodies and wing-body geometries by the end of FY 1982.

- Develop methods for automatically generating meshes about complicated 2- and 3-D aerodynamic wings and bodies and integrate their use into existing accurate, fast implicit codes in such a way to maintain the favorable convergence and resolution properties of these codes by end of FY 1982.

- Improve the efficiency of the algorithms used for the Reynolds-averaged codes by end of FY 1982.

- Develop codes using 3-D vortex and vortex-in-cell methods for wall-bounded shear flow and arbitrary-shaped separated flows by end of FY 1982.

- Develop advanced codes for analyzing the 3-D flow over wings including viscous effects in the boundary layer and wake by end of FY 1982.

- Develop 2-D solution adaptive grid methodology for time-dependent viscous flow solutions by the end of FY 1982.

JUSTIFICATION:

The amount of wind-tunnel test time required to develop new, complex aircraft designs has increased nearly exponentially when measured in terms of test hours. Costs of conducting these experimental flow simulations have increased correspondingly. On the other hand, the cost of simulating a given flow mathematically on the computer has been decreasing nearly exponentially, since computer technology growth has increased computer speed more rapidly than computer cost. Therefore, high-capacity computers can complement wind tunnels and more efficiently simulate certain types of flows, thereby providing the designer with a tool for rapidly optimizing designs and preventing costly design changes. Moreover, high-speed computation should allow detailed investigation of basic fluid dynamic phenomena as well as simulation of flows that are highly impractical or impossible to duplicate in ground facilities.

SPECIFIC OBJECTIVE

TITLE: Viscous Flows

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Gary Hicks

SPECIFIC OBJECTIVE:

To extend the experimental data base for turbulent flows to acquire improved understanding of turbulent flow. Evaluate turbulence models, predict and control boundary-layer transition, reduce turbulent skin friction drag; predict and reduce airframe aerodynamic noise.

- o Improve understanding of shock/boundary layer interaction and separated turbulent flows.
- o Investigate schemes for turbulent skin friction drag reduction to include surface geometry modifications and vortex absorbing walls.
- o Develop technology for quiet supersonic/hypersonic wind tunnel to improve confidence in boundary layer transition data.
- o Investigate fundamentals of boundary layer transition and influence of stream and wall disturbances across entire speed range, including development and validation of applicable stability theories.
- o Develop techniques for achieving and maintaining extensive laminar flow regions naturally and with partial boundary-layer control systems at both subsonic and supersonic speeds.
- o Obtain detailed accurate experimental data to improve the understanding of the physics of turbulent shear flows, to help derive semi-empirical turbulence models, and to generate efficient turbulence prediction methods.
- o Conduct fundamental research in the generation of noise by turbulent aerodynamic flows impinging on aircraft surfaces and identify and evaluate candidate devices and techniques for noise reduction.

TARGETS :

- Perform large scale tests of turbulent drag reduction concepts to include riblets, large-eddy break-up devices, and rigid wavy walls by end of FY 1982.

- Gather data to validate turbulence model for general purpose three-dimensional boundary layer code by end of FY 1982.

- Select promising turbulence models and optimize coefficients for separated flow on transonic airfoils by FY 1982.

- Obtain first fluctuation amplification measurements, including receptivity studies, in a three dimensional boundary layer (rotating disk) by end of FY 1983.

- Complete research for detailed design of supersonic quiet tunnel utilizing recent discovery of quiet test core due to rapid expansion nozzle by end of FY 1983.

- Verify turbulence model for separated flow on transonic airfoils by FY 1983.

- Determine whether small longitudinal surface grooves and large porosity turbulence fences can be optimized to produce a net drag reduction of 15 percent by FY 1983.

- Obtain data of sufficient detail for 3-D separated flows on single configurations to guide the development of numerical models by end of FY 1984.

- Develop methodology and study basic physics, generation, and growth of disturbances including detailed measurement of spatial growth for theory validation by end of FY 1984.

- Complete several detailed experimental studies of three-dimensional free-mixing layers using a combined LV-RAMAN measurement system by end of FY 1985.

- Optimize stationary oscillatory surface curvature to provide cyclical relaminarization and lower drag by end of FY 1986.

JUSTIFICATION:

The understanding of turbulence is the pacing item in aerodynamic analysis and is generally recognized as the primary unsolved problem in that field. Because of its importance in prediction methodology, a large data base is required to provide information to develop simple engineering models of turbulent flows. In addition, some very precise basic physics-type measurements of turbulent flows are needed that can lead to a significant breakthrough in our understanding. This understanding can lead to improved methods of reducing turbulent drag and/or to more accurate predictions of the performance of advanced aircraft. Turbulent skin friction drag is the largest single source of drag on long-range aircraft. Controlling the boundary-layer transition and reducing the turbulent skin friction drag will reduce fuel consumption for all classes of aircraft.

SPECIFIC OBJECTIVE

TITLE: Airfoil Aerodynamics

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Randolph A. Graves

SPECIFIC OBJECTIVE:

To provide analytical and computational analyses coupled with experimental procedures and test facilities to advance the understanding of airfoils and airfoil systems in both steady and non-steady flows and to employ these tools in the development of advanced technology single- and multi-element airfoils for rotary and fixed wing aircraft.

- o Generate precise theoretical analyses to provide understanding of the factors presently limiting design accuracy such as surface effects, flow transition, turbulent separation, and wake effects.
- o Develop new and improve existing airfoil research facilities to remove restriction of walls and support interferences, Reynolds number, and free stream turbulence.
- o Generate and document the aerodynamic behavior of new families of airfoils, aerodynamic controls, and high lift systems by use of both theory and experiment.

TARGETS:

- o Provide operational airfoil code for transonic flow with massive trailing-edge separation by the end of FY 1982.
- o Provide operational airfoil code for subsonic flow with leading-edge separation bubble in FY 1982.
- o Develop a 3-D adaptive wall capability for ventilated test section transonic wind tunnels by the end of FY 1982.

- o Complete tests of supercritical propeller airfoils by the end of FY 1982.
- o Apply airfoil analytical methods at low Reynolds numbers and correlate with experiment during FY 1982.
- o Complete testing of transonic airfoil with oscillating control surface during FY 1982.
- o Perform wind tunnel and flight tests of natural laminar flow airfoils including aerodynamic controls and high lift systems during FY 1983.
- o Develop and test high lift airfoil systems at full scale Reynolds numbers for commercial and military aircraft by the end of FY 1983.
- o Complete installation of advanced sidewall boundary layer control system in 6x28 inch transonic tunnel in FY 1983.

JUSTIFICATION:

Achievement of improved safety, efficiency, and performance of all types of fixed- and rotary-wing aircraft by U.S. manufacturers in the highly competitive international market requires both timely and adequate application of modern computational methods and well equipped experimental facilities to be coupled in order to rapidly expand and extend airfoil technology and make the results available for use.

SPECIFIC OBJECTIVE

TITLE: Airframe Component Interaction

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Gary Hicks

SPECIFIC OBJECTIVE:

To explore the aerodynamic phenomena associated with the interaction of airframe components at subsonic and supersonic speeds; and to expand the technology base that provides for the development of advanced wing/body/nacelle configurations.

- o Develop theoretical methods of predicting the complete surface aerodynamic-load distribution for high-speed aircraft and missile configurations.
- o Generate basic experimental data and theoretical analyses for innovative configurations, controls, and high-lift systems.
- o Explore fundamental approaches for achieving improved lift/drag performance for the low-speed (terminal area) and cruise regimes for advanced subsonic and supersonic cruise vehicles.
- o Investigate wing, control surface, propulsion components, and fuselage combinations to attain improved lift/drag and stability characteristics for advanced configurations.

TARGETS:

- o Include in PANAIR the effects of propulsion system momentum changes and the capability of streamline tracing, and determine the feasibility of incorporating improved nonviscous drag calculations and discrete vortices into the code by FY 1982.
- o Include separation-induced vortex flow modeling in transonic analysis theory - FY 1982.

- o Complete initial theoretical and experimental study of application of transonic design-by-analysis method to design of forward swept wing configuration - FY 1982.

- o Initiate theoretical and experimental study of leading-edge vortex breakdown leading to prediction and control capability - FY 1982.

- o Develop technology required for multiple primary vortex and arbitrary planform capability in free vortex theory - FY 1982.

- o Complete assessment of propulsion simulation techniques for transport airplanes - FY 1983.

- o Develop advanced panel method to generate a velocity gradient derivative matrix approach for design of high lift wing fuselage configurations- FY 1983.

- o Demonstrate application of free vortex sheet theory to design optimization of slender transonic maneuvering aircraft configurations - FY 1983.

- o Complete investigation of effects of streamline contouring of nacelles and pylons to reduce installation drag - FY 1983.

- o Complete technology required to extend vortex flow theories to include viscous effects on pressure distributions and on primary and secondary separations - FY 1983.

- o Incorporate nonlinear effects and leading-edge thrust into an experimentally verified supersonic wing design procedure - FY 1984.

- o Develop analytical methods for predicting effects of installing propulsion systems on transport airplanes - FY 1984.

- o Developing 3-D high lift analysis codes using finite difference solutions to Navier Stokes equations - FY 1986.

JUSTIFICATION:

The power required by an aircraft, and consequently the fuel consumption, is related directly to the aerodynamic drag. A sizable portion of the drag of an aircraft may be attributed to the interference between propulsion and airframe components. Reductions in component interaction drag can be realized through the experimental and analytical development of configuration design and analysis methods.

SPECIFIC OBJECTIVE

TITLE: Experimental Methods and Instrumentation

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Gary Hicks

SPECIFIC OBJECTIVE:

To provide the technology for the increased aerodynamic experimental research capability required to improve prediction of performance and aircraft missile designs and to explore advanced aerodynamic concepts.

- o Provide techniques for minimizing or eliminating wind-tunnel testing errors due to wall interference.
- o Develop the fundamental understanding permitting the design and costing of an advanced magnetic suspension balance system to eliminate support interference for both static and dynamic wind tunnel testing.
- o Advance the science of non-intrusive instrumentation for high speed flow diagnosis with emphasis on laser optical techniques.
- o Improve flight test research capability by developing advanced instrumentation and flight test techniques.
- o Extend development of transonic cryogenic wind-tunnel technology and other advanced test techniques and explore new applications of the cryogenic concept to increase productivity to wind tunnel research.

TARGETS:

- o Provide technology for detailed design of large superconducting magnetic suspension systems by end of FY 1982.
- o Develop technology for combining cryogenic wind tunnel concept with adaptive wall test sections and magnetic suspension systems by FY 1982.
- o Complete calibration of computer driven flexible wall airfoil test section for the 0.3 meter cryogenic tunnel by FY 1982.

- o Provide long range 3-D Laser Velocimeter for Ames 7x10-ft. wind tunnel by FY 1982.
- o Improve semi-span test techniques for wind-tunnel testing by FY 1982.
- o Complete flight test of Miniature Multichannel Pressure Sensor System by FY 1983.
- o Complete flight test of Integrated Sensor System by end of FY 1983.
- o Complete laboratory tests of High Accuracy Fuel Mass Flow Meter by FY 1984.

JUSTIFICATION:

NASA's strong position in advanced aerodynamic technology stems to a great extent from its development and application of advanced experimental facilities and techniques, closely coupled with advanced aerodynamic theories. New technology has resulted in the urgent need for improved experimental transonic facilities, ground and flight test techniques and instrumentation in order to assure adequate simulation of the critical shock/boundary-interactions involved and to avoid tunnel-wall and model-support interference which become critical in the high subsonic and transonic regimes. Recent developments in the areas of instrumentation, cryogenic tunnels for high Reynolds number testing, advanced tunnel-wall concepts and correction techniques, and the unique magnetic support and balance concept offer NASA an outstanding opportunity to maintain its strong position and provide the advanced transonic test techniques and instrumentation needed for precise aerodynamic testing.

SPECIFIC OBJECTIVE

TITLE: Cryogenic Test Technology

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Gary Hicks

SPECIFIC OBJECTIVE:

To develop the test technology required to fully exploit the unique capabilities of the pressurized cryogenic wind tunnels such as the National Transonic Facility (NTF) in the performance of research and development studies related to advanced aerodynamic design concepts at full scale Reynolds numbers.

- o Extend development of cryogenic technology and full-scale Reynolds number test techniques to insure maximum utilization of the unique research and development capabilities of the new Langley National Transonic Facility.
- o Develop design criteria for models to be tested under high pressure and cryogenic conditions.
- o Develop new or improved techniques for reliably extrapolating wind-tunnel test results to flight Reynolds number conditions.
- o Provide model support equipment and advanced instrumentation for testing in cryogenic wind tunnels.

TARGETS:

- o Design and construct pre-test calibration equipment for models under cryogenic conditions by FY 1982.
- o Install model attitude system in NTF by FY 1982.
- o Evaluate Moire and Fringe Projection Technique by FY 1982.
- o Complete fabrication of cryogenic semi-span force balance by FY 1982.

- Install Electronic-Sensed Pressure System in NTF by FY 1982.

- Design and procure high angle of attack sting system by FY 1982.

- Complete evaluation of the effect of non-adiabatic wall conditions on boundary layer transition by FY 1982.

- Procure propulsion simulation system by FY 1983.

- Complete tests on pathfinder models No. 1 and No. 2 by FY 1983.

JUSTIFICATION:

NASA's strong position in advanced aerodynamic technology stems to a great extent from its development and application of advanced experimental facilities and techniques, closely coupled with advanced aerodynamic theories. Advances in aerodynamic concepts are being developed which provide high aerodynamic efficiency at high subsonic and transonic speeds by optimizing the progression of supercritical flow over aerodynamic components. This new technology has resulted in the urgent need for full-scale Reynolds number test capability. The construction of the National Transonic Facility will provide NASA an outstanding opportunity to maintain its strong position and provide the advanced methods needed for aerodynamic technology development. This work supports the initial break-in and familiarization period of the NTF and will provide the first data on Reynolds number effects covering the full range for modern aircraft.

SPECIFIC OBJECTIVE

TITLE: Supersonic/Hypersonic Aerodynamics

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Orgnization/Individual: Research and Technology Division/Clinton E. Brown

SPECIFIC OBJECTIVE:

To provide the experimental techniques, the analytical methods, and the fundamental aerodynamic data base needed to permit the efficient aerodynamic design of future supersonic/hypersonic vehicles.

- o Conduct research for the improvement of supersonic and hypersonic flight efficiency through more complete understanding of high speed flow behavior over wings and bodies.
- o Carry out fundamental experimental investigations of wings, bodies, and controls at supersonic/hypersonic speeds.
- o Development of the capability of calculating complete aerodynamic characteristics of complex vehicle shapes.
- o Development of computer aided research techniques including automated aerodynamic optimization procedures.

TARGETS:

- Test in FY 1982 a new technique for obtaining force data on complete configurations using substitute gases to simulate the exhaust.
- Develop by FY 1983 improved analysis techniques for determining the aerodynamic characteristics of complete vehicle concepts.
- By 1983 develop three-dimensional flow field analysis techniques for wing-body configurations as well as for inlet and nozzle exhaust flow fields.

JUSTIFICATION:

The aerodynamic technology developed by this program will provide the United States with new advanced aircraft options which may prove vital to both civil and military future needs. Supersonic/Hypersonic aircraft with long-range capability and low sonic boom levels have the potential of providing a major step in transportation in the latter part of the century, a strike or reconnaisance mission for the military, and a low-cost space logistics system. For routes in excess of 4000 miles, the productivity ratio of the hypersonic transport would increase to even higher values than future supersonic transports. The potential growth in productivity of both the supersonic and hypersonic transports makes their continued study important for future growth of the air transport industry. Military options for flight in the speed range greater than one should be maintained by a continued fundamental study of the aerodynamic phenomena in this speed range.

SPECIFIC OBJECTIVE

TITLE: Applied Mathematics

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Randolph Graves

SPECIFIC OBJECTIVE:

To provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments.

- Extend utility of mathematical and numerical analysis.
- Apply advanced computational techniques to the areas of fluid dynamics, acoustics, and structural analysis.
- Advance the state of the art in applied computer science.

TARGETS:

- Investigate methods for transforming irregular computational domains into rectangular domains with uniform computational grids during FY 1982.
- Develop techniques for display of computed results using raster graphic devices during FY 1982.
- Improve treatment of boundary conditions in splitting method for 3-D Navier-Stokes equations by end of FY 1982.
- Application of mixed finite element techniques to flutter analysis in transonic flow during FY 1982.
- Improve spectral methods for the solution of Navier-Stokes 3-D flow by the end of FY 1983.
- Develop mathematical model of acoustic propagation in the presence of turbulence by FY 1983.
- Apply conjugate gradient type methods to structural analysis and fluid dynamics in FY 1983.
- Demonstrate accurate treatment of 2-D incompressible flows with large Reynolds number by the end of FY 1982.

JUSTIFICATION:

Advances in applied mathematics and computer science are essential elements in the development of aerospace science and engineering. They are the tools engineers use in design, simulation, prediction, and analysis. In fact, much research in applied mathematics and computer science is carried forward in meeting the objectives of practically all disciplines found in the programs of the Office of Aeronautics and Space Technology. The broad applicability of this field and the benefits expected from giving it specific emphasis, however, justify a specific objective in applied mathematics and computer science. Recent experience has shown this to be true in progress made in solutions of partial differential equations, in development of new algorithms, and in evolution of new, efficient means for application of computers.

SPECIFIC OBJECTIVE

TITLE: Wake Vortex Alleviation

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual: Research and Technology Division/Clinton E. Brown

SPECIFIC OBJECTIVE:

To reduce the hazard potential of wake vortices shed by transport aircraft through aerodynamic techniques without significant detrimental effects on aircraft performance.

- o Develop experimental and numerical analysis techniques to improve the understanding of fundamental flow mechanisms associated with multiple wake vortex generation, their interaction and decay.
- o Refine upset criteria for safe operation of fixed- and rotary-wing aircraft.

TARGETS:

- o Experimentally determine near field characteristics of unalleviated and alleviated wake vortices by end of FY 1982.
- o Establish critical atmospheric characteristics related to wake vortices by end of FY 1982.
- o Establish upset criteria for satisfactory vortex alleviation by end of FY 1982.
- o Complete development of code to calculate near field wake for unseparated wing by mid FY 1983.
- o Extend near field wake code to account for engine wake effects by end of FY 1984.
- o Complete development and validation of far-field codes by end of FY 1984
- o Complete development of wake alleviation design criteria by end of FY 1984.
- o Perform detailed flow field measurements near high lift wings to define initial wake vortex shedding and beginning of vortex wake roll-up - FY 1984.
- o Demonstrate reduced separation for landing in FY 1985.

JUSTIFICATION:

The persistent nature of trailing vortices generated by jet transports creates a documented safety hazard for following aircraft and severely curtails optimum use of the nation's airports. The present solution to the problem adopted by the Federal Aviation Administration (FAA)--increase separation distances from 3 to 6 miles for certain combinations of generator and following aircraft--is not satisfactory because of the greatly reduced runway utilization rate. A joint NASA/FAA program, is geared to reduce safe separation distances to 1 or 2 miles through development and implementation of advanced electronic equipment for increased accuracy in air traffic control. However, unless the wake vortex hazard is minimized, it will continue to set the minimum separation distances. Thus, the FAA, National Transportation Safety Board (NTSB), Aircraft Owners and Pilots Association (AOPA), and the Air Transport Association (ATA) have identified the hazard potential of wake vortices to be one of the primary airspace/airport operating problems.

SPECIFIC OBJECTIVE

TITLE: Operation of Computational Facilities

Program/Discipline Objective Title: Aerodynamics R&T

Responsible Organization/Individual:
Research and Technology Division/Randolph Graves

SPECIFIC OBJECTIVE:

To provide the operational and maintenance resources necessary for the advanced computer facilities needed to support the computational needs of the research and technology programs in the areas of Aerodynamics, Aerothermodynamics, and Materials and Structures.

- o Support the computational needs of basic fluid dynamic research in such areas as turbulence modeling, chemical and solid state physics, algorithm development, 3-D viscous flows, etc.
- o Support applied computational aerodynamics and provide graphical output necessary for rapid analysis of geometric modeling.
- o Support computational structural analysis for the development of improved structural design techniques.
- o Support the development of advanced aerothermodynamic codes necessary to planetary exploration programs.
- o Support the development of helicopter and aircraft configuration refinement and optimization codes.

TARGETS:

- o This specific objective supports targets listed in the Aerodynamics, Aerothermodynamics, and Materials and Structures Programs.

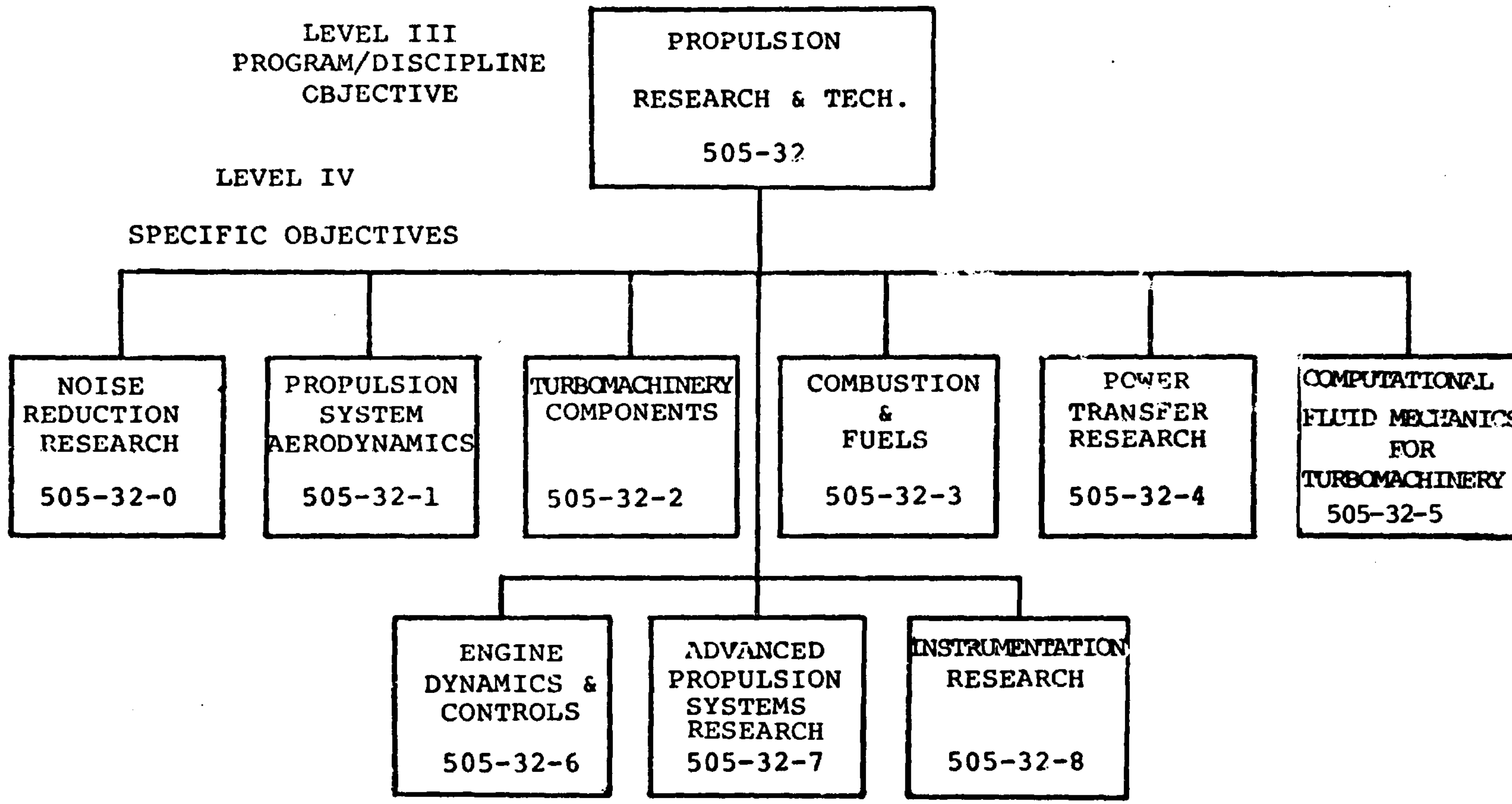
JUSTIFICATION:

The computational facilities support a wide range of research and development activities of the Aeronautics and Astronautics Directorates, Ames Research Center, other government agencies, universities, and aerospace industries. The unique capabilities of the advanced computational facilities provide the large scale computer resources needed to further the state-of-the-art in computational analysis and routinely run large applied codes necessary in design and analysis of aeronautical and missile systems.

5

PROPULSION R&T

PROPULSION R&T WORK BREAKDOWN STRUCTURE
LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Propulsion Research and Technology

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Research and Technology Division/Cecil C. Rosen

PROGRAM/DISCIPLINE OBJECTIVE:

To provide through basic research, applied technology, and experimental evaluation, the knowledge, understanding, and technology base necessary to achieve safer and more energy efficient, economical, reliable, and environmentally acceptable propulsion systems for future aircraft of all types ranging from small general aviation aircraft and helicopters to commercial transports and military aircraft.

SPECIFIC OBJECTIVES:

- Noise Reduction Research: To develop technology and design methodologies to reduce aircraft noise in consonance with weight, performance and economic requirements.

- Propulsion System Aerodynamics: To develop the technology, analytical codes, and design methodology, and extend the experimental data base in inlets, nozzles, and propellers to improve stability and performance and reduce integration losses associated with advanced propulsion systems and their integration with the airframe.

- Turbomachinery Components: To improve efficiency, operating range, distortion tolerance, durability, and reliability, and to reduce the weight, volume, and cost of fans, compressors, and turbines required for advanced propulsion systems.

- Combustion and Fuels: To provide technology for advanced combustion and aircraft fuel systems for future civil and military applications aimed at improving performance, durability, and reliability while achieving fuel flexibility and reduced emissions.

- Power Transfer Research: To advance the fundamentals of friction and wear and the technology of bearings, seals, gears, shafts, lubricants, and lubrication systems to achieve improved life, reliability, efficiency, and performance in the high-temperature, high-pressure, and high-speed environment of advanced gas turbine engines and mechanical power transmission systems.

- Computational Fluid Mechanics for Turbomachinery: To develop improved analytical and computational methods which represent steady and unsteady flow conditions in advanced fans, compressors, turbines, and propellers where mixed subsonic, transonic, and supersonic flows are present, and to develop the methodology for the use of these methods in the design and development of future propulsion systems.

- Engine Dynamics and Controls: To improve the understanding of propulsion system dynamic behavior and to provide an improved technology base for future engine system development in the area of control hardware, software, and modeling technology for safe, reliable operations and the dynamic response characteristics of engine components and systems for development of analytical prediction techniques.

- Advanced Propulsion Systems Research: To investigate the feasibility and potential benefits of new or unusual engine technologies and/or concepts for future military and commercial aircraft, and to establish the technology for advanced air-breathing propulsion systems which permit sustained high-speed flight of potential civil and military hypersonic vehicles.

- Instrumentation Research: To develop and demonstrate technology providing instrumentation and measurement techniques for present and future needs of fundamental, applied component, engine, and flight research programs.

SPECIFIC OBJECTIVE

TITLE: Noise Reduction Research

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John R. Facey

SPECIFIC OBJECTIVE:

To develop technology and design methodologies to reduce aircraft noise in consonance with weight, performance, and economic requirements.

- o Fundamental Aeroacoustics - develop theories and data base to describe mechanisms by which propulsion components and flows generate acoustic energy and to understand the propagation of the acoustic energy through and radiation from propulsion systems, as well as develop means to inhibit the noise generation and radiation.
- o Component Research - test and evaluation of subscale models and components to determine configurations for reduced generation and improved absorption of acoustic energy.
- o Modeling - develop the capability to describe and quantify the acoustic energy generated by propulsion components and flows. Also, incorporate component models into overall propulsion system noise prediction capability.

TARGETS:

- o Complete model of far-field noise generation by shock waves in jet flows - FY 1982.
- o Evaluation of high-speed turboprop noise prediction capability using JetStar flight data - FY 1982.
- o Complete model for combustor far-field noise generation, and identify critical variables for control - FY 1983.

- Complete improved model of high-speed turboprop near-field noise accurate to ± 2dB - FY 1983.
- Complete acoustic and performance evaluation to verify thermal acoustic shield model to allow optimized designs for maximum jet noise reduction - FY 1983.
- Complete fundamental theory for acoustic propagation in acoustically treated ducts to allow 50 percent treatment weight reduction, and complete simplified aft-duct suppressor design method - FY 1984.
- Complete prediction methods for advanced propulsion systems to guide future research and to provide for future design tradeoffs - FY 1984.
- Complete acoustic and performance evaluation to verify outer stream suppressor model - FY 1984.
- Complete evaluation of feasibility of combustor noise control at the source - FY 1985.
- Complete and validate model for rotor source noise that will provide a design-to-noise capability - FY 1985.
- Verify shock control methods to suppress up to 2dB of supersonic jet noise - FY 1986.
- Validate far-field radiation model for fan duct inlets and exhausts, and identify critical variables for noise control by redirection - FY 1986.

JUSTIFICATION:

The noise of aircraft operations has an adverse effect on the general population that impedes the free growth of the air transportation industry. Airport operations face constraints exacerbated by increasing population density, and aircraft manufacturers are under competitive pressure worldwide for quieter products. The NASA noise reduction research program is the sole government-funded source of technology to reduce aircraft noise at the source. The program is intended to provide source-noise reduction technology that is compatible with other requirements of weight, performance, and economy.

SPECIFIC OBJECTIVE

TITLE: Propulsion System Aerodynamics

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John R. Facey

SPECIFIC OBJECTIVE:

To develop the technology, analytical codes, and design methodology, and extend the experimental data base in inlets, nozzles, and propellers to improve stability and performance and reduce integration losses associated with advanced propulsion systems and their integration with the airframe.

- Internal Flow - develop and verify a family of 2D and 3D viscous codes for internal flow in engine nozzles, ducts, and inlets.
- Propulsion System/Airframe Integration - develop and verify generic 2D and 3D viscous codes that will allow the analysis and optimization of propulsion system and airframe integration for both turboprop and turbofan engines.
- Propeller Technology - develop and demonstrate technology for advanced high-speed aerodynamic performance for various advanced propeller concepts that offer improved performance and lower noise.

TARGETS:

- Complete code development for external flow of isolated fighter aircraft nozzles - FY 1982.
- Extend the experimental data base for inlets to verify analysis and codes

  Supersonic inlet cones - FY 1982
  Shock/boundary-layer interaction - FY 1983
  Axisymmetric inlet at angle of attack - FY 1985.

- Obtain verification data to define the aerodynamic performance of advanced high-speed propellers - FY 1983.

- Develop and verify generic 3D viscous analyses for nacelle/pylon/wing interactions for subsonic transports - FY 1983.
- Complete exhaust flow mixer analysis - FY 1984.
- Develop generic 3D viscous analysis for nacelle/fuselage interactions for subsonic transport - FY 1984.
- Complete analytical evaluations of inlet and nozzle performance for turboramjet engines for very high speed aircraft - FY 1984.
- Obtain aerodynamic performance and wake data for a counter-rotating propeller - FY 1985.
- Verify codes for internal flow of an axisymmetric inlet at zero angle of attack - FY 1986.
- Develop propeller/wing interaction code - FY 1986.

JUSTIFICATION:

Until recently, supersonic inlets were designed using inviscid analysis, requiring expensive, time-consuming testing to develop the boundary-layer control system. Advanced 3D codes developed through this program will provide the ability to design inlets and nozzles with three-dimensional shapes which were not previously amenable to analysis. Advances in computational methods will also lead to improvements in installed performance through optimized, minimum-drag integration of the propulsion system and the airframe.

Advanced turboprops offer fuel savings of 15 percent to 20 percent relative to high-bypass turbofan engines incorporating equivalent core engine technology. Improved analyses of flow through high-speed propellers are needed to optimize propeller designs and to effectively integrate the propeller/nacelle system with the airframe.

SPECIFIC OBJECTIVE

TITLE: Turbomachinery Components

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To improve efficiency, operating range, distortion tolerance, durability, and reliability, and to reduce the weight, volume, and cost of fans, compressors, and turbines required for advanced propulsion systems.

- Fans and Compressors - improve the performance and efficiency of small axial and centrifugal compressors, conduct benchmark verification experiments to validate computational codes, and investigate unsteady aerodynamic characteristics of flutter, forced vibration, and stagnation stall in advanced single and multistage component designs.

- Turbines - extend the life of high-temperature, high-pressure core turbines and improve overall performance and efficiency of small axial/radial turbines through increased emphasis on fundamental flow and heat transfer analysis and benchmark verification experiments.

TARGETS:

- Complete detailed velocity distribution measurements within the blading of an advanced fan stage using a laser anemometer to provide verification of 3D compressible flow codes - FY 1982.

- Determine effects of casing treatment on compressor stall recovery - FY 1984.

- Develop and verify the technology for high effectiveness cooling of advanced high temperature turbines - FY 1984.

- o Determine the performance characteristics and loss mechanisms for small compressor and turbine variable area concepts such as flex wall diffusers and translating endwalls - FY 1985.
- o Determine the stalling characteristics and recovery of a high-speed, highly loaded core compressor inlet stage group - FY 1984.
- o Develop and verify design methodology to minimize the adverse effects of scaling large compressors and turbines to a small size - FY 1986.
- o Develop the analytical capability to predict boundary-layer behavior and associated heat transfer of turbine blades, vanes, and endwalls with high heat fluxes, complex coolant flows, and unsteady flow fields produced by upstream wakes - FY 1987.
- o Develop and verify models for generation and transport of nonaxisymmetric flows in high-speed core compressors - FY 1987.

JUSTIFICATION:

Fundamental disciplinary research on fans, compressors, and turbines enhances basic understanding in critical areas that continue to have a strong influence on overall progress in aeronautical propulsion. This ongoing research provides technical advances to support efforts within NASA to improve and advance propulsion systems that permit aircraft to operate more efficiently over a wider range of flight speeds and altitudes.

Advanced military aircraft engines require lightweight fans, compressors, and turbines which are efficient over a broad range of operating conditions. The fans and compressors must have adequate stall margin to permit stable operation with severely distorted inlet flows. Commercial applications such as energy efficient transport aircraft have similar requirements for advanced turbomachinery and efficient high-speed propellers, and in addition require low noise, low fuel consumption, and good durability and maintainability. Advanced V/STOL, rotorcraft and general aviation propulsion systems also need efficient, lightweight, durable and reliable components. Continued R&D is required to improve cycle efficiency through increased pressure ratio and component efficiencies.

The component sizes being investigated span the range covering small civil helicopters at the low end and large jumbo-jet transports at the upper end of the size range. Both civil and military missions are included.

SPECIFIC OBJECTIVE

TITLE: Combustion and Fuels

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/Stephen M. Wander

SPECIFIC OBJECTIVE:

To provide technology for advanced combustion and aircraft fuel systems for future civil and military applications aimed at improving performance, durability, and reliability while achieving fuel flexibility and reduced emissions.

- Fuels Research - develop a fundamental knowledge and understanding of the characteristics of aviation fuels and their effects on the performance, durability, reliability, and safety of both aircraft and engine fuel system components.

- Combustion Fundamentals - achieve a basic understanding of the fundamental aerodynamic and chemical kinetic processes which govern combustion and analytically characterize the governing physical phenomena.

- Modeling - improve and validate analytic codes and models for predicting combustor internal aerothermodynamic performance and develop computer codes for predicting the behavior of future aviation fuels in engine and aircraft fuel systems.

- Component Research - identify and evaluate new subcomponent/component technologies that will provide technology for improved performance, durability, and fuel flexibility in future combustors and aircraft fuel systems.

TARGETS:

- Complete refinery studies relating jet fuel quality/quantity to changing petroleum crude/syncrude feedstocks - FY 1982/FY 1984.

- Establish preliminary fuel/air mixing model - FY 1982.

- Complete property characterization of fuels synthesized from heavy petroleum crudes and shale oil - FY 1983.

- Identify turbulence model deficiencies - FY 1983.

- Complete analysis of combustor/fuel system concepts for LH_2 fueled aircraft - FY 1984.

- Complete test demonstration of advanced combustor concepts (multi-zone, variable geometry) for burning zone stoichiometry control - FY 1985.

- Complete development of model for fuel injection and vaporization and related combustion and emission effects - FY 1986.

- Define reaction mechanisms and rate constants which describe fuel degradation (pyrolysis) processes - FY 1986.

JUSTIFICATION:

The trend for increasing pressures and temperatures in aircraft engines places an increasing burden on fuel and combustion systems to perform reliably over extended periods of operation with varying property fuels. Improved computer models, able to predict complex reacting flows, are an essential ingredient to the design of future combustors that are optimized for maximum combustion efficiency, and durability and minimum environmental impact. A more complete and basic understanding of the fundamental combustion processes, including turbulence effects, is required if combustion modeling is to be developed to a level suitable for design practice. State-of-the-art combustors and fuel systems have been designed to operate on current specification jet fuels with only a limited understanding of the effects that fuel property variations will have on performance and durability. Research on combustion and aircraft fuel systems is required to define the impact of varying fuel properties and to assess the potential of advanced concepts to utilize future alternative aviation fuels.

<u>SPECIFIC OBJECTIVE</u>

TITLE: <u>Power Transfer Research</u>

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To advance the fundamentals of friction and wear and the technology of bearings, seals, gears, shafts, lubricants, and lubrication systems to achieve improved life, reliability, efficiency, and performance in the high-temperature, high-pressure, and high-speed environment of advanced gas turbine engines and mechanical power transmission systems.

- o Tribology - develop an improved understanding of lubrication and wear mechanisms, formulation of lubricating materials and integration of mechanical, physical, and chemical elements into tribology design criteria.
- o Mechanical Components - explore innovative concepts and design methodology for durable bearings, gears, seals, and shafts in advanced gas turbine engines.
- o Rotor Dynamics - improve the prediction and control of rotor dynamic forces and methods of balancing and damping.
- o Transmissions - develop advanced concepts and demonstrate efficient and reliable gear, traction, hybrid, and variable speed transmissions.

TARGETS:

- o Verify rotor rub-response model in rig tests - FY 1982.
- o Develop gas path seals technology
  - Demonstrate abrasive blade tip/abradable case material combination suitable to 1500°F and demonstrate feasibility of in-service trenching - FY 1982.
  - Demonstrate an advanced blade tip/ceramic shroud combination for high-temperature turbines operating up to 3000°F gas temperature - FY 1986.

- Complete an interdisciplinary assessment of key tribology elements limiting the life and durability of lubricated contacts - FY 1982.

- Formulate a model for prediction of seal whirl forces and seal damping - FY 1984.

- Complete dynamic analysis of high contact ratio internal and external spur gears including rim effects and multiple paths for planetary gearing - FY 1984.

- Complete validation of 500 H.P. and 3000 H.P. hybrid transmission concepts and identify and quantify the effects of scale - FY 1984.

- Demonstrate the feasibility of high force damper concepts for high rotor unbalance conditions as in blade out - FY 1985.

- Verify predictive models for gear and bearing life which reflect the effects of design and operating variables typical of turboprop, rotorcraft, and gas turbine applications - FY 1985.

- Demonstrate acceptable life and mechanical integrity of advanced case carburized high-temperature ball bearings operating at 3.0 million DN - FY 1987.

JUSTIFICATION:

Power transfer research is focused on evolving the technology of mechanical components for aircraft gas turbine engines and mechanical power transfer systems such as helicopter transmissions, interconnects on V/STOL aircraft, and speed reducers for high efficiency turboprops and geared-fan engines. Advances in mechanical components such as bearings, gears, and seals are required, not only to improve performance, efficiency, life, and durability of engines and transmissions, but also to enable designers to take full advantage of advances in structures and aerodynamic components. Turbine and compressors used in future high-energy cores must operate at higher rotative speed, higher temperatures, and increased pressure ratios than present bearings, seals, and lubricants allow. Improved engine sealing will be a prime requisite for continued advances in energy efficiency and new balancing procedures with more effective dampers will be required for better rotor motion control of future supercritical rotors.

SPECIFIC OBJECTIVE

TITLE: Computational Fluid Mechanics for Turbomachinery

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To develop improved analytical and computational methods which represent steady and unsteady flow conditions in advanced fans, compressors, turbines, and propellers where mixed subsonic, transonic, and supersonic flows are present and to develop the methodology for the use of these methods in the design and development of future propulsion systems.

- Inviscid Analyses & Codes - develop flow models, analyses, and codes for solution of non-viscous steady and unsteady flow in axial and mixed flow compressor and turbine blade rows.

- Viscous Analyses & Codes - develop flow models, analyses, and codes for subsonic and transonic viscous steady and unsteady flow in axial and mixed flow compressor and turbine blade rows, and advanced high-speed propellers.

- Design & Optimization Techniques - develop inverse design methods for direct calculation of blade geometrics for specified conditions such as shock-free flows, controlled diffusion, and endwall loading.

TARGETS:

- Complete and publish preliminary 3D inviscid Euler code - FY 1982.

- Complete and publish 2D viscous Navier-Stokes code - FY 1982.

- Develop and verify supersonic flutter models - FY 1983.

- Complete and publish 3D potential flow code for both axial and centrifugal geometries - FY 1983.

- Complete and publish 2D cascade design code for high turning and solidity - FY 1983.

- Develop unsteady aerodynamic analysis and codes for prediction of propeller blade flutter and forced vibration - FY 1984.

- Complete and publish 3D shockless design code - FY 1985.

- Develop and verify subsonic/transonic flutter models - FY 1985.

- Complete and publish 3D viscous Navier-Stokes code - FY 1986.

- Complete development of aerodynamic forcing function model - FY 1987.

- Develop and verify aerodynamic damping model - FY 1987.

JUSTIFICATION:

The service introduction of advanced technology turbomachinery components requires expensive accumulation of design and confidence-building experience. This experience is presently acquired through the costly and time-consuming procedure of experimental verification of incremental component improvements. A reliable methodology for application of sophisticated analytical techniques could result in an impressive reduction in cost and time to improve and develop advanced turbomachinery components. The analytical techniques have been known and applied in a limited fashion over a number of years. The enormous complexity of the governing flow equations has previously limited the full utilization of these equations. The emergence in recent years of advanced data processing machines has made it possible to start applying computational techniques for the complete solution of the flow equations, taking into account all variables such as viscous effects, time unsteady effects, and three-dimensional secondary flows.

SPECIFIC OBJECTIVE

TITLE: Engine Dynamics and Controls

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John R. Facey

SPECIFIC OBJECTIVE:

To improve the understanding of propulsion system dynamic behavior and to provide an improved technology base for future engine system development in the area of control hardware, software, and modeling technology for safe, reliable operations and the dynamic response characteristics of engine components and systems for development of analytical prediction techniques.

- Analytical Modeling - develop and validate analytical methodologies capable of predicting propulsion system dynamic behavior both in and out of normal operating regions.
- System Response - establish the performance and investigate the systems effects of new component concepts.
- Control Theory and Simulation - develop analytical control theories and methods as well as real-time simulation capability to provide optimization of engine performance and engine condition monitoring.
- Control Hardware - develop innovative sensors and actuators for increased capability and reliability.

TARGETS:

- Complete prototype of parallel-microcomputer simulator having the capability for F-100 class engines - FY 1982.
- Complete the high bypass engine experimental phase of the stall recovery program - FY 1983.
- Successfully demonstrate that analytical redundancy techniques can accommodate control sensor failures - FY 1984.

- o Validate design of 1700°C optical temperature sensor - FY 1984.
- o Demonstrate the operation of a general purpose parallel-microcomputer simulator having capability for all classes of propulsion systems - FY 1985.
- o Complete initial compression system stability models - FY 1986.
- o Demonstrate long-life 250°C optically-switched actuator - FY 1986.

JUSTIFICATION:

Engine dynamics and controls research is being conducted in direct support of the technology needs of both military and commercial aircraft, with application to a broad range of advanced vehicle types. Highly maneuverable military aircraft must avoid flow discontinuities and subsequent performance degradation caused by inlet unstarts and compressor stalls. Supersonic cruise vehicles must operate safely at high levels of propulsion system performance to be economically viable. This program is directed toward these needs with primary emphasis on achieving a better understanding of the dynamic interaction and control phenomena involved in engine operation and providing more reliable theory and prediction techniques to support the evolution of future designs. Another aspect of the program involves the development of technology for digital computer controls, which will be a primary factor in the development of reliable and economical propulsion systems in the future. At this point in time, digital controls lack the maturity and reliability of the hydromechanical systems that are currently in use. Thus, powerful reliability-enhancing technology is required to assure operational acceptance of digital electronic systems. Ultimately the integration of the propulsion and flight control systems will provide the potential for up to 10 percent improvement in fuel economy, reduced pilot workloads, and improved engine life for commercial aircraft.

SPECIFIC OBJECTIVE

TITLE: Advanced Propulsion Systems Research

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/Stephen M. Wander

SPECIFIC OBJECTIVE:

To investigate the feasibility and potential benefits of new or unusual engine technologies and/or concepts for future military and commercial aircraft, and to establish the technology for advanced air-breathing propulsion systems which permit sustained high-speed flight of potential civil and military hypersonic vehicles.

- Advanced Engine System Tradeoffs - evaluate potential of propulsion system concepts and sensitivities for performance, efficiency, durability, weight and cost, identify enabling technology research requirements, and define opportunities for capitalizing on technology advancements.

- Advanced Propulsion Systems - establish through fundamental research, analytical modeling, and component research, a data base of performance and operational characteristics for the development of advanced hypersonic propulsion concepts and design and analysis procedures.

TARGETS:

- Validate analytical models for three-dimensional turbulent, supersonic flow fields and implement its use as an inlet design tool - FY 1982.

- Measure temperature and specie concentration in high-speed mixing reacting flows by non-intrusive optical means - FY 1984.

- o Demonstrate, by small-scale ground tests, the installed performance of an inlet-combustor module of an airframe integrated scramjet engine - FY 1985.
- o Validate and incorporate into combustor design models, large scale turbulence-chemistry interactions - FY 1987.

JUSTIFICATION:

Investigations of advanced propulsion systems are required to support national objectives in energy conservation and to insure continued preeminence of the U.S. air transportation industry. Advanced engine concepts which incorporate unconventional components such as variable-geometry or regenerators may offer significant benefits. Other concepts might utilize fuels such as synthetics or cryogens which are not dependent on the supply of petroleum. There is a continuing need to search for and evaluate concepts and techniques for improving the performance of advanced propulsion systems, in order to appropriately guide future experimental research.

Progress in high-speed propulsion is hampered by a lack of understanding of the fundamentals of turbulent, mixing, and reacting flows in combustors. Experimental and analytical research in this area offers the potential for major improvements in efficiency of future high-speed propulsion systems.

Many studies have been conducted showing the potential of hypersonic aircraft for use in military and civil applications, and for space exploration. The potential of sustained hypersonic flight depends in great part on the integration of the scramjet propulsion system with the vehicle aerodynamic and structural system. The NASA program in hypersonic propulsion is unique in this country and is essential to the exploration of this important potential and to the development of the technology base for its eventual realization.

SPECIFIC OBJECTIVE

TITLE: Instrumentation Research

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Research and Technology Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To develop and demonstrate technology providing instrumentation and measurement techniques for present and future needs of fundamental, applied component, engine, and flight research programs.

- Research Instrumentation R&D - develop and apply new or improved sensors and measurement systems for use in basic studies characterizing fundamental phenomena, and in component and engine research programs to define operating environment and engine component interactions.

- Flight Instrumentation R&D - develop new or improved engine mounted instrumentation systems for use in controls, engine monitoring systems, and flight R&D programs.

TARGETS:

- Demonstrate techniques for making dynamic combustor gas temperature measurements to 3800°F, turbine blade and vane temperature measurements to 1800°F, and combustor liner heat flux measurements to 1600°F - FY 1983.

- Demonstrate acceptable performance of uncooled engine mounted electronic components, sensors, and systems capable of operating to 1000°F - FY 1986.

- Demonstrate a capability of measuring the turbulent fluctuating velocities in an engine combustor environment - FY 1988.

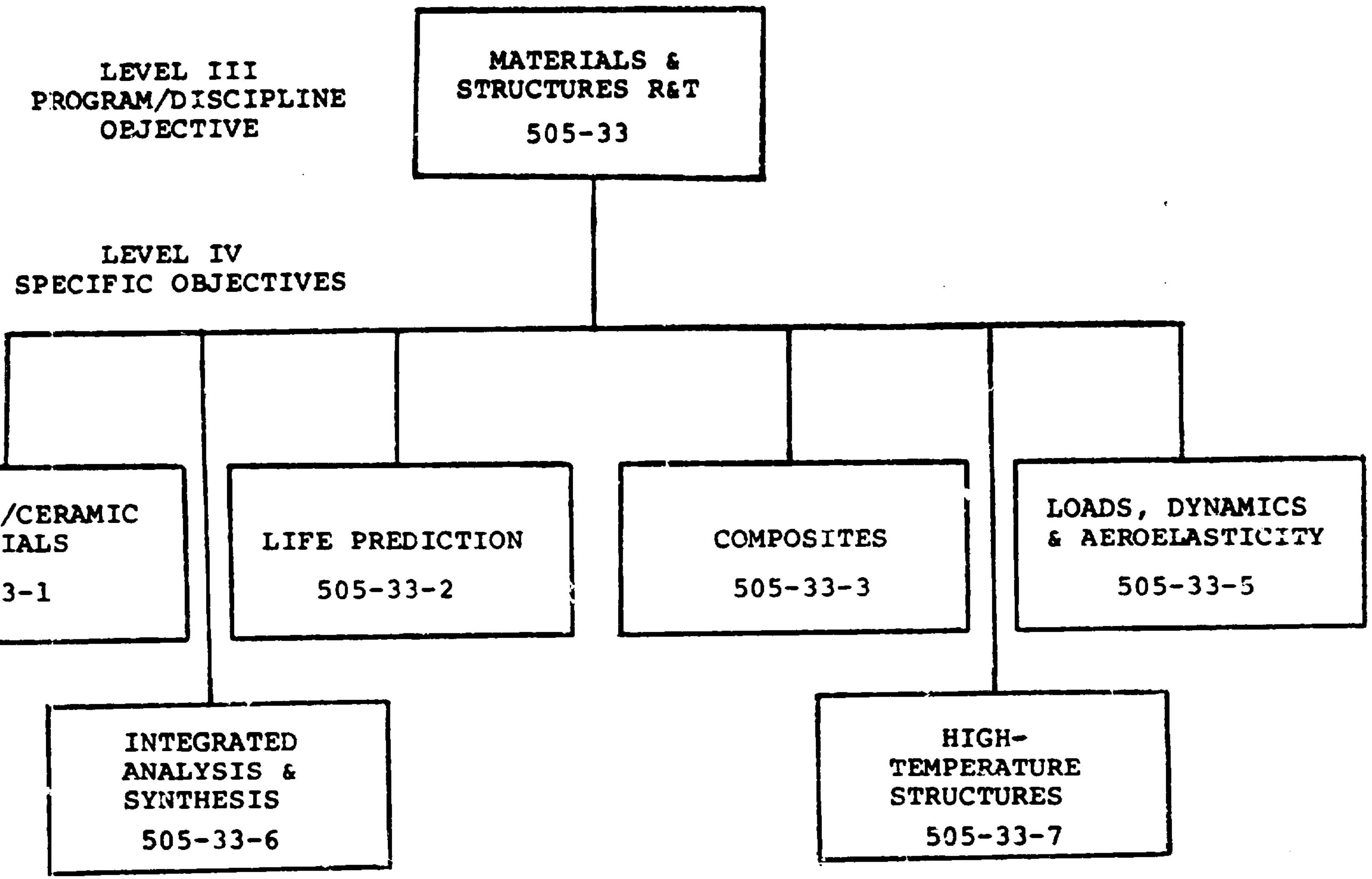
JUSTIFICATION:

Achieving higher levels of efficiency in advanced gas turbine engines will necessitate higher pressure and temperature levels throughout the engine, together with reductions in component size and weight. As a result, greater thermal and aerodynamic loads will be placed upon compressors, turbines, and combustors. Increased durability, reliability, and fuel flexibility will also be required to maintain the U.S. competitive position in aeropropulsion. Meeting these needs will require more precise measurement of an increasingly hostile operating environment (pressure, temperature, chemical composition, radiation, velocity, and turbulence), and conditions of the components (temperature, strain) and engine (stall, flutter, vibration), so that superior analytical tools can be conceived and validated and uncertainties in design margins reduced. Development of advanced high durability, high temperature, precision instrumentation will meet these needs.

MATERIALS AND STRUCTURES R&T

MATERIALS AND STRUCTURES R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: <u>Materials and Structures R&T</u>

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Research and Technology Division/Leonard A. Harris

PROGRAM/DISCIPLINE OBJECTIVE:

To provide a materials and structures technology that will permit the aerospace industry to develop new and improved, safe and reliable metals, polymers, and ceramics and the application of these materials to advanced structures that will result in significant improvements in the performance, safety, durability, and economy of commercial, military and general aviation aircraft.

SPECIFIC OBJECTIVES:

- Metallic/Ceramic Materials: To provide materials and processing technologies for advanced metallic and ceramic materials that can contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines and airframes.
- Life Prediction: To characterize and understand the fatigue and fracture behavior of metallic, ceramic, and composite materials in order to develop reliable life prediction techniques applicable to both engine and airframe structures.
- Composites: To exploit the full weight reduction potential of highly loaded composite airframe and engine structure via optimized characteristics of fibers and matrices, advanced damage tolerant concepts, improved analytical prediction of composite properties, and understanding of environmental effects; and to achieve lower cost and greater reliability through the development of advanced processing techniques.

- Loads, Dynamics and Aeroelasticity: To develop improved methods for the analytical determination of loads, deformations and stability of airframe and engine structural components and systems. To acquire reliable experimental data from wind-tunnel, spin rig and flight test programs for use in validation of analytical methods and in demonstrating the effectiveness of advanced concepts such as flutter suppression and load alleviation using active controls and/or aeroelastic tailoring.

- Integrated Analysis and Synthesis: To develop accurate and affordable advanced computational methods and computational facility architectures and technology needed to support the structural synthesis of airframe and engine components and systems in an integrated, multidisciplinary design environment.

- High-Temperature Structures: To provide the structural concepts and design methods required to achieve improved efficiency and durability of engine components operating in high temperature environments, and to support future development of hypersonic aircraft.

SPECIFIC OBJECTIVE

TITLE: Metallic/Ceramic Materials

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual. Research and Technology Division/Michael A. Greenfield

SPECIFIC OBJECTIVE:

To provide materials and processing technologies for advanced metallic and ceramic materials that can contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines and airframes.

- o Improve the basic understanding of microstructure and materials behavior under airframe and engine operating conditions in order to develop improved physical and mechanical properties of advanced alloys, ceramics, and coatings.
- o Explore advanced concepts in metallic and ceramic materials and the related processing requirements that offer potential for higher material use temperatures and/or stresses in turbine engines.
- o Develop innovative joining and processing methods for incorporating advanced materials into efficient, low-cost airframe structures.

TARGETS:

- o Achieve 60 ksi strength at 2500°F for non-hot pressed SIC/SI_3N_4 in FY 1984.
- o Demonstrate a metallic coating with 10,000 hours rig life at 2000°F in FY 1986.
- o Demonstrate feasibility of improved rim/bore strength PM disk for 1% decrease in SFC by FY 1985.
- o Characterize the strengthening mechanisms of cobalt and tantalum in superalloys so as to develop suitable substitutes by FY 1983.

JUSTIFICATION:

Cost-benefit studies have established that major improvements in aircraft performance and economy can be obtained by increasing turbine engine operating temperatures and by reducing engine weights. The importance of such improvements has been re-emphasized by the national need to conserve fuel, reduce aircraft noise, and reduce engine pollution. Improved high-temperature materials would make possible higher specific thrusts, lower specific fuel consumption, greater reliability, and/or lower operating costs. Both civil and military aircraft would benefit from the use of improved materials. Improved materials are of such importance to the military that a coordinated, interdependent program has been developed with the Air Force on materials for aircraft turbines.

Advancements in lower cost methods of airframe component fabrication and concepts directed at lighter weight, more corrosion-resistant alloys have a direct bearing upon direct cost of ownership and the viability of aircraft as an efficient means of transportation, particularly in a time of soaring fuel costs.

SPECIFIC OBJECTIVE

TITLE: Life Prediction

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Research and Technology Division/Michael A. Greenfield

SPECIFIC OBJECTIVE:

To characterize and understand the fatigue and fracture behavior of metallic, ceramic, and composite materials in order to develop reliable life prediction techniques applicable to both engine and airframe structures.

- o To understand the interrelationship of a material structure and properties and to characterize microscopic deformation and cracking mechanisms as a basis to predict materials behavior and life.
- o To develop analytical and experimental techniques to characterize thermal and structural response of materials under realistic operating environments.
- o To advance the state of the art in nondestructive evaluation so as to be able to better characterize defects and their location in complex structures and to determine material properties directly.

TARGETS:

- o Complete activities in strain range partitioning in FY 1982.
- o Extend crack closure models of propagation to include cracked holes in FY 1984.
- o By end of FY 1984 demonstrate an NDE method to locate and evaluate composite delamination in real structures.
- o By FY 1984 identify and characterize microscopic deformation and cracking mechanisms causing creep/fatigue failures.
- o By FY 1986 demonstrate the ability to predict cyclic stress/strain response from uniaxial data for a combustor liner under multiaxial load.

JUSTIFICATION:

Maintenance and repair costs are a substantial part of the total direct cost to airlines. At the present time, this cost is nearly 11 percent of direct operating cost. Nearly 75 percent of military engine maintenance costs are due to the failure of hot section components, and 25 percent of all engine failures are attributed to fatigue. The fatigue and fracture program is aimed at improving procedures to predict fatigue crack initiation, crack propagation and fracture of these structures and propulsion system components. The improved life-prediction procedures resulting from an increase in the knowledge of how materials behave under complex loadings and temperature will contribute to increased service life and thus reduce operating costs.

SPECIFIC OBJECTIVE

TITLE: Composites

Program Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Research and Technology Division/Charles F. Bersch

SPECIFIC OBJECTIVE:

To exploit the full weight reduction potential of highly loaded composite airframe and engine structure via optimized characteristics of fibers and matrices, advanced damage tolerant concepts, improved analytical prediction of composite properties, and understanding of environmental effects; and to achieve lower cost and greater reliability through the development of advanced processing techniques.

- o Synthesize, characterize and evaluate new and improved composite matrices and fibers for application in both airframe and engine structures.

- o Develop the mechanics technology required for the design of efficient, fault-tolerant advanced structural components subject to combined loads, impact, post buckling effects and local discontinuities.

- o Determine the effects of expected service environments on the mechanical properties and lifetime of structural composites and joints.

- o Develop adhesives and other joining or repair methods for more efficient utilization of composites, improved fire resistant, nontoxic polymers and composites, and processing technology capable of providing very large (50 to 100 feet), thick, and variable thickness components.

TARGETS:

- In FY 1982, predict within ± 15 percent the static strength of graphite/epoxy laminates containing buffer strips.
- Develop, by 1982, a polyimide matrix resin with processing characteristics comparable to epoxies and thermomechanical properties comparable to commercial polyimides.
- By end of FY 1982, complete research on the effects of moisture.
- Demonstrate the capability to predict real time properties on the basis of accelerated tests by FY 1985.
- Develop by 1984, adhesives for joining aerospace structures with useful life of 10,000 hours at 450°F and 2000 hours at 550°F.
- By 1985, develop an organic matrix resin with improved toughness and processibility compared to state-of-the-art 350°F core epoxies while maintaining current mechanical properties.

JUSTIFICATION:

Improved materials contribute in a variety of ways to the ever-present demand for safer, more efficient and higher performing aircraft.

Composites have a vast potential for use in aircraft and engine structures because of a combination of lightweight, high strength, high stiffness, and a large degree of flexibility in tailoring properties to specific requirements. The lighter weight is directly transferable into such benefits as improved fuel economy.

Safe, efficient operation also requires reliability. To achieve this, a varied program covering environmental effects, flaw detection and prevention and improved fabrication and joining techniques must be conducted.

SPECIFIC OBJECTIVE

TITLE: Loads, Dynamics and Aeroelasticity

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Research and Technology Division/Sam Venneri

SPECIFIC OBJECTIVE:

To develop improved methods for the analytical determination of loads, deformations and stability of airframe and engine structural components and systems. To acquire reliable experimental data from wind-tunnel, spin rig and flight test programs for use in validation of analytical methods and in demonstrating the effectiveness of advanced concepts such as flutter suppression and load alleviation using active controls and/or aeroelastic tailoring.

TARGETS:

- Develop and validate, in FY 1982, a method for predicting transient loads, stresses and deformations caused by loss of a fan, compressor or turbine blade.
- Validate integrated design procedure for structural benefits resulting from acting control of maneuver and gust loads and flutter suppression on a high aspect ratio transport-type wing in FY 1983.
- Complete, by FY 1983, the analysis methods compendium on vibration and flutter of turbine engine rotor systems and components.
- Develop, by FY 1984, the understanding and prediction capabilities needed to apply active and passive controls technology to the design of energy efficient commercial aircraft and military aircraft with stores.
- Develop by FY 1984, new concepts to increase engine rotor blade mechanical damping.

- o Develop methods for identification and quantification of interior noise sources and transmission paths in FY 1983.
- o Develop, by FY 1986, structural modeling, analysis and test techniques for use during design in determining the crash dynamic behavior of transport aircraft.

JUSTIFICATION:

This objective aims at contributing to the technology base required to support future aircraft design goals, namely, improved performance, ride quality and service life, and lower costs. It seeks to provide improvements in the analytical and experimental techniques for predicting and controlling the unsteady aerodynamic loading, the structural dynamic response to this loading, and aeroelastic phenomena arising from the interplay of the two. The accurate prediction and effective control of these factors can result in lightweight, low-cost structural configurations.

There is a recognized need for improved prediction methods in unsteady transonic aerodynamics. Structural response computational methods need to be improved in order to more effectively account for the complex interactions with aerodynamics, flight controls, and propulsion forces. Wind-tunnel and flight test data are required to validate analytical advances and to demonstrate techniques for improving vehicle performance, ride quality and service life.

SPECIFIC OBJECTIVE

TITLE: Integrated Analysis and Synthesis

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Research and Technology Division/Deene Weidman

SPECIFIC OBJECTIVE:

To develop accurate and affordable advanced computational methods and computational facility architectures and technology needed to support the structural synthesis of airframe and engine components and systems in an integrated, multidisciplinary design environment.

- o Development and verification of advanced analysis/synthesis software modules.
- o Definition of procedures for the use of software modules in design optimization, and the formulation of aeroelastic and thermal design optimization constraints.
- o Exploitation of advances in computer hardware to improve the efficiency of structural calculations.

TARGETS:

- o Validate, by end of FY 1982, a design concept for a low-cost engine frame which is 20% lighter and 30% less expensive than conventional designs.
- o Develop a method for concurrent aircraft strength and flutter optimization, including global, local and discontinuous variables by end of FY 1982.

  Develop a specialized software system to construct geometric descriptions and discrete analytical models of engine structural components and systems by FY 1983.
- o Develop, by FY 1983, design approaches and software requirements for a digital electronic device to simulate structural dynamic behavior of engine structural systems.

- o Simulate a large-scale finite element machine by the end of FY 1983.

- o Develop, by FY 1984, a methodology for global optimization of airframes and engine components under aerodynamic, strength, aeroelastic and performance design constraints.

- o Develop, by FY 1984, modularized analysis methods to simulate complex material mechanical behavior for use in optimization of engine structural components.

JUSTIFICATION:

Computer-aided design methods have become an indispensable tool in the development of high performance, environmentally acceptable and economical aeronautical systems. These requirements tend to intensify with time and necessitate corresponding advances in the analysis/synthesis methods on a continual basis. Additionally, the current dramatic advances in computer hardware capabilities have created a unique opportunity for improving computational efficiencies through specialized adaptations of hardware to the computational methods and vice versa. Furthermore, advances and developments of new materials require development of streamlined and modular analysis methods for adaptation in a computer-aided design environment.

SPECIFIC OBJECTIVE

TITLE: High Temperature Structures

Program Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Research and Technology Division/Sam Venneri

SPECIFIC OBJECTIVE:

To provide the structural concepts and design methods required to achieve improved efficiency and durability of engine components operating in high temperature environments, and to support future development of hypersonic aircraft.

- o Develop improved analytical methods for predicting the thermomechanical flight environments of airframe and engine components.
- o Develop and evaluate, with appropriate experiments, advanced structural concepts for turbine engine hot section components and for hypersonic airframes and engines with emphasis on scramjets.

TARGETS:

- o Develop and validate improved methods for the prediction of thermomechanical cyclic stress/strain history of turbine engine hot section components by end of FY 1984.
- o Demonstrate fabricability and determine thermal/structural performance of practical hydrogen-cooled scramjet structures by end of FY 1986.
- o Develop effective structural concepts for an airframe and a hydrocarbon scramjet for a hypersonic missile by end of FY 1986.

JUSTIFICATION:

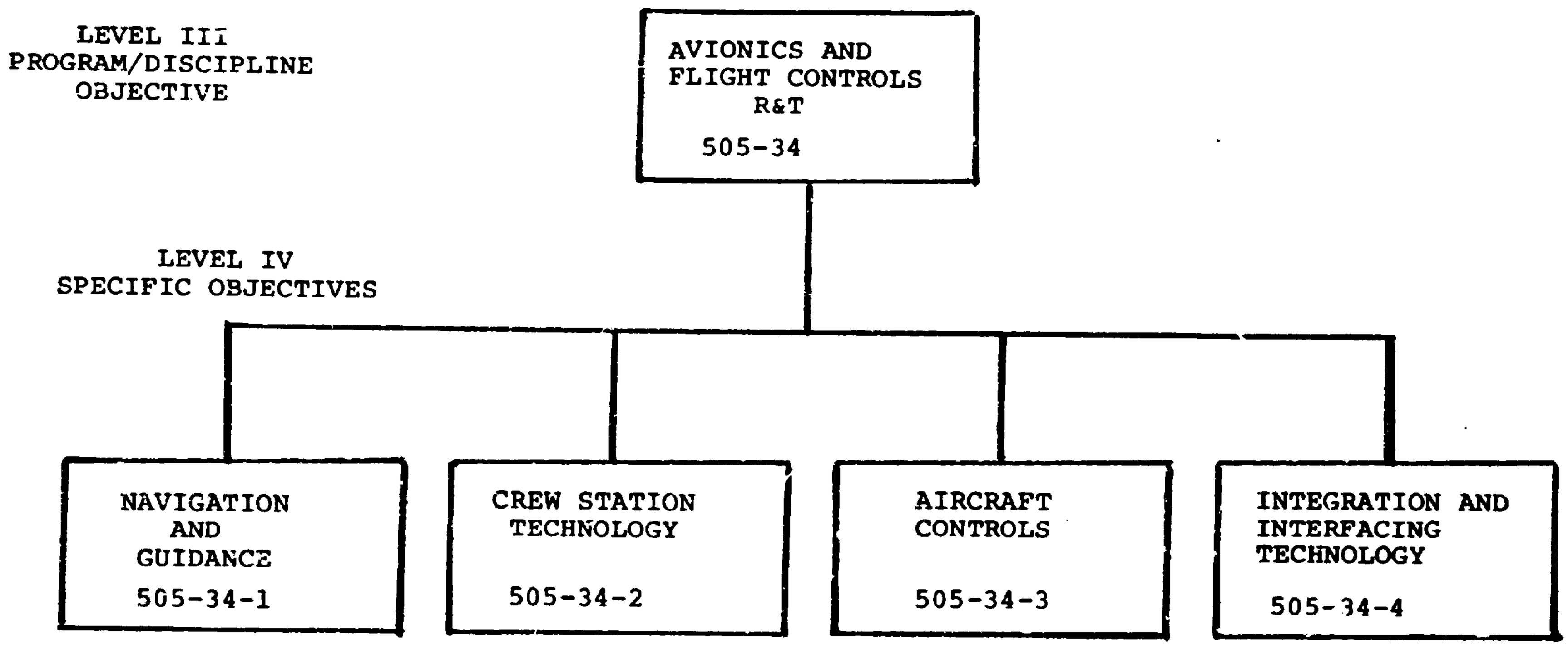
The accurate prediction of the service life of turbine engine hot section components will permit significant reductions in the amount of unscheduled aircraft maintenance, which is a major operating cost item. This specific objective seeks to develop the basic tools for establishing the fatigue environment as needed for life prediction. It also seeks to develop new structural design concepts utilizing advanced materials to permit prolonged operation in the high-temperature flight environments which will be encountered in future hypersonic military aircraft and missiles, as well as in potential hypersonic civil aircraft.

AVIONICS AND FLIGHT CONTROL R&T

7

AVIONICS AND FLIGHT CONTROLS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Avionics and Flight Controls

Program Area Title: Research and Technology Base

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

PROGRAM/DISCIPLINE OBJECTIVE:

To develop technology for the advancement of aircraft controls and guidance systems necessary to reduce costs and increase safety, performance and efficiency in military and civil aircraft fleets in the late 1980's and early 1990's.

SPECIFIC OBJECTIVES:

- Navigation and Guidance: To develop technology for precise navigation and guidance within the National Airspace System, considering such requirements as Air Traffic Control (ATC) system capacity and environment, and the use of innovative hybrid system concepts providing alternative approaches to enhance the utility, safety and operating efficiency.

- Crew Station Technology: To develop, in consonance with human factors activities, the design concepts and integration methodologies for advanced crew station systems which can reduce crew workload, improve cockpit systems performance and flexibility, and increase the safety and efficiency of aircraft operations in the air traffic environment of the 1980's.

- Aircraft Controls: To develop advanced control system concepts and synthesis techniques which exploit the application of analysis techniques, control devices and integrated design procedures to enhance the performance, safety and efficiency of future aircraft control system designs.

- Integration and Interfacing Technology: To develop advanced architectural concepts and techniques which will establish design guidelines for the practical integration of advanced controls and guidance systems and associated redundancy management functions resulting in more economical, reliable, maintenance-free aircraft systems.

SPECIFIC OBJECTIVE

TITLE: Navigation and Guidance

Program/Discipline Objective Title:
Avionics and Flight Controls R&T

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To develop technology for precise navigation and guidance within the National Airspace System, considering such requirements as ATC system capacity and environment, and the use of innovative hybrid system concepts providing alternative approaches to enhance the utility, safety and operating efficiency.

- o Develop theory and techniques to design and evaluate advanced flight path guidance systems for future National Airspace System.
- o Develop theory and system concepts minimizing fuel use and operational inefficiencies.
- o Develop analytical tools for antenna design and placement on aircraft.
- o Maintain a joint university program fostering innovative graduate level research activities.

TARGETS:

- o Conduct computerized study of GPS antennas on General Aviation aircraft - FY 1982.
- o Initiate flight experiments of a modified weather radar for application to turbulence detection - FY 1982.
- o Establish onboard navigation redundancy level required to provide a given certainty of information availability - FY 1983.
- o Develop and simulate an advanced flight path management system for high density, mixed-traffic airspace operations - FY 1984.
- o Evaluate the combination of physical redundant navigation sensors and analytical redundancy concepts to identify aircraft flight control anomolies - FY 1986.

JUSTIFICATION:

The large number of aircraft currently operating in the U.S. Air Transportation System has imposed a heavy burden on the National Airspace System environment; furthermore, the additional requirement of improved operating efficiency adds increased workload and complexity of present and near-term systems. To go beyond automating existing methods we must develop theoretical techniques to lay a foundation on which to design advanced concepts. These theoretical techniques must accommodate hybrid concepts (onboard/ground-based/satellite-based) and provide a basis for measuring the relative value of data links and advanced components. Specific advanced components such as antennas, turbulence detectors and navigation/guidance sensors must also be considered as supporting elements to provide a complete data base prior to undertaking system verification tasks.

SPECIFIC OBJECTIVE

TITLE: Crew Station Technology

Program/Discipline Objective Title:
Avionics and Flight Controls R&T

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To develop, in consonance with human factors activities, the design concepts and integration methodologies for advanced crew station systems which can reduce crew workload, improve cockpit systems performance and flexibility, and increase the safety and efficiency of aircraft operations in the air traffic environment of the 1980's.

- Develop advanced display concepts (joint with DOD).
- Develop information input/output (I/O) techniques for advanced cockpit configurations.
- Develop methods for integrating cockpit subsystems.
- Define pilot/system interface requirements.

TARGETS:

- Demonstrate experimental hybrid (rasterscan and stroke) display generation technology in conjunction with color CRT and monochrome thin-film electroluminescent (TFEL) media - FY 1982.
- Evaluate high-resolution TFEL media as a display device for flight display formats - FY 1982.
- Demonstrate varistar-multiplexed liquid crystal displays (LCD) for large area application and touch panel control - FY 1982.
- Improve brightness and color capability of TFEL materials and uniformity of varistar-addressed LCD materials - FY 1983.
- Initiate development of color panel media technology - FY 1984.
- Complete trade-off analyses and evaluations of conceptual cockpit display systems - FY 1985.

JUSTIFICATION:

Aircraft cockpit displays and controls have, in general, been increasing in number over the years, with over 100 now required for operation of a typical transport. The problem for the single pilot of a general aviation airplane can be equally acute, especially in marginal weather and/or IFR conditions which impose great demands on his attention and capabilities. The development of advanced multipurpose displays and microprocessor-implemented mode controls for various flight regimes could significantly simplify crew tasks and has the potential for reducing the cost of cockpit systems. Integration of these and related technologies into flight and simulation research cockpits can permit the evaluation of promising cockpit concepts under realistic operational conditions. This program can be expected to lead to crew station cost reductions as much as 25 percent over current levels, while providing a significant increase in crew capability for aircraft systems management through improved system performance and flexibility.

SPECIFIC OBJECTIVE

TITLE: Aircraft Controls

Program/Discipline Objective Title:
Avionics and Flight Controls R&T

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To develop advanced control system concepts and synthesis techniques which exploit the application of analysis techniques, control devices and integrated design procedures to enhance the performance, safety and efficiency of future aircraft control system designs.

- o Advance the state-of-the-art in control theory and analytical tools.
- o Develop fault-tolerant digital propulsion controls.
- o Evaluate active control concepts.
- o Develop control system synthesis and modeling techniques for multidisciplinary applications.
- o Develop highly-reliable, flight-crucial control concepts.
- o Establish systems criteria and simulation techniques.

TARGETS:

- o Complete development of an automated configuration design and synthesis capability for active control functions - FY 1982.
- o Complete analysis of preliminary shuttle flight data for establishing improved handling qualities and flight control design criteria for future "shuttle-craft" vehicles - FY 1982.
- o Initiate simulation studies to evaluate automated in-flight monitoring concepts for improved aircraft operations - FY 1982.

- o Complete the analysis and ground-based simulation of control reliability concepts providing the foundation for ultra-reliable control system architecture - FY 1983.
- o Complete development and evaluation of aircraft flight parameter estimation procedures for utilization in high angle-of-attack, non-linear regions of the flight envelope - FY 1983.
- o Establish procedures for prediction of aeroelastic mode and control coupling influence on pilot ratings for advanced aircraft - FY 1983.
- o Identify impact of advanced components (i.e., sensors, actuators, effectors) on active control system performance - FY 1983.
- o Complete a conceptual design of a fault-tolerant controller for propulsion system applications - FY 1984.
- o Establish the theoretical framework for non-linear inverse system control concepts - FY 1984.
- o Demonstrate real-time trajectory optimization algorithms for civil and military applications - FY 1985.

JUSTIFICATION:

As a result of both growing aircraft system complexity and promising economic advantages, future aircraft require more automated digital control systems which practically and reliably can be applied in full-authority, flight-critical functions. To realize this potential, it is necessary that we develop and maintain a technology data base as a source of basic knowledge and understanding for systems validation under more advanced demonstration programs.

SPECIFIC OBJECTIVE

TITLE: Integration and Interfacing Technology

Program/Discipline Objective Title:
Avionics and Flight Controls R&T

Responsible Organization/Individual:
Research and Technology Division/ Herman A. Rediess

SPECIFIC OBJECTIVE:

To develop advanced architectural concepts and techniques which will establish design guidelines for the practical integration of advanced controls and guidance systems and associated redundancy management functions resulting in more economical, reliable, maintenance-free aircraft systems.

- Conduct research in fully-integrated system architecture design methodology.
- Define and develop advanced data distribution concepts.
- Advance the state-of-the-art in fault sensing, isolation and redundancy management.
- Formulate validation experiments for AIRLAB.
- Develop system assessment and validation methodologies.
- Investigate lightning environmental effects.
- Develop diagnostic emulation techniques.

TARGETS:

- Initiate definition and development of an experimental optical data distribution network - FY 1982.
- Complete preliminary laboratory evaluations and analyses of fault-tolerant computer designs - FY 1982.
- Complete development of a third generation reliability assessment tool - FY 1982.
- Complete lightning model and first order digital system upset methodology - FY 1982.
- Initiate the development of advanced theory and analytical techniques for the design of fully-integrated flight control and guidance systems - FY 1982.
- Complete optical planer wavelength demultiplexer device development - FY 1983.

- Demonstrate techniques for performing normal and failure modes effects criticality analysis at the hardware and software design logic level through diagnostic emulation - FY 1983.

- Establish first experimental test plans for evaluating integrated system designs in AIRLAB - FY 1984.

- Initiate subsystem flight test program - FY 1986.

JUSTIFICATION:

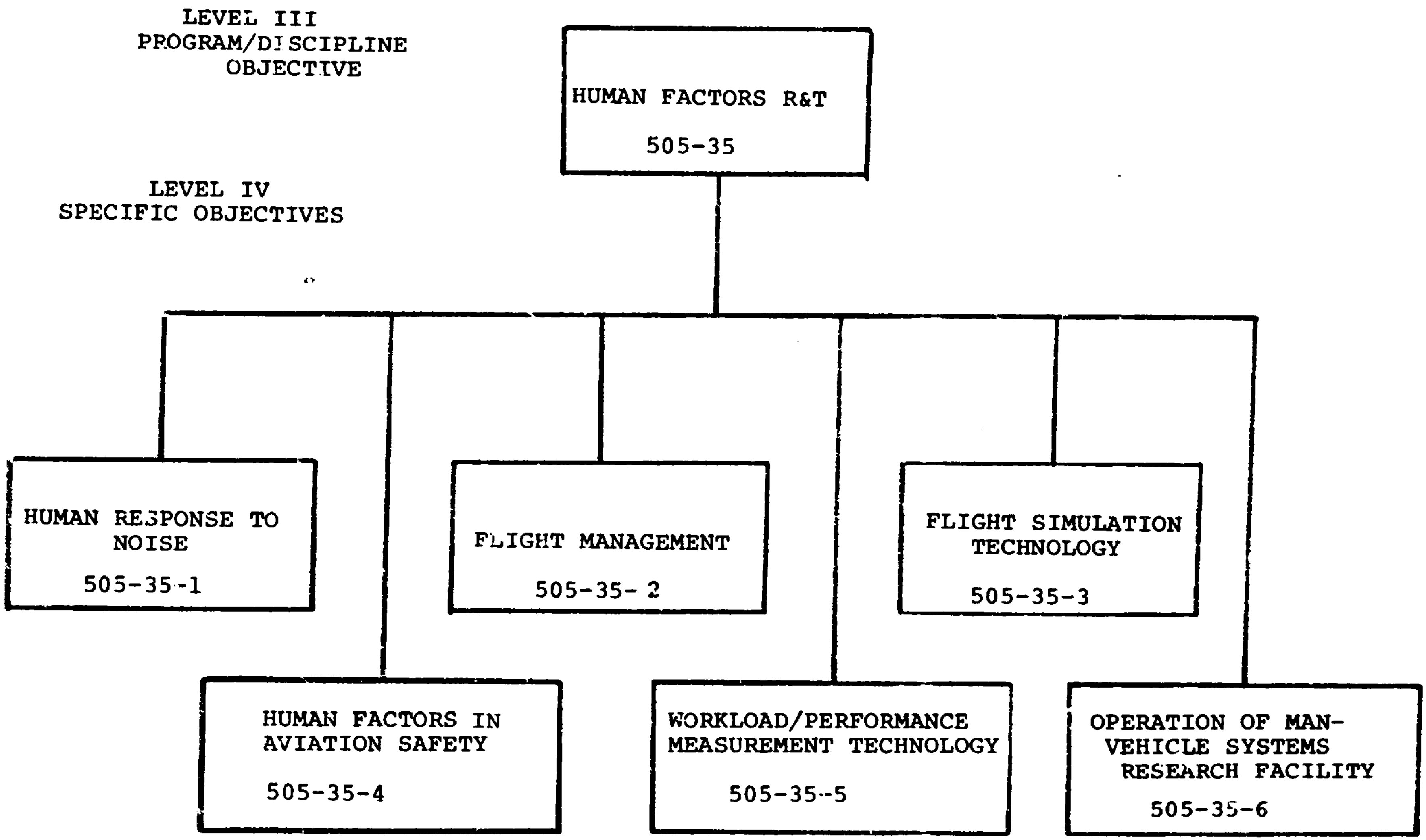
Integration of major aircraft subsystem elements at the design stage can result in significant improvement in future aircraft. For example, systems integration implemented on transport-class aircraft, will permit significant fuel/weight savings and provide a reduction in dispatch delays through increased reliability while utilizing one-third of the equipment of today's transports. In order to realize these benefits of integrated control, system design techniques must be advanced beyond that currently available to airframe manufacturers and electronics vendors. New architecture concepts and associated system assessment tools required for a full-time, fully integrated system must be developed and optimized to provide the fault tolerance and economic viability necessary for commercial and military applications.

HUMAN FACTORS R&T

8

HUMAN FACTORS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Human Factors R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

PROGRAM/DISCIPLINE OBJECTIVE:

To provide the research and technology base for solutions to the human problems impeding the growth or safety of air transportation.

SPECIFIC OBJECTIVES:

- Human Response to Noise: To develop technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on aircraft crews and passengers.

- Flight Management: To develop crew/cockpit/air traffic control (ATC) interaction technology base required to improve operational performance, capacity and safety.

- Flight Simulation Technology: To develop the technology base that will permit the economical and reliable substitution of simulators for actual flight operations in aeronautical research, development, and pilot training.

- Human Factors in Aviation Safety: To reduce the incidence of aviation accidents attributable to human error.

- Workload/Performance Measurement Technology: To develop technologies for assessing pilot/crew member workload and for performing human factors assessments of displays.

- Operation of Man-Vehicle Systems Research Facility: To provide for the operation, maintenance and enhancement of the man-vehicle system research facility at Ames Research Center.

SPECIFIC OBJECTIVE

TITLE: Human Response to Noise

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on aircraft crews and passengers.

TARGETS:

- o Define noise dose-response relationships for single and multiple aircraft noise events which include aircraft type, time-of-day, activity, and situational effects - FY 1984.
- o Quantify the reduction in airport community noise impact which can be achieved by ground track and scheduling optimization - FY 1982.
- o Define takeoff and approach profiles which minimize noise impact consistent with safety and aircraft performance constraints - FY 1983.
- o Determine ride quality criteria in a combined noise and vibration environment - FY 1983.
- o Quantify the reduction in airport community noise impact which can be achieved by optimum scheduling of flights by time-of-day, consistent with demand constraints - FY 1985.

JUSTIFICATION:

In spite of major technical achievements in aircraft and noise reduction technologies, substantial controversy still exists with respect to the amount of noise reduction necessary to realize a benefit to airport communities. The problem is that the noise measurement units used to describe and forecast human response have too much variance to permit a reliable determination of noise reduction benefit. Research is needed to define and understand the influence of the various stimulus, environmental, and human factors on how communities respond to aircraft noise. Within the last two years substantial progress has been made in understanding how some of the above factors come into play and affect the usefulness of the single- and multiple-event descriptors. The NASA research program is the principal effort within the U.S. To fulfill NASA's responsibility to provide the technical basis for aircraft noise abatement and environmental acceptability, human research is required. Its successful accomplishment will provide the means for sound policy decisions about aircraft noise levels in the future.

SPECIFIC OBJECTIVE

TITLE: Flight Management

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop crew/cockpit/air traffic control (ATC) interaction technology base required to improve operational performance, capacity and safety.

- o Investigate alternative control-display configurations and modes.
- o Improve crew capability in interactions with the aircraft environment.

TARGETS:

- o Refine human factors guidelines for design and use of advanced navigational flight displays - FY 1983.
- o Define the role of aircrews and controllers based on consideration of an appropriate use of automation - FY 1984.
- o Evaluate the impact of probable air traffic control elements of the 1990's on crew performance, roles, and training - FY 1985.
- o Develop and evaluate solution concepts to the modified roles placed on crews by the 1990 air traffic control system in terms of cockpit configurations, flight procedures and control-display characteristics - FY 1985.

JUSTIFICATION:

The future will continuously challenge aviation systems technology with problems arising from increases in traffic density, changes in patterns of community needs for air transportation, and the need to reduce the environmental impact of aircraft operations within the context of increased safety, energy management and reduced costs. To meet these needs, changes in air traffic control, flight operations and procedures are anticipated. If the crew is to function effectively in this increasingly complex environment, accompanying improvements in cockpit systems and procedures are required.

Major questions about optimal crew roles and crew/system interfacing are being asked. Crew system communications including entry of information and system commands; the location, content, and format of displays; and procedures for accomplishing automated and manual functions must be specified. This program will provide the research base necessary to formulate these specifications and will result in implementation and flight testing of new hardware and software concepts in conjunction with human operators. It is anticipated that the resulting cockpit concepts will contribute substantially to future aircraft safety.

SPECIFIC OBJECTIVE

TITLE: Flight Simulation Technology

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop the technology base that will permit the economical and reliable substitution of simulators for actual flight operations in aeronautical research, development and pilot training.

- o Assess visual scene generation and motion cue techniques.
- o Develop computational techniques to improve simulator operations and management, and performance measurement.
- o Develop human performance model prediction capability.

TARGETS:

- o Assess computational techniques to improve simulator capability - FY 1982.
- o Define the strategies for cost-effective application of simulation to air transport pilot training - FY 1983.
- o Quantify and apply objective pilot performance measurement techniques such as describing functions to simulation - FY 1983.
- o Study and evaluate human-machine models for performance prediction related to simulation tasks - FY 1983.
- o Establish methodology and analytic basis for conducting large scale, full-mission simulations - FY 1984.
- o Establish the parametric relationships for optimal application of simulators to air transport pilot training - FY 1985.

JUSTIFICATION:

The advantages of simulators over airborne flight training include reduced cost, fuel savings, safety and more efficient training. Investigations of the handling characteristics of new aircraft, practice of emergency procedures and maneuvers which can be hazardous if conducted in the air, and evaluation of new display and control systems, pilot capabilities, crew roles and flight procedures under future possible configurations of the air traffic system are but a few of the research and technology (R&T) areas where simulators play a vital role. In training, simulators permit repeated practice of a particular maneuver without the "set up" time necessary in airborne flight, provide the student with a permanent record of his performance, and permit stopping the "aircraft" for a review of critical points. The result is more effective and more efficient training, as recognized by the increasing allowance of simulator time as a substitute for actual flight time in pilot qualification and proficiency checks under Federal Aviation Administration (FAA) regulations.

Restrictions preventing wider usage of simulators were identified in a joint NASA/Department of Defense (DOD) study leading to the organization of the NASA/DOD Simulation Coordinating Group. This group meets semiannually to develop areas for agency interdependency. Items including F-15 simulator certification, motion transfer of training studies, and a data bank of simulation technology were addressed in 1977. The study also identified the inadequate understanding of perceptual cues associated with detection of acceleration and limitations in the technology for generating realistic visual scenes. In addition, the simulation fidelity required is known to vary with different R&T and training applications. However, clearly defined relationships have not been established. Because costs increase with the degree of fidelity realized, criteria relating fidelity and application are required. The research program described is responsive to the needs identified by the NASA/DOD study and the Simulation Coordinating Group. The anticipated consequence of this program is the cost-effective application of simulators on a broad scale.

SPECIFIC OBJECTIVE

TITLE: Human Factors in Aviation Safety

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To reduce the incidence of aviation accidents attributable to human error.

TARGETS:

- o Continue operational research using human factors information contained in the Aviation Safety Reporting System (ASRS) data base, specifically pursuing the major topics of cockpit resource management and information transfer within the aviation system - FY 1982.
- o Develop analytical framework for assessing safety contribution of alternative procedures and display concepts - FY 1983.
- o Develop guidelines for aircrews to use in avoiding or minimizing the effects of circadian desynchronosis - FY 1986.

JUSTIFICATION:

Air transport safety has improved consistently since World War II. These improvements are derived from a number of sources including improved pilot training, more reliable systems and structures, and advances in air traffic navigational and airport facilities. The aviation community, however, has been unable to reduce the incidence of accidents attributable to human error (about 60% for air transports and 80% for general aviation). The human error issue is thus one of the most serious facing the U.S. and world air transport industry. Larger aircraft and rapidly escalating liability judgments have made air transport safety crucial to the economic survival of the airline industry.

Recognizing the absolute necessity to mount a full-scale attack on the human error issue, the national and international aviation communities have joined forces to eliminate the human error problem. NASA is a full member of this team and is looked to solely to provide the scientific and technical insight necessary to solve the problem.

SPECIFIC OBJECTIVE

TITLE: Workload/Performance Measurement Technology

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop technologies for assessing pilot/crew member workload and for performing human factors assessments of displays.

TARGETS:

- o Complete development of oculometer - FY 1982.
- o Complete development of oculometer data reduction techniques - FY 1983.
- o Assess the validity of traditional workload measures (e.g., physiological, memory, task loading)-FY 1983.
- o Develop and validate practical interpretations of oculometer data in terms of human performance - FY 1984.
- o Determine the feasibility of subdividing "workload" into component parts (e.g., mental, physical, emotional, etc.) and developing measures for each component - FY 1984.
- o Perform exploratory research into the development of valid, reliable measures of aircrew performance - FY 1984.

JUSTIFICATION:

The next generation of aircraft will make greatly increased usage of new types of displays made possible through the great strides that have been made in micro-electronics and flat-panel display technology. These include: cockpit display of traffic information (CDTI), head-up displays (HUD), collision avoidance systems (CAS), etc. Each of these will have to be throughly investigated to insure that in solving existing problems, they do not introduce other problems.

Existing workload and performance measurement technology is not sufficiently advanced to permit the discriminations that need to be made. This is exemplified by the debates that have been encountered recently concerning the mandatory retirement of airline pilots at age 60, and the certification of new aircraft for any given crew complement.

NASA/Ames has conducted preliminary research into pilot performance and workload measures during the last five years. This has brought about the realization that little is known about the components of cockpit workload and performance. Existing measures are of dubious validity. Work must be done to determine whether "workload" is a viable concept, and if so whether it can be broken down into measurable components such as mental, physical, and emotional. Research must be carried out to determine which components of workload, if any, that current measurement techniques (e.g., task loading, physiological, memory, time estimation) are tapping.

The research oculometer which has been under development at Langley, holds promise for allowing objective, unintrusive measures of workload and performance to be developed. These avenues must be explored.

SPECIFIC OBJECTIVE

TITLE: Operation of Man-Vehicle Systems Research Facility (MVSRF)

Program Title Area: Human Factors R&T

Responsible Organization/Individual: Research and Technology Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To provide for the operation, maintenance, and enhancement of the man-vehicle system research facility at Ames Research Center.

JUSTIFICATION:

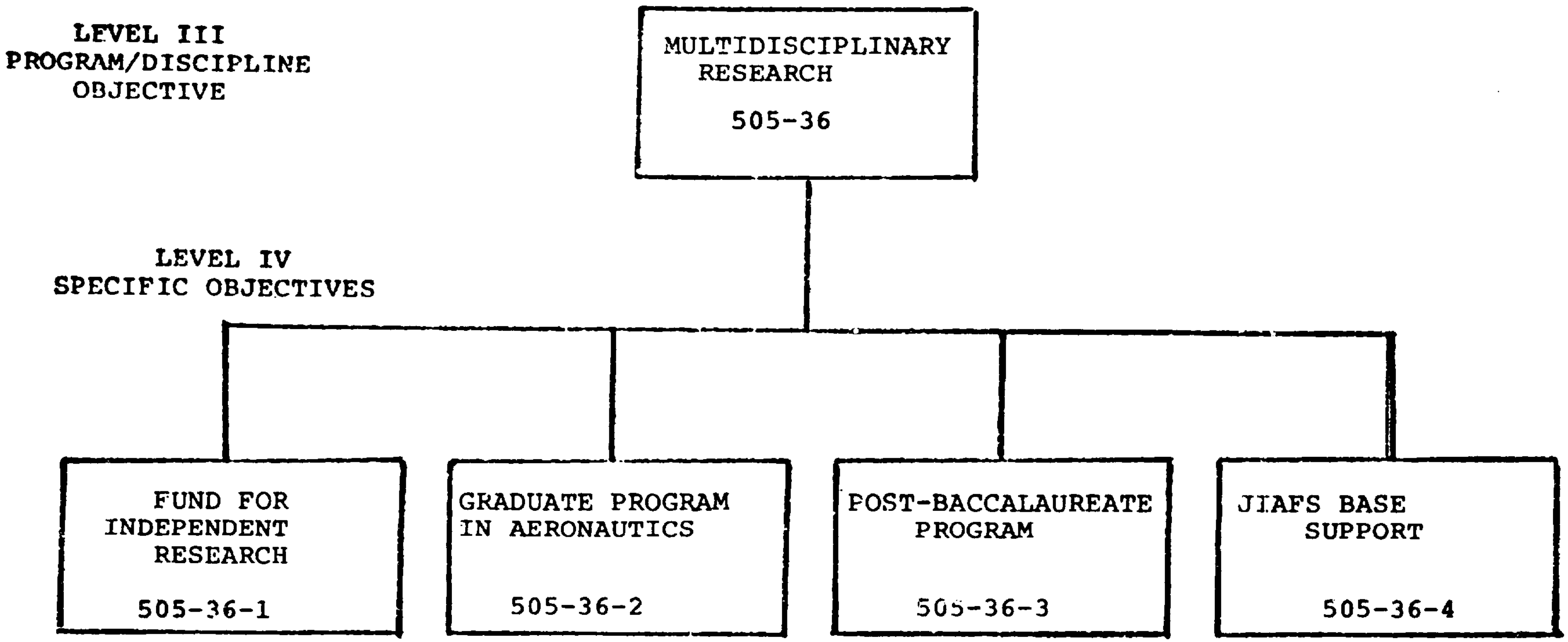
The MVSRF is a research facility consisting of two full-mission simulators which can be flown interactively or independently, together with a simulated air traffic control interface. One of the two simulators will represent a 727; the other a generic aircraft of the 1990-2000 time frame. The two simulators will share a computer-generated image (CGI) visual system. The 727 cab will also have a six degree-of-freedom motion system. The facility will be used to research aviation human factors issues requiring high operational fidelity such as: circadian desynchronosis, the role of automation in future cockpits, integrated predictive cockpit displays, and information management in advanced air traffic control systems.

MULTIDISCIPLINARY RESEARCH

9

MULTIDISCIPLINARY RESEARCH WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Multidisciplinary Research

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Research and Technology Division/ Raymond S. Colladay

PROGRAM/DISCIPLINE OBJECTIVE:

To conduct basic research of a multidisciplinary nature related to the field of aeronautics technology.

SPECIFIC OBJECTIVES:

- Fund for Independent Research: To conduct novel, long-range, high-risk, basic research investigations in engineering and physical sciences related to aeronautics through the support of unsolicited proposals and of proposals received in response to announcements of research opportunities in specific areas.

- Graduate Program in Aeronautics: To sponsor graduate training and research that is relevant and acceptable to both NASA and the university in the field of aeronautics. A significant portion of the training will be through student research conducted with faculty support at a NASA Center using NASA facilities.

- Post-Baccalaureate Program: To encourage a greater number of newly graduating, U.S. citizen engineers to pursue graduate training in aeronautical engineering.

- JIAFS Base Support: To provide a core level of funding for the Joint Institute for Advancement of Flight Sciences (JIAFS) which is an extension of the School of Engineering and Applied Science, George Washington University, located at Langley Research Center.

SPECIFIC OBJECTIVE

TITLE: Fund for Independent Research

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Research and Technology Division/Raymond S. Colladay

SPECIFIC OBJECTIVE:

To conduct novel, long-range, high-risk, basic research investigations in engineering and physical sciences related to aeronautics through the support of unsolicited proposals and of proposals received in response to announcements of research opportunities in specific areas, for example:

- Turbulence modeling
- Drag reduction
- Controls theory
- Propulsion efficiency

JUSTIFICATION:

The Fund for Independent Research provides resources to support proposals for innovative research, investigate high-risk concepts, and initiate fundamental studies in areas not presently included in a specific discipline program of the Office of Aeronautics and Space Technology (OAST). It allows OAST to respond to new ideas and concepts in order to ensure the continued, long-term growth in aerospace technology.

SPECIFIC OBJECTIVE

TITLE: Graduate Program in Aeronautics

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Research and Technology Division/Clinton E. Brown

SPECIFIC OBJECTIVE:

To sponsor graduate training and research that is relevant and acceptable to both NASA and the university in the field of aeronautics. A significant portion of the training will be through student research conducted with faculty support at a NASA Center using NASA facilities.

JUSTIFICATION:

The training of skilled researchers for the field of aeronautics is a major concern of NASA, not only to staff its own Centers, but also to assure their availability for the entire aeronautical community. Started at the behest of Congress, the program of Graduate Training in Aeronautics provides for excellent interactions among students, faculty and NASA Center personnel to conduct good research.

SPECIFIC OBJECTIVE

TITLE: Post-Baccalaureate Program

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Research and Technology Division/ Clinton E. Brown

SPECIFIC OBJECTIVE:

To encourage a greater number of newly graduating, U.S. citizen engineers to pursue graduate training in aeronautical engineering.

JUSTIFICATION:

A potential, and serious, reduction in the number of aeronautical engineers may develop in the U.S. within the next 5-10 years. This situation may result due to the dramatic decline expected in the number of 18 year olds graduating from high school in the next 6 years and the large number of present aeronautical engineers who will reach retirement age. Thus, it is essential that we begin immediately to encourage a greater fraction of the present engineering students to pursue careers in aeronautical engineering.

SPECIFIC OBJECTIVE

TITLE: JIAFS Base Support

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Research and Technology Division/Clinton E. Brown

SPECIFIC OBJECTIVE:

To provide a core level of funding for the Joint Institute for Advancement of Flight Sciences (JIAFS), which is an extension of the School of Engineering and Applied Science, George Washington University, located at Langley Research Center.

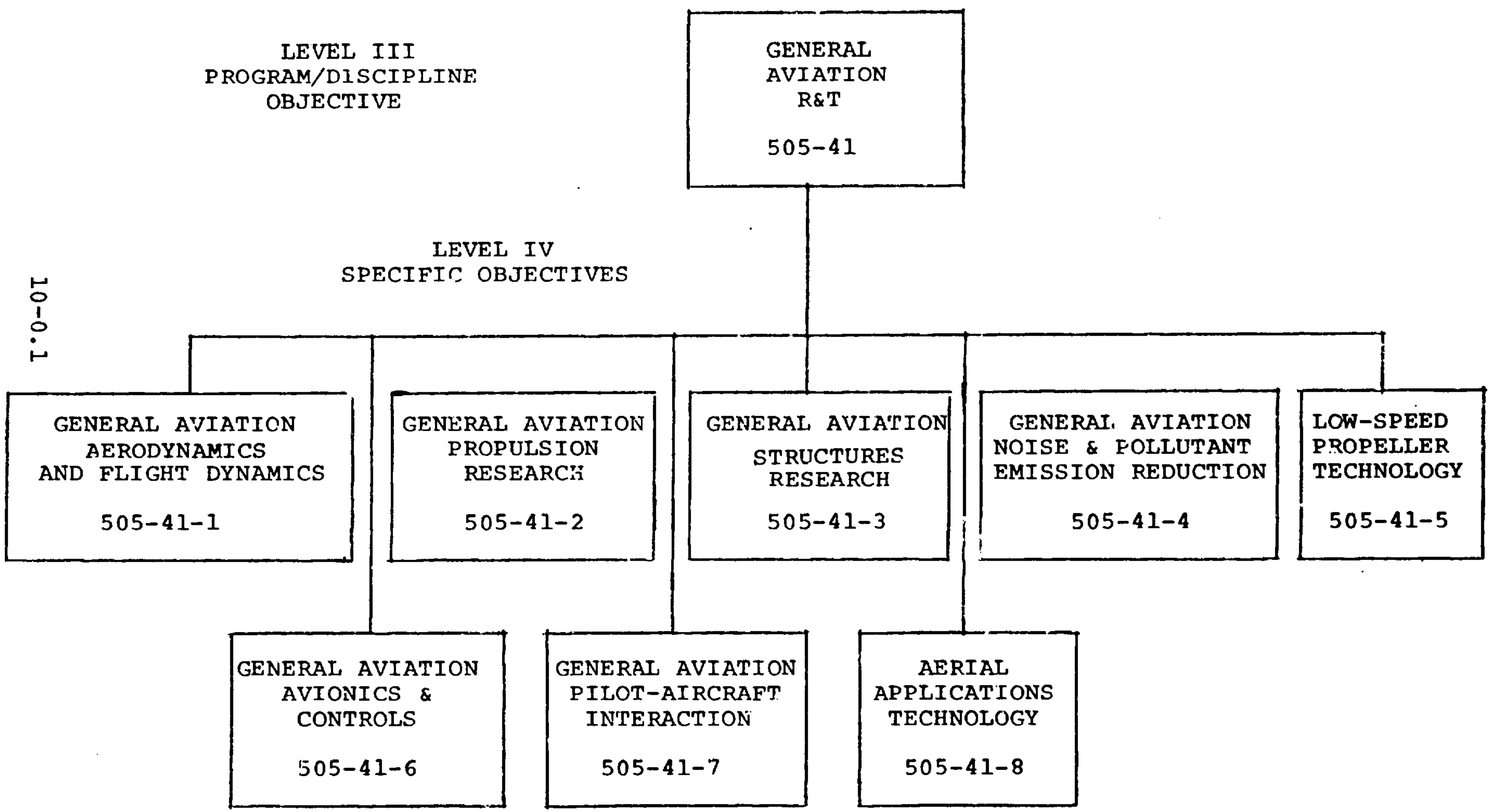
JUSTIFICATION:

In the past JIAFS has received all of its support through several separate grants (in FY 80 16 grants covered by 30 RTOP's) with the various research groups at Langley that it serves. However, this process places an unnecessary overhead burden on the negotiation of each grant for a small amount of administrative support and it fails to provide the flexibility to cover graduate stipends for top flight graduate students until a grant can be negotiated. The JIAFS core funding will resolve the difficulties.

GENERAL AVIATION R&T

10

GENERAL AVIATION R&T WORK BREAKDOWN STRUCTURE
LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: General Aviation R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

PROGRAM/DISCIPLINE OBJECTIVES:

To develop and demonstrate the feasibility of new technologies for improving general aviation aircraft and to promote early transfer of these technologies to industry. These objectives include improvements in safety, energy efficiency, utility and environmental impact based on advanced technology in aerodynamics and flight dynamics, propulsion, structures and materials, avionics and human factors.

SPECIFIC OBJECTIVES:

- General Aviation Aerodynamics and Flight Dynamics: To provide an advanced technology base for the design of general aviation and commuter transport aircraft that are safer, lower cost and more productive, including the development of advanced techniques and design data on aerodynamic performance, stability and control, stall/spin resistance, and handling qualities.
- General Aviation Propulsion Research: To establish the technology base for advanced gas turbine and intermittent-combustion general aviation engines which have reduced fuel consumption, weight and emissions, broad-specification fuels capability, lower cost and maintenance, and improved reliability.
- General Aviation Structures Research: To develop and demonstrate new concepts and analytical techniques in aircraft structural design for increased crash load energy absorption and occupant load alleviation and to develop technology for composite structures specifically tailored to the requirements of general aviation.

- General Aviation Noise and Pollutant Emission Reduction: To develop technology that will reduce general aviation noise and pollutant emissions with minimum weight, performance and economic penalties.

- Low-Speed Propeller Technology: To advance general aviation propeller technology in order to increase performance and reduce energy consumption, improve aircraft safety, and reduce aircraft noise.

- General Aviation Avionics and Controls: To develop and demonstrate advanced avionics and control concepts specially suited to general aviation aircraft which can lead to improved performance, safety, operational capability and compatibility with air traffic control systems, with particular emphasis on affordability and on single pilot operation.

- General Aviation Pilot-Aircraft Interaction: To study the functional roles and requirements on the general aviation pilot in current and future air transportation systems, and to investigate ways to reduce pilot work load, increase pilot efficiency and improve safety.

- Aerial Applications Technology: To develop new technology for improvements in the accuracy, safety, performance, efficiency, and productivity of existing and future agricultural aircraft and aerial applications dispersal systems, with particular emphasis on integrated aerodynamics system design.

SPECIFIC OBJECTIVE

TITLE: General Aviation Aerodynamics and Flight Dynamics

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

SPECIFIC OBJECTIVE:

To provide an advanced technology base for the design of general aviation and commuter transport aircraft that are safer, lower cost and more productive, including the development of advanced techniques and design data on aerodynamic performance, stability and control, stall/spin resistance, and handling qualities.

- o Perform analysis, wind-tunnel and flight testing of low drag natural laminar flow airfoils and wings.
- o Develop data and techniques for aerodynamic configuration and engine-cooling drag reduction.
- o Develop techniques for design of improved stall/spin characteristics.
- o Establish mission-related stability, control and handling qualities criteria.
- o Provide optimization procedures and design data for conventional and unconventional aircraft configurations.

TARGETS:

- o Complete model and full scale aircraft flight tests of stall/spin characteristics of T-tail aircraft. FY 1982
- o Initiate development of stall deterrent or spin prevention system concepts for twin engine aircraft. FY 1982

- o Complete initial flight evaluation of natural laminar flow (NLF) full span wing glove, and initiate design of complete NLF wing. FY 1982
- o Complete mission benefit/penalty trade-off analysis of advanced configurations for G.A. and commuter aircraft types. FY 1983
- o Develop data base for canard configuration design of general aviation aircraft. FY 1983
- o Complete evaluation of alternative propulsion system arrangements for advanced commuter aircraft design. FY 1983
- o Complete initial design and simulation of gust load alleviation and ride quality improvement concepts for commuter aircraft. FY 1983
- o Complete flight test evaluations of NLF wing. FY 1984
- o Provide spin-resistant design criteria. FY 1985

JUSTIFICATION:

General aviation has become indispensable in business and transportation and plays an increasingly important role in the overall economy. Recent additional emphasis includes special requirements for small commuter transport aircraft. In each area the need exists for important technological improvements related to arerodynamics and flight dynamics, including increased safety, increased efficiency, and greater utility. A better understanding of underlying aerodynamic design features to achieve stall/spin resistance and/or recovery techniques is needed, as well as improved control and handling qualities. For greater fuel efficiency, aerodynamic drag of all types must be reduced, while increased aircraft utility requires improved control and handling qualities as well as expanded operating envelopes. All these areas are appropriate topics for NASA research and technology investigations.

SPECIFIC OBJECTIVE

TITLE: General Aviation Propulsion Research

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

SPECIFIC OBJECTIVE:

To establish the technology base for advanced gas turbine and intermittent-combustion general aviation engines which have reduced fuel consumption, weight and emissions, broad-specification fuels capability, lower cost and maintenance, and improved reliability.

- o Enhance combustion process modelling.
- o Develop improved cooling techniques.
- o Advance turbosupercharger technology.
- o Conduct conventional and unconventional intermittent combustion engine research (spark ignition reciprocating and rotary combustion engines, and diesels).
- o Advanced general aviation turbine engine technology.

TARGETS:

o Evaluate the Lewis intermittent combustion processes simulation code, correlating it with experimental engine data.	FY 1982
o Establish cooling requirements of advanced piston engine combustion chamber configurations and evaluate cooling techniques.	FY 1982
o Complete studies of high altitude turbosupercharger technology requirements.	FY 1982

- Complete initial evaluation of airflow and fuel injection parameters for advanced two-stroke cycle diesel engines using a single cylinder research engine. FY 1982

- Complete intermittent combustion engine heat transfer codes for conventional and unconventional combustion chambers. FY 1983

- Complete initial airflow and combustion system evaluation of an advanced design stratified charge rotary combustion engine using a single rotor research engine. FY 1983

- Demonstrate design requirements for stratified charge fuel injection systems, based on effects of atomization, nozzle position and other parameters, relative to fuel consumption, emissions, and fuel grade tolerance. FY 1984

- Complete the technology readiness and base for candidate advanced engines. FY 1986

JUSTIFICATION:

Propulsion is a major factor in general aviation safety, fuel efficiency, utility, weight, cost, and environmental compatibility. Improvements are desired in each of these areas of concern but must be based on thorough research. Improved engines of all types, both conventional and unconventional, are potentially useful as future commuter and general aviation propulsion systems under specific circumstances, including reciprocating spark ignition and diesels, rotary combustion, and gas turbines. Improved turbosupercharging is also needed for several of these engine types. The lead time for industry development and incorporation of significant product changes and new engine types is quite lengthy, the process is quite costly, and the industry has limited capabilities for the kind of precursor research and technology needed. NASA is well suited to undertake the needed research and technology in order to reduce technical risks and encourage the earliest possible implementation of new technologies which can have major beneficial impact on general aviation.

SPECIFIC OBJECTIVE

TITLE: General Aviation Structures Research

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/ Raymond E. Rose

SPECIFIC OBJECTIVE

To develop and demonstrate new concepts and analytical techniques in aircraft structural design for increased crash load energy absorption and occupant load alleviation.

- o Develop analytical methods for predicting gross aircraft fuselage behavior during crash impact and the dynamic response of localized structural elements.
- o Develop design methodology to improve the energy absorption performance in both metallic and composite fuselage structure.
- o Develop load attenuating seat concepts with high performance restraint systems.
- o Develop low-cost, low temperature processable composite materials for aircraft structures.
- o Verify predicted performance of composite structures through design, fabrication and test of selected components.

TARGETS:

- o Verify structural concepts for combined general aviation seats and subfloor elements, analytically and experimentally using full-scale crash tests. FY 1982
- o Develop and demonstrate crash energy absorption concepts for general aviation aircraft subfloor structures. FY 1982

- o Complete integrated computer code for combined analysis of seat/occupant/restraint system. FY 1982
- o Complete parametric analyses and design trade studies to identify composite structural concepts for general aviation aircraft. FY 1982
- o Initiate low-cost manufacturing studies and development of composite structural concepts for general aviation aircraft. FY 1982
- o Initiate subfloor components tests and full-scale crash tests of composite structured general aviation aircraft. FY 1983
- o Complete composite design and manufacturing technology development for general aviation aircraft elements and subcomponents. FY 1985
- o Initiate demonstrations of advanced technology through design, fabrication and test of composite structural components. FY 1986

JUSTIFICATION:

With the growth of general aviation there has been increased concern over fatalities due to crashes in all types of aircraft and the need for improved fuel efficiency. Technology for advanced materials and design concepts which will reduce the likelihood and severity of transport aircraft fires is being addressed in the NASA Fire-Resistant Materials Engineering program, while this research addresses structural design concepts for both metallic and composite fuselage structures and the effects of crash impact. The degree of occupant survivability in both lightweight and transport aircraft crashes could be greatly enhanced by improved structural configuration design and materials selections to attenuate occupant loads and absorb crash impact energy in a protective manner.

This program is developing methods for large-deflection nonlinear analysis of aircraft structures, components and restraint systems; improved design concepts for better energy absorption and attentuation of loads transmitted to occupants; and will develop the technology to produce composite structure specifically suited for general aviation aircraft.

Composite structure offers high potential for improving performance and fuel efficiency of general aviation aircraft. To achieve this potential, technology developments are required to produce composite structures that are durable, lightweight, and cost competitive with metallic structures. Other benefits anticipated include improved damage tolerance, reliability and maintainability.

SPECIFIC OBJECTIVE

TITLE: General Aviation Noise and Pollutant Emission Reduction

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

SPECIFIC OBJECTIVE:

To develop technology that will reduce general aviation propulsion noise and pollutant emissions with minimum weight, performance and economic penalties.

TARGETS:

o Complete flight tests of propellers to demonstrate achievable noise and aerodynamic performance for single engine and light twin engine general aviation aircraft.	FY 1982
o Establish a data base for designing quiet propellers.	FY 1982
o Develop aeroacoustic design software and flight test quiet propellers for heavy twin engine general aviation and commuter aircraft.	FY 1984
o Develop, and implement in the Aircraft Noise Prediction Program (ANOPP), computer code modules for predicting all propulsion noise components for heavy twin engine general aviation and commuter aircraft.	FY 1984

JUSTIFICATION:

Aircraft noise near airport communities has been a long-time problem for general aviation. While some noise relief is possible through operational methods, significant improvements will depend on advances in the underlying technologies, particularly if undesired penalties in terms of efficiency and weight are to be avoided. While current Environmental Protection Agency aircraft pollutant emission control standards exempt general aviation, continued growth of the general aviation fleet, as well as commercial fleet, could lead to future constraints on general aviation if emissions levels are not reduced. As with noise, improvements in the underlying technologies are needed to make possible such reductions without incurring performance and operational penalties.

SPECIFIC OBJECTIVE

TITLE: Low-Speed Propeller Technology

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

SPECIFIC OBJECTIVE:

To advance general aviation propeller technology in order to increase performance and reduce energy consumption, improve aircraft safety, and reduce aircraft noise.

TARGETS:

- o Evaluate initial propeller proplet configurations. — FY 1982
- o Demonstrate performance of advanced propeller geometries capable of reducing fuel consumption by at least 5%. — FY 1983
- o Develop a preliminary system of integrated design/analysis computer codes for commuter and general aviation propellers. — FY 1983
- o Demonstrate technology of composite propeller blades 25% lighter in weight and more efficient than current propeller blades. — FY 1985

JUSTIFICATION:

Few basic improvements in general aviaton propeller design have occurred since World War II, yet recent advances in aerodynamic and acoustic theories and in composite structural design should be applicable to general aviation propellers, leading to important energy savings (more than 5 per cent), weight reductions (more than 25 per cent of blade weight), noise reductions (perhaps 6 dB), and improved structural reliability and safety. Strongly endorsed by the general aviation industry and user community, this research encompasses a broad spectrum of propeller sizes, power requirements and aircraft speeds applicable to commuter and general aviation. It complements ongoing programs for improving performance of general aviation engines (gas turbine, rotary combustion, and reciprocating spark ignition and diesel types).

SPECIFIC OBJECTIVE

TITLE: General Aviation Avionics and Controls

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Raymond E. Rose

SPECIFIC OBJECTIVE:

To develop and demonstrate advanced avionics and control concepts specially suited to general aviation aircraft which can lead to improved performance, safety, operational capability and compatibility with air traffic control systems, with particular emphasis on affordability and on single pilot operation. Research objectives include:

- o More effective Pilot Advisories;
- o Improved guidance/navigation capability;
- o Simplified procedures/operations;
- o Functional integration; and
- o Improved safety/utility.

TARGETS:

o Demonstrate a gyroless magnetometer for autopilot functions.	FY 1982
o Initiate DABS experimental flight tests.	FY 1982
o Demonstrate synthetic voice technology using low-cost systems.	FY 1982
o Complete development of digital in-flight IFR simulator.	FY 1983
o Initiate the fabrication of a laboratory evaluation model of an advanced modular-configured general aviation cockpit using low-cost, new and derivative display/generation devices and techniques.	FY 1984
o Demonstrate feasibility of satellite-aided IFR approach to uncontrolled airports.	FY 1985

JUSTIFICATION:

The trend toward greater use of and dependence on avionics systems in general aviation reflects a number of factors, including increasingly demanding air traffic control requirements, increasingly complex operational procedures, and much greater utilization of general aviation aircraft by business and industry, particularly under less than ideal traffic and weather conditions. These factors also cause an increase in the complexity of the on-board avionics and controls with an associated increase in systems costs. A related result is greater demands on the pilot in terms of training and proficiency in order to avoid any degradation in safety of operations (the majority of general aviation activities are single pilot operations). All these considerations indicate the need for research and technology for affordable advanced avionic systems specifically suited for general aviation applications, with particular attention to single pilot operational problems. The NASA program emphasizes systems concept investigation, evaluation of design techniques and criteria, and the investigation of the potential of sensors and control devices especially attractive for general aviation.

SPECIFIC OBJECTIVE

TITLE: General Aviation Pilot-Aircraft Interaction

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Raymond E. Rose

SPECIFIC OBJECTIVE:

To study the functional roles and requirements on the general aviation pilot in current and future air transportation systems, and to investigate ways to reduce pilot workload, increase pilot efficiency and improve safety.

TARGETS:

o Determine procedural and other software changes required to improve efficiency of single-pilot instrument flight rules (IFR) operations in current air traffic environment.	FY 1982
o Evaluate cockpit speech recognition and generation concepts.	FY 1982
o Evaluate a speech recognition/ synthesis system by simulation.	FY 1983
o Verify and validate advanced information and flight management concepts such as the Demonstration Advanced Avionics System (DAAS).	FY 1983
o Evaluate CDTI/DABS capability.	FY 1984

JUSTIFICATION:

General aviation has received little systematic human factors research and, yet, must operate in the same environment as transport aircraft. While the driving factors of the National Airspace System are the same for transport and general aviation aircraft, the wide variety of roles in general aviation which differ from commercial operations have not been addressed. The general aviation community represents a significant portion of aircraft operations with over 98% of all registered aircraft in this category. The community has a wide diversity of aircraft capability ranging from single-engine trainers to helicopters to business jets, and a wide range of pilot experience from student through commercial ratings. Further, general aviation pilots are required to perform many of the tasks of transport pilots without the aid of additional crew members and complex electronic equipment. It is necessary to better understand the demands placed on general aviation pilots and develop methods for assuring their efficient and safe participation in the National Airspace System, especially considering the numerous changes that are expected.

This program will provide the requisite studies to better understand the interface requirements and performance demands on the general aviation pilot and will provide design data for aircraft. The consequences of this program are anticipated to be more effective aircraft design and improvements in efficiency which impact safety.

SPECIFIC OBJECTIVE

TITLE: Aerial Applications Technology

Program/Discipline Objective Title: General Aviation R&T

Responsible Organization/Individual: Aeronautical Systems Division/Harry W. Johnson

SPECIFIC OBJECTIVE:

To develop new technology for improvements in the accuracy, safety, performance, efficiency, and productivity of existing and future agricultural aircraft and aerial applications dispersal systems, with particular emphasis on integrated aerodynamic system design.

- o Reduce drift of chemicals out of target areas and improve overall dispersal pattern uniformity.
- o Improve safety and performance in the high angle-of-attack phases of the mission.
- o Expand performance capability for high-volume dry-materials dispersal systems.

TARGETS:

o Complete flight tests to document effects of wake modification devices on dispersal patterns, airplane performance, and handling qualities.	FY 1982
o Publish wake interaction computer codes for predicting dispersal patterns.	FY 1983
o Complete ground-based experiments to develop design theory for high-volume dry-materials dispersal systems.	FY 1984
o Conduct flight experiments with high-volume aerial fertilizing dispersal systems.	FY 1985

JUSTIFICATION:

The use of aircraft has become an indispensable element in the production of food and fiber and in the protection of public health in the United States and many parts of the world. In the U.S., approximately 200 million acres are treated annually by over 8000 aircraft dispensing roughly $1 billion of agricultural chemicals. This use of aircraft accounts for approximately 10 percent of total U.S. agricultural productivity. Continued health and growth of this industry is dependent on overcoming several critical technological problems. Recent trends in the development of new agricultural aircraft indicate that current development of new aerial applications systems technology is necessary and timely.

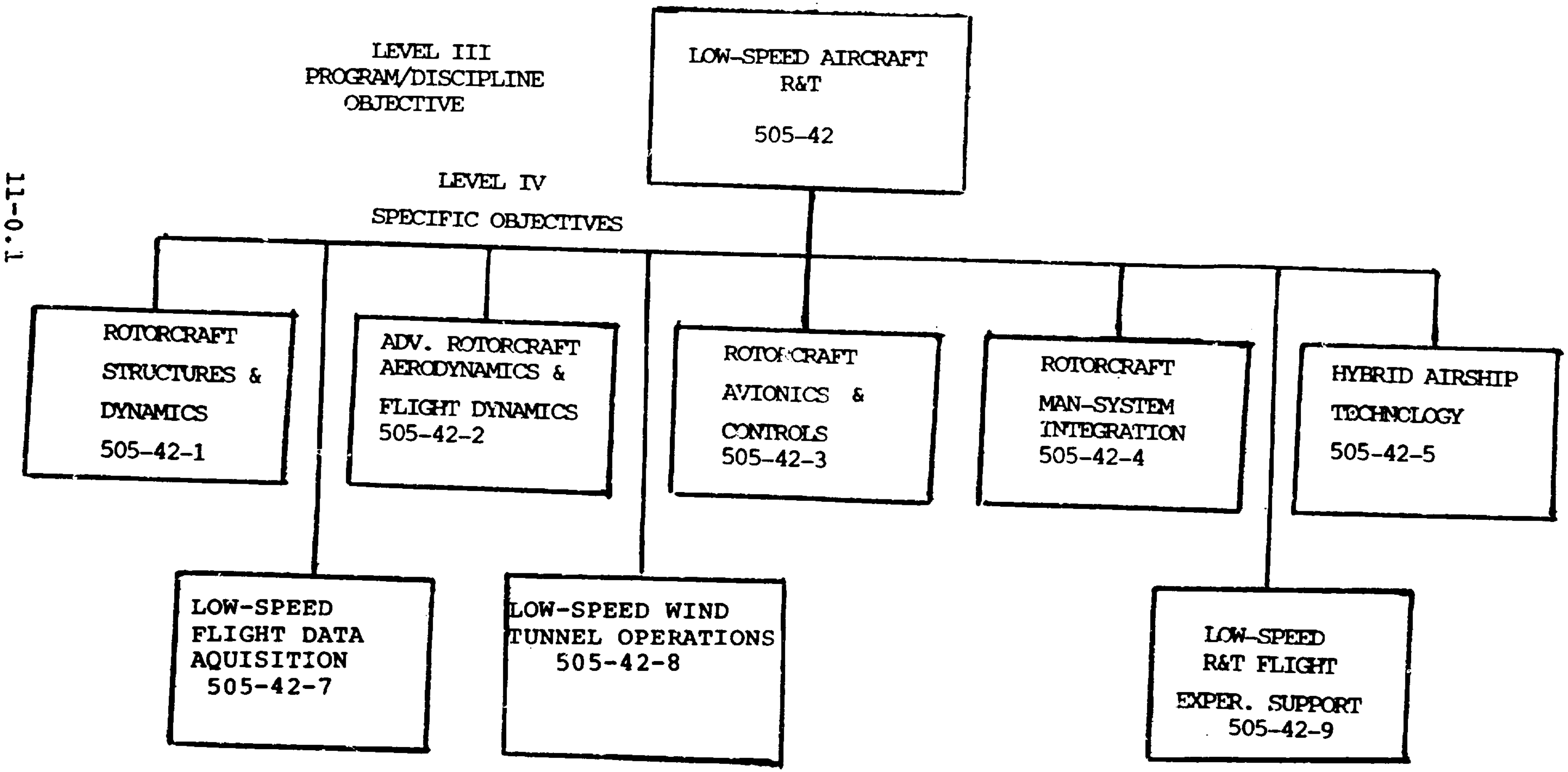
More precise and uniform applications of chemicals with minimum drift into nontarget areas must be achieved in light of rising costs of materials and concern over the adverse environmental effects of agricultural chemicals. Newly emerging agricultural aircraft designs are utilizing turbine engines, composite materials, and advanced configurations. With larger payloads and large amounts of excess power available for auxiliary functions, these aircraft designs may be capable of penetrating new markets such as high-volume aerial fertilizing. Research capabilities exist within NASA to provide the technology required for significant improvements in future aerial applications systems.

LOW-SPEED AIRCRAFT R&T

11

LOW-SPEED AIRCRAFT AERODYNAMICS & FLIGHT DYNAMICS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Low-Speed Aircraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

PROGRAM/DISCIPLINE OBJECTIVE:

To provide through state-of-the-art advances, improvements in 1) technology areas of rotorcraft structures, dynamics, aerodynamics, flight dynamics, controls, avionics, and man-system integration, 2) the understanding of hybrid rotor/airship feasibility, and 3) the technology areas of V/STOL aircraft propulsion, aerodynamics, and flight dynamics.

SPECIFIC OBJECTIVES:

- Rotorcraft Structures and Dynamics: To develop promising rotorcraft applications from state-of-the-art advances in materials, complex computerized prediction and new measurement techniques in selected disciplines: structures and materials (designs and usage), acoustics (external noise), and aeromechanics (loads, vibration, aeroelasticity), together with their associated testing techniques. To increase the understanding of the potential for reduced rotorcraft noise and vibration, and improved structural design.

- Advanced Rotorcraft Aerodynamics and Flight Dynamics: To increase the understanding of rotorcraft applications arising out of state-of-the-art advances in complex computerized prediction, new measurement techniques, electronic cockpit displays, and control augmentation in selected disciplines: aerodynamics and aero-acoustics (rotor wakes, local airloads, surface pressure predictions), rotor dynamics (stability, active controls, milti-cyclic control), and handling qualities. To lower the risk of rotorcraft design by providing accurate, correlated prediction methods in performance, loads and vibration, and in airloads for noise estimation. To provide data for revising air-worthiness standards for all-weather operation.

- Rotorcraft Avionics and Controls: To establish a technology data base in avionics and controls comprised of new and derivative components, concepts, and techniques for solutions to the unique problems impeding the safety, utility, and efficiency of rotorcraft vehicles.

- Rotorcraft Man-System Integration: To develop advanced information display, data entry and pilot interface techniques for helicopter IFR operations, low visibility landing, industrial mission performance and obstacle avoidance; develop pilot workload and stress assessment techniques to allow comparison of advanced helicopter control system navigation and guidance systems; and determine information requirements, pilot performance limits and operational procedures associated with improved helicopter flight operations.

- Hybrid Airship Technology: To provide the technology required and evaluate concepts for the design and development of hybrid airships which combine aerostatic (buoyant) lift with rotor thrust and control systems.

- Low-Speed Flight Data Acquisition: To provide safe and productive acquisition of flight research data.

- Low-Speed Wind Tunnel Operations: To provide safe and productive operations of the wind tunnel facilities for low-speed aerodynamic and noise research at Ames.

- Low-Speed R&T Flight Experiments Support: To provide a ground-based support capability for Ames research aircraft flight experiments in low-speed aerodynamics, acoustics, flight dynamics and control, guidance and navigation and avionics systems for advanced vehicles including rotorcraft, V/STOL and STOL aircraft.

SPECIFIC OBJECTIVE

TITLE: Rotorcraft Structures and Dynamics

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To develop promising rotorcraft applications from state-of-the-art advances in materials, complex computerized prediction and new measurement techniques in selected disciplines: structures and materials (designs and usage), acoustics (external noise), and aeromechanics (loads, vibration, aeroelasticity), together with their associated testing techniques. To increase the understanding of the potential for reduced rotorcraft noise and vibration, and improved structural design.

TARGETS:

Acoustics

- o Develop and validate a comprehensive design-for-noise capability accurate to $\pm$ 3dB by 1985 by adding to the Farassat/Nystrom program broadband noise modeling (1982) and nonlinear terms (1983) - LaRC.

Aeromechanics

- o Validate a next-generation aeroelastic prediction capability for isolated rotor dynamic loads, vibration and aeroelastic stability (FY 1983) using data generated through new, highly detailed, small scale tests (FY 1982) - ARC.

- o Develop methods for predicting dynamic stall and tip effects (FY 1982) which will lead to more advanced, verified methods for all unsteady aerodynamic phenomena due to airfoil pitch, plunge and yaw (FY 1985) - LaRC.

- o Complete a feasibility flight test in a joint program of a higher harmonic control system to demonstrate vibration levels below .05g throughout the flight envelope (FY 1982) - LaRC.

- o Complete development of analysis of coupled rotor-fuselage vibratory response (FY 1982) - LaRC.

- o Establish the feasibility of optimizing blade design for minimizing vibratory loads using tailored stiffness, planform and mass distribution (FY 1984) - LaRC/ARC.

Structures and Materials

- o To quantify the effects of long-term flight exposure on the strength of secondary Kevlar structures (FY 1987) and primary graphite structures (FY 1990) to determine design criteria and specifications - LaRC.

JUSTIFICATION:

The development of composite materials, ultra-fast computers, micro-electronics, and new measurement techniques has opened up new opportunities for quantum improvements in rotorcraft vibration, external noise, and durable, light-weight structures. Vibration and external noise seriously compromise the acceptance and economic utility of both military and civilian rotorcraft. For the rotor system, the use of composites in blade manufacture allows specific tailoring of design parameters that can reduce vibration and noise. It now appears possible to optimize the design of a composite blade in a cost-effective manner. In addition, the use of microprocessors and high speed actuators now allows higher harmonic control of blade pitch that promises even greater reductions in vibration as well as active control for gust alleviation, performance enhancement, noise control, etc.

In the fuselage, the application of thin guage composites is unique to rotorcraft and merits a long term evaluation of the strength degradations on an operating helicopter. Such work should lead to the confident specification of such materials in primary structures where weight, crashworthiness, and durability (corrosion) are important. For a VTOL that frequently operates in a salt spray environment the use of composites is of unique significance.

SPECIFIC OBJECTIVE

TITLE: Advanced Rotorcraft Aerodynamics and Flight Dynamics

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To increase the understanding of rotorcraft applications arising out of state-of-the-art advances in complex computerized prediction, new measurement techniques, electronic cockpit displays, and control augmentation in selected disciplines: aerodynamics and aero-acoustics (rotor wakes, local airloads, surface pressure predictions), rotor dynamics (stability, active controls, multi-cyclic control), and handling qualities. To lower the risk of rotorcraft design by providing accurate, correlated prediction methods in performance, loads and vibration, and in airloads for noise estimation. To provide data for revising air-worthiness standards for all-weather operation.

TARGETS:

Aerodynamics and Aero-acoustics

- To analyze and test rotorcraft component phenomena (ARC):
  - dynamic stall of an advanced airfoil, test, pitch only (FY 1982), plunge (FY 1983) and tip sections (FY 1984).
  - large scale circulation control airfoil, test (FY 1982).
  - unsteady aerodynamic interaction of blade and vortex, test (FY 1982).
  - rotor/fuselage aerodynamic interaction, analysis, simple geometrics (FY 1982), rotor/fuselage/tail/tail rotor interactions (FY 1983).
  - complete 3-D aerodynamic code development, rigid blade, single azimuth cases (FY 1984).

- complete analysis and correlation of analytical models of rotor aerodynamics and dynamics (FY 1984).

o To conduct small scale rotor tests measuring airloads in sufficient detail for input to LaRC noise prediction techniques (FY 1984) - ARC. To understand the scaling laws for such measurements using full-scale tests and real world effects through flight test evaluations of noise and surface pressures (FY 1984) - ARC.

o To provide data on small scale tests that are jointly sponsored by the Army in the LaRC V/STOL tunnel in performance, noise, hub and pylon aerodynamics, flow visualization and fuselage mounted wings (FY 1982) - LaRC.

Rotor Dynamics

o Complete analysis of open-loop, closed-loop, and adaptive multi-cyclic control (FY 1984), following the test of a multi-cycle control system in the 40 x 80-ft. wind tunnel - ARC.

Handling Qualities

o Define helicopter minimum control augmentation and display requirements for low level terrain following military missions (FY 1985) - ARC.

o Complete a data base to define acceptable control and display systems of minimum cost and complexity, and define certification criteria for instrument and non-instrument terminal operations (FY 1984) - ARC.

JUSTIFICATION:

The development of ultra-high speed computers and new measurement techniques has opened up the promise of accurate prediction methods in the detailed aerodynamic phenomena responsible for noise, vibration, and blade loads. A fully integrated methodology incorporating high mode, coupled structural dynamics, 3-D lifting surface Navier Stokes aerodynamics with free wake modeling and interactions with other surfaces is currently beyond the state-of-the-art. Therefore, the prediction methods currently concentrate on component or isolated parameters to identify ways to reduce noise, vibration and loads, while retaining high performance.

In addition to the above opportunities, multi-cyclic control may demonstrate the feasibility of large reductions in vibration in a proof-of-concept flight test. If that is true, systematic wind tunnel tests are needed to explore its full utilization for optimization of performance, noise, and loads, and perhaps active control applications in gust alleviation and automatic responses to emergencies (tail rotor loss, engine failure, etc.). Overall, this technology promises quantum jumps in rotorcraft safety and reliability, two of the leading complaints of civilian helicopter users.

The same microprocessor technology that makes multi-cyclic control feasible also has opened up opportunities for light-weight, inexpensive cockpit displays and augmentation systems. Such developments may allow cost-effective operations in difficult rotorcraft tasks such as terrain following, and IFR terminal approaches. The work under this objective broadens the uses and capabilities of helicopters which should expand civilian markets and enhance national security missions.

SPECIFIC OBJECTIVE

TITLE: Rotorcraft Avionics and Controls

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jeffrey H. Godfrey

SPECIFIC OBJECTIVE:

To establish a technology data base in avionics and controls comprised of new and derivative components, concepts, and techniques for solutions to the unique problems impeding the safety, utility, and efficiency of rotorcraft vehicles, emphasizing the areas of:

- Remote site navigation and guidance
- Advanced stability and control systems
- Low-speed sensors

TARGETS:

- ARC - Complete design of advanced actuators for rotor control - FY 1982.

JUSTIFICATION:

The rotorcraft sector of aviation has grown significantly in the past decade due to its unique capability for fast, short-range transportation and remote-area operations. It is becoming a major element in forest management, resource exploration, public service, construction projects, and cargo distribution. To assure the growth of this important segment of aviation, a technology data base in avionics and controls is needed to provide the foundation for required improvements in safety, all-weather operations, flying qualities, and reliability/maintainability. The application of concepts such as active controls and fly-by-wire can ultimately provide ride qualities equivalent to fixed wing aircraft making the vehicle utilization more acceptable. Similarly, on-board guidance concepts can be developed permitting rotorcraft to meet remote-site operational demands.

SPECIFIC OBJECTIVE

TITLE: Rotorcraft Man-System Integration

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jeffery H. Godfrey

SPECIFIC OBJECTIVE:

To develop advanced information display, data entry, and pilot interface techniques for helicopter IFR operations, low visibility landing, industrial mission performance, and obstacle avoidance; develop pilot workload and stress assessment techniques to allow comparison of advanced helicopter control system navigation and guidance systems; and determine information requirements, pilot performance limits, and operational procedures associated with improved helicopter flight operations.

TARGETS:

- o Initiate studies of integrated controller for reduction of pilot manual workload -- FY 1982.
- o Determine pilot/crew information requirements for future ATC procedures and improved helicopter flight operations -- FY 1982.
- o Complete Human Engineering Analysis for TAFCOS/Multilift studies -- FY 1982.
- o Complete simulation and data collection of the TAFCOS/Multilift study analysis -- FY 1983.
- o Complete development of standard helicopter pilot workload and performance measurement methods -- FY 1984.

JUSTIFICATION:

Helicopters, which represent over 60% of all U.S. military aircraft, have recently assumed an increasingly important role in a wide variety of civil applications, including corporate transportation , industrial applications, and public services. Because of the rapid expansion of the U.S. civilian fleet, which is conservatively expected to double within the next ten years, the FAA has become increasingly interested in developing aircraft certification criteria, operational procedures and traffic control methods which can cope effectively with unique helicopter characteristics, particularly IFR certification requirements, procedures for low-level and remote area navigation, low visibility landing criteria, specifications for urban heliports, and simulator methodologies for aircraft certification and helicopter pilot training. Although many of these considerations are topically similar to problems in the fixed-wing area, the fact that helicopters have different kinds of workload demands on the aircrew necessitates that these issues be given separate research consideration.

SPECIFIC OBJECTIVE

TITLE: Hybrid Airship Technology

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Norman J. Mayer

SPECIFIC OBJECTIVE:

To provide the technology required and evaluate concepts for the design and development of hybrid airships which combine aerostatic (buoyant) lift with rotor thrust and control systems.

- Develop the design elements and criteria required for determination of the flight and control characteristics, aeroelasticity, and dynamics and response to ground winds and gusts of hybrid airships
- Determine efficient configurations and design concepts for hybrid vehicles suited for short haul heavy lift and long endurance patrol.
- Identify characteristics and criteria required for hybrid airship subsystems and components.
- Provide technical assistance to other agencies in the evaluation of advanced airship concepts.

TARGETS:

- Develop complete linear equations of motion for four rotor hybrid configurations in FY 1982.
- Develop aeroelastic characteristics of suspension system, envelope, and car structure of hybrid airships in FY 1982.
- Identify characteristics and requirements for large-scale and full-scale components for ground testing in FY 1982.
- Large-scale wind tunnel tests in FY 1982.

JUSTIFICATION:

Recent studies have determined that most modern lighter-than-air vehicles will require various combinations of rotor and propeller thrust to augment static lift and provide sufficient low speed control during take-off, landing, and cargo handling operations. These aircraft will consist of new hybrid configurations which necessitate development of a new technology base in aerodynamics, control, aeroelasticity, and operational techniques.

SPECIFIC OBJECTIVE

TITLE: Low-Speed Flight Data Acquisition

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

SPECIFIC OBJECTIVE:

To provide safe and productive acquisition of flight research data.

- Support ground-based instrumentation and data acquisition facilities.
- Support the development of advanced flight test instrumentation.
- Maintain modern flight data reduction, display, and real-time data monitoring capabilities.
- Support simulation/RPRV improvement.
- Support flight loads calibration facilities upgrade.

TARGETS:

- Provide support of approved facility upgrading at DFRC including the Simulation/RPRV Facility and the Flight Loads Facility.

JUSTIFICATION:

Flight test of advanced aeronautical vehicles requires highly productive ground-based and flight data systems. The productivity of such systems is dependent on the rapid acquisition of accurate data from carefully planned and executed flights of research aircraft. Important precursor activities include accurate calibration of flight instrumentation, including flight loads measurement systems. In addition, advanced simulation and RPRV techniques may be coupled to increase the productivity of high-risk flight investigations.

A critical aspect of achieving high productivity in flight data handling is related to the manner in which new computational capability is assembled in a system to provide real-time monitoring of flight data for safety and flight-progress control. The timely conversion of flight data to engineering units, plotted in appropriate format, is also essential to expedite the publication of flight research results.

SPECIFIC OBJECTIVE

TITLE: Low-Speed Wind Tunnel Operations

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

SPECIFIC OBJECTIVE:

To provide safe and productive operations of the wind tunnel facilities for low-speed aerodynamic and noise research at Ames.

- Support experimental research to provide baseline data for the development of accurate prediction methods for vehicle performance, stability, and control in low-speed flight, V/STOL aerodynamics, and rotorcraft aeromechanics.
- Support research into aircraft noise generation and its effects in relation to aircraft design.
- Maintain, operate, and improve the Static Test Facility and the 7 x 10-ft. wind tunnel.
- Support the 40 x 80-80 x 120-ft. operational check-out, data systems readiness, and bring the test complex to operational status.

TARGETS:

- Following modification of 40 x 80-80 x 120-ft. complex, bring it to operational status during FY 1982.
- Support low-speed aerodynamic and noise wind tunnel testing at Ames during FY 1982.

JUSTIFICATION:

Research on low-speed aerodynamics for all aircraft is essential. Precise prediction methods, especially for maximum lift, drag, V/STOL aerodynamics, and rotorcraft aeromechanics are not available and will not be in the foreseeable future. It is therefore necessary to conduct experimental research both to provide answers and to provide data for the development of accurate prediction methods. In many of these problems, the need to match Reynolds Number, Mach Number, structural dynamics, or propulsion parameters dictate full- or large-scale experiments in the 40 x 80-80 x 120-ft. complex.

With the recent concentration on maintaining a quality environment, and resultant civil regulations, noise has become as important a parameter in airplane design as is aerodynamics. Recent research has shown that configuration effects on noise generation are substantial, and thus noise research has become an important segment of low-speed aircraft research programs.

SPECIFIC OBJECTIVE

TITLE: Low-Speed R&T Flight Experiments Support

Program/Discipline Objective Title: Low-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

SPECIFIC OBJECTIVE:

To provide a ground-base support capability for Ames research aircraft flight experiments in low-speed aerodynamics, acoustics, flight dynamics and control, guidance and navigation, and avionics systems for advanced vehicles including rotorcraft, V/STOL and STOL aircraft.

- o Provide laser and radar tracking.
- o Provide real-time and post-flight test data acquisition.
- o Provide precision landing information with Microwave Landing System aids.
- o Provide meteorology and noise measurement systems.
- o Provide a data link between ARC and field test facilities.

TARGETS:

- o Improve near-real-time dynamic data acquisition, monitoring, and processing capability at Ames - FY 1983.
- o Provide data acquisition support for the Rotorcraft/VTOL Operations area at ARC - FY 1984.

JUSTIFICATION:

Flight evaluations play a vital role in the Ames Research Center's broad program of analytical and experimental research in aerodynamics, acoustics, flight dynamics and control, guidance and navigation, and avionics systems with emphasis on advanced rotorcraft, V/STOL and STOL aircraft, and support of other government agencies. An essential part of these flight evaluations are ground-based facilities for tracking, data acquisition and processing, landing systems aids, meteorology and noise measurement systems needed to gather, process, and properly display the data required for the safe and efficient conduct of flight evaluations.

HIGH-SPEED AIRCRAFT R&T

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HIGH-SPEED AIRCRAFT R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV

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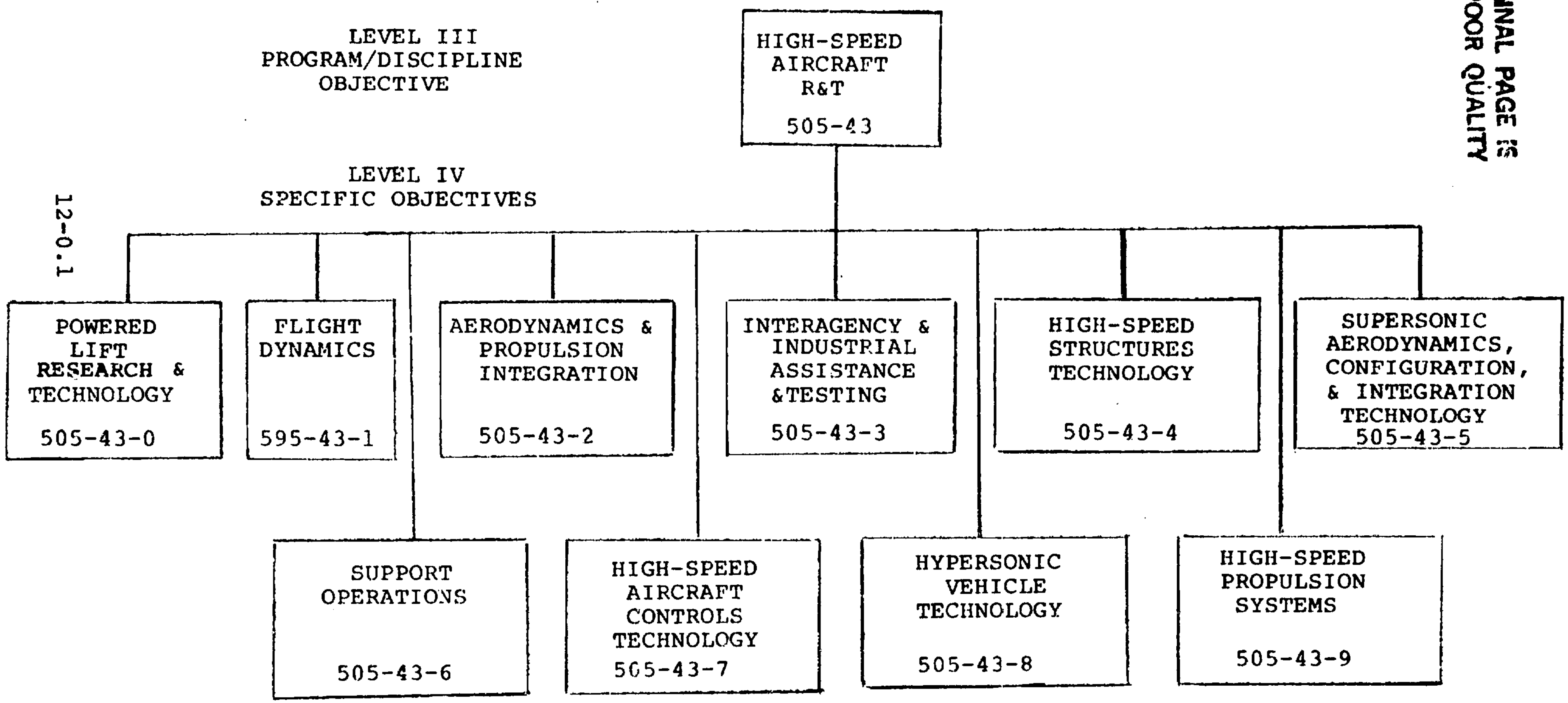


PROGRAM/DISCIPLINE OBJECTIVE

TITLE: High-Speed Aircraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine

PROGRAM/DISCIPLINE OBJECTIVE:

To generate technology advancements needed to achieve improved high-speed aircraft, including economic, safe, and reliable civil aircraft and technologically superior military vehicles and systems.

SPECIFIC OBJECTIVES:

- Powered Lift Research and Technology: To provide the unique analytical methods, advanced experimental test techniques, and the technology base in the areas of aerodynamics, propulsion, configuration integration and flight dynamics required for the development of effective high performance powered lift aircraft including both vertical/short takeoff and landing (V/STOL) and short takeoff and landing (STOL).

- Flight Dynamics: To develop better understanding of basic phenomena, improved analytical and experimental techniques, and new concepts related to dynamic and handling-qualities characteristics of aircraft in all flight regimes but especially in the high angle-of-attack stall/spin area.

- Aerodynamics and Propulsion Integration: To develop, through analytical and experimental studies and tests, an aerodynamics and propulsion integration technology data base for advanced configuration concepts applicable to the design of improved future military and civil high-speed airplanes and missiles.

- Interagency and Industrial Assistance and Testing: To provide technical assistance, consultative services, and support through the use of NASA facilities to other Government agencies and the airplane/missile industry.

- High-Speed Structures Technology: To establish a high temperature structures and materials technology base that permits significant reductions in structural weight by research on new materials, structural design, and fabrication techniques providing satisfactory fatigue, fracture, and thermal/cyclic life characteristics under high speed flight conditions.

- Supersonic Aerodynamics, Configuration, and Integration Technology: To develop a technology data base for high-speed military and civil aircraft design concepts incorporating improved aerodynamic performance, advanced configurations, and propulsion system/airframe integration techniques.

- Support Operations: To provide support and operations of the high-speed wind tunnels at the Ames Research Center and flight vehicle support for required chase planes, flight-readiness flying, remotely-piloted vehicle drops, and other support activities at the Dryden Flight Research Center.

- High-Speed Aircraft Controls Technology: To develop integrated airframe/propulsion control system technology essential for future high-speed aircraft.

- Hypersonic Vehicle Technology: To carry out a program of applied research to develop key technologies to support future development of air-breathing aircraft and missiles in the Mach 3-8 class.

- High-Speed Propulsion Systems: To develop the critical advanced propulsion component technologies necessary for future civil/military, high-speed cruise aircraft. Components that operate at sustained high temperatures and stresses with variable cycle features that will permit efficient operation over the speed range and to meet environmental requirements for civil applications under static and flight conditions.

SPECIFIC OBJECTIVE

TITLE: Powered Lift Research and Technology

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Gordon Banerian

SPECIFIC OBJECTIVE:

To provide the unique analytical methods, advanced experimental test techniques, and the technology base in the areas of aerodynamics, propulsion, configuration integration and flight dynamics required for the development of effective high performance powered lift aircraft including both vertical/short takeoff and landing (V/STOL) and short takeoff and landing (STOL).

- Improve powered lift flow and performance prediction methods.
- Develop and validate improved powered lift experimental tests techniques.
- Improve the lift/thrust performance and control vectoring of powered lift propulsive systems for the diverse operating environment of STOL and V/STOL flight.
- Evaluate flight control systems and display concepts to define general flight dynamics design and operational criteria for ship- and land-based V/STOL aircraft.
- Improve powered lift aircraft flight test techniques and ground-based simulation modeling.
- Provide a data base for powered lift aircraft configuration and propulsion system integration through selected small- and large-scale powered model investigations of criteria to optimize overall configuration aerodynamic performance, propulsion integration, control, and stability.
- Determine the flight and operational characteristics of representative advanced powered lift aircraft designs through piloted real-time simulation evaluations.

- o Provide computational and experimental support for cooperative NASA/Navy powered lift technology development activities as mutually agreed upon and funded by the Navy.

TARGETS:

- o Perform initial test evaluation of compact multimission aircraft propulsion simulator for small-scale powered model research. (ARC) FY 1982

- o Evaluate the high-speed aerodynamic characteristics of four twin-engine powered lift configurations through wind-tunnel tests with flow-through nacelle models. (ARC) FY 1982

- o Evaluate the high-speed aerodynamic characteristics of single-engine V/STOL fighter characteristics through competitively awarded contractor design studies. (ARC) FY 1982

- o Evaluate powered lift inlet cruise drag with new balance system in 12-inch diameter subsonic V/STOL propulsion model. (LeRC) FY 1982

- o Evaluate powered lift thrust modulation by variable pitch fan blades and variable inlet guide vanes on 20-inch diameter subsonic V/STOL propulsion model. (LeRC) FY 1982

- o Evaluate design criteria for optimized use of propulsion integrated in a supercruiser configuration concept for high lift, thrust reversing/vectoring and longitudinal trim control through test of a modest-scale powered model. (LeRC) FY 1983

- o Develop general criteria from ground-based simulation for design of control and display concepts to provide satisfactory V/STOL handling qualities and flight operational characteristics. (ARC) FY 1983

- o Evaluate the low-speed characteristics in hover and transition flight of a large-scale close-coupled canard twin-engine powered lift fighter configuration. (ARC) FY 1983

- o Examine the aerodynamic and simulated flight characteristics of a subsonic twin tilt nacelle utility V/STOL design throughout its speed and altitude envelope. (ARC) FY 1983

- o Evaluate a stealthy supersonic powered lift inlet concept through 12-inch diameter propulsion model test. (LeRC) FY 1983
- o Determine through model tests the performance and stealth characteristics of a stealthy supersonic powered lift propulsive nozzle concept. (LeRC) FY 1984
- o Develop advanced computational methods for V/STOL inlet flow fields, forebody/inlet interactions, and propulsion streams to identify propulsion-induced effects and airframe/propulsion interactions. (ARC) FY 1984
- o Develop the technology, and provide and validate experimental systems for simulating propulsion in small powered lift aircraft models in high-speed wind tunnels. (ARC) FY 1984
- o Examine the performance of advanced ejector concepts for thrust augmentation in hover, ground effect and transition flight. (ARC) FY 1984
- o Develop and verify advanced methods for correcting and evaluating wall effects, for measuring ground effect in large wind tunnels, and for three-dimensional sophisticated measuring of V/STOL flows including direction, pressure, temperature and turbulence. (ARC) FY 1985
- o Provide design methodology for predicting aerodynamic characteristics of V/STOL aircraft in transition flight and while hovering in and out of ground effect under the influence of propulsive flow. (ARC) FY 1986

JUSTIFICATION:

The great value of V/STOL flight capability in both the civil and military marketplace is well demonstrated by the growing use of helicopters. High speed fixed wing, powered lift aircraft have begun to make important operational inroads through the Harrier and Freehand aircraft programs in the U.S. and abroad. The Navy is striving to realize the potential of additional powered lift aircraft types to greatly increase its sea-based-air effectiveness. The Air Force has renewed interest in the use of powered lift for a number of requirements, with particular attention to runway denial situations. However, the technical difficulties in overcoming the inherent vehicle penalties associated with providing STOL and V/STOL flight capability (which tend to become greater as aircraft design speed and range increase) have been important factors in stalling powered lift aircraft development programs.

NASA-conceived and -conducted R&T Base powered lift programs since the 1950's have had a large part in forming the technology base for the recent growing military interest in powered lift. NASA must continue a strong powered lift base program as the lifeline for both near- and far-term powered lift aircraft developments, to attain marked improved computational and experimental techniques specifically oriented to the unique needs of powered lift, and to maintain a broad integrated technology base applicable to most potential powered lift aircraft types in the general areas of configuration aerodynamics, propulsion systems and flight dynamics.

SPECIFIC OBJECTIVE

TITLE: Flight Dynamics

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/David Kier

SPECIFIC OBJECTIVE:

To develop better understanding of basic phenomena, improved analytical and experimental techniques, and new concepts related to dynamic and handling-qualities characteristics of aircraft in all flight regimes but especially in the high angle-of-attack stall/spin area.

- o Develop analytical techniques for determining stability and control characteristics from flight test data.
- o Develop theoretical and experimental techniques for determining aircraft stall/spin behavior, for establishing the fundamental and aerodynamic influences and for achieving desired resistance or recovery characteristics.
- o Develop new approaches for analyzing handling qualities and for achieving specific aircraft dynamic responses.

TARGETS:

- o Develop technology for rockets for emergency spin recovery and perform flight tests (RPRV) of rocket spin recovery concepts in FY 1982.
- o Develop forced-oscillation dynamic stability measurement capability for high angles of attack and Reynolds numbers during FY 1982.
- o Conduct exploratory investigations of new dynamic test apparatus to determine the significance of data obtained from these new techniques.
- o Complete the flight evaluation of nose shapes on stall/spin characteristics using the Spin Research Vehicle. Initiate modification of SRV to 3-surface configuration.

- Continue the cooperative program between LaRC and DFRC, investigating causes and cures of wing rock during FY 1982.

- Evaluate high angle-of-attack characteristics employing wind-tunnel simulators and, when appropriate, drop models of advanced configurations (forward swept wing, supersonic cruise, canards, 3-surface).

- Develop an analytical method for determining spin entry and recovery behavior by end of FY 1983.

JUSTIFICATION:

The dynamic stability and control characteristics of aircraft and their handling qualities have significant influence on aircraft usefulness, efficiency, and safety in actual operations. Although research in these areas, is, for the most part, strongly mission- and vehicle-type oriented, continued development of fundamental understanding and improved basic analytical and experimental techniques is essential for a strong foundation of future-directed investigations. The trend of increased application of active control technology to a variety of aircraft systems establishes the need for and timeliness of developing advanced techniques for determining aerodynamic/structural/control system characteristics from flight test data, and the practicality of this technology brings about the need for new concepts and approaches for its application to achieve desirable response and handling behavior.

Military aircraft continue to experience inadvertent loss of control when performing maneuvers at high angles-of-attack and, in many cases, fatal aircraft accidents result due to stall at low altitude or unrecoverable spins. Improved analytical and experimental techniques are needed so that future aircraft can be designed with desired spin resistance or recovery characteristics. The broad flight regime of stall, post-stall, spin and spin recovery is one wherein the aerodynamic stability and control characteristics are of great significance and, at the same time, very difficult to establish with desired accuracy, necessitating advancements in experimental capabilities. The efforts under this specific objective advance the technology applied to military aircraft and are coordinated with the DOD.

SPECIFIC OBJECTIVE

TITLE: Aerodynamics and Propulsion Integration

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To develop, through analytical and experimental studies and tests, an aerodynamics and propulsion integration technology data base for advanced configuration concepts applicable to the design of improved future military and civil high-speed airplanes and missiles.

- o Formulate advanced concepts for improved supersonic cruise and maneuver capability of combat airplanes and missiles.
- o Conduct wind-tunnel and ground-facility tests of advanced aerodynamic configurations, inlet designs, and nozzle concepts over a wide range of speeds, from subsonic to transonic and supersonic, and at simulated combat operating conditions.
- o Formulate and test improved methods of integrating missiles with the carrying aircraft and achieving high-speed release.
- o Apply advanced aerodynamic and propulsion integration concepts to derivatives of existing combat aircraft to determine performance and maneuverability advantages.
- o Perform selected aerodynamic experiments to obtain data and improve techniques for the comparison of theoretical predictions with ground and flight test results.

TARGETS:

- o Complete, by FY 1982, ground facility tests of a versatile, low-aspect-ratio, non-axisymmetric research nozzle.

- Initiate, by FY 1982, wind tunnel tests of nozzle design and installation concepts with significant potential for reducing observables.

- Develop, by FY 1983, the aerodynamic technology base for the design of monoplanar missiles with high-speed cruise and maneuver capability.

- Initiate, by FY 1984, ground facility tests of a high-aspect-ratio non-axisymmetric nozzle.

- Establish, by FY 1984, an aerodynamic technology data base for efficient weapons integration, carriage, and separation at supersonic speeds.

- Develop, by FY 1985, a unified wing design rationale for the trade-off of optimum features at different speeds, subsonic-transonic-supersonic, for highly maneuverable combat aircraft.

JUSIFICATION:

NASA has maintained preeminence in the formulation of advanced concepts for aerodynamic configurations and inlet/nozzle and integration propulsion for combat airplanes and missiles far in advance of the specific needs of the military services which eventually apply these concepts. Thus, when military planners establish the need for new advanced capabilities in combat airplane or missile systems, an extensive source of verified experimental data is available for incorporation into the preliminary designs generated by industry and for the use of the military services in the system selection process. Continued effort is needed to evolve and test unique new concepts which further improve the high-speed performance and maneuverability of combat airplanes and missiles as well as to better integrate the two for overall system effectiveness. Numerous cooperative efforts have existed and will continue to exist with the Air Force, Navy, and Army involving NASA technical expertise and unique facilities in the planning, selection, and development of innovative combat airplane and missile designs leading to improved systems capabilities. In this way, NASA is able to transfer new ideas and concepts into emerging designs and at the same time achieve a realistic understanding of developmental problems which eventually lead to further improvements. The advances made in combat airplane and missile aerodynamics and propulsion integration technology are achieved by innovative concepts, and the methodology also has applicability to advanced civil vehicles of the future.

SPECIFIC OBJECTIVE

TITLE: Interagency and Industrial Assistance and Testing

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To provide technical assistance, consultative services, and support through the use of NASA facilities to other Government agencies and the airplane/missile industry.

- o Assist the Department of Defense (DOD) on airplane and missile development programs in response to their requests to NASA; conduct joint activities with other Government agencies; and respond to industry requests on a fee or reimbursable basis, or as joint research activities.
- o Conduct ground facility and flight tests at Ames, Langley and Lewis Research Centers, and Dr: len Flight Research Center on developmental models of airplanes and missiles on a specific request basis.
- o Utilize NASA wind tunnels, simulators, and computational capabilities toward the solution of developmental airplane and missile problems.
- o Provide NASA expert participation on ad hoc groups, boards, etc. for the technical evaluation of developing airplanes and missile concepts.
- o Consider and utilize, when appropriate, inputs and information derived from interagency and industrial assistance programs to assist in establishing priorities for NASA research programs.

TARGETS:

- o Conduct, in FY 1982, experimental investigations augmented by theoretical analyses to support current DOD airplane and missile development programs, as well as those identified in future requests.

- o Provide, in FY 1982, consultative services and technical assistance to DOD, as requested, on current and future development programs such as the B-1, F-16, F-18, AV-8B, and other aircraft.

- o Provide, in FY 1982, technical assistance and facilities support to other Government agencies and the airplane/missile industry, on a specific request basis, to achieve improved future systems.

JUSTIFICATION:

The Department of Defense needs and requests NASA assistance on most major military aeronautical development programs to perform tests in unique NASA facilities, to conduct urgent tests that the DOD is unable to accomplish in its facilities, and to provide technical consultation. The main thrust of this assistance is to help DOD evaluate and improve specific military systems in the current inventory or under active development in order to establish and maintain U.S. preeminence in military activities. The activities and tests provide a substantial amount of design information and analyses which permits the DOD and its contractors to make sound decisions toward realizing critical development milestones and achieving safe, reliable, and higher performing aircraft of the future. This assistance to DOD, and other activities in support of the airplane/missile industry and other Government agencies, provides NASA with the important benefit of a better definition of problem areas requiring more basic research and a better awareness of the practical problems involved in applying new aeronautical technologies.

SPECIFIC OBJECTIVE

TITLE: High-Speed Structures Technology

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jack Suddreth

SPECIFIC OBJECTIVE:

To establish a high temperature structures and materials technology base that permits significant reductions in structural weight by research on new materials, structural design, and fabrication techniques providing satisfactory fatigue, fracture, and thermal/cyclic life characteristics under high speed flight conditions.

- o Explore the potential of superplastic forming and diffusion bonding of titanium for aircraft applications.
- o Evaluate and evolve metal alloys and composite materials and structures for high temperature aircraft requirements.
- o Refine and improve load and structural design techniques and procedures for high-speed aircraft.

TARGETS:

- o Initiate fiber reinforced titanium technology program. FY 1982
- o Initiate high temperature aluminum alloy technology program. FY 1982
- o Complete the B-1 SMCS activity. FY 1982
- o Complete titanium SPF/DB, adhesive bonding and low cost, cold forming of beta alloy activities begun in SCR program. FY 1983
- o Complete time/temperature/stress testing activities begun in SCR program. FY 1983
- o Complete aeroelasticity/flutter model analysis begun in SCR program. FY 1983

JUSTIFICATION:

The aircraft design problem of sizing structural components to worst case aerodynamic loads with minimum structural weight is accentuated in high speed aircraft. High temperatures, high speed, high angle of attack, coupled with highly swept, thin, complex, contoured flexible wings, require precise and accurate determination of loads and thermal/cyclic life requirements.

High-speed structures technology is directed to solution of these problems through identification and characterization of advanced high-strength, low-weight composite and titanium materials of construction capable of operating at the elevated temperatures necessary for high speed aircraft. Weight reduction and fabrication improvements are being developed through use of improved resin/fiber composites and titanium. Refinement of computational procedures provides the methodology for aerodynamic loads, structural design, and weight optimization of selected aircraft configurations.

SPECIFIC OBJECTIVE

TITLE: Supersonic Aerodynamics, Configuration, and Integration Technology

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jack A. Suddreth

SPECIFIC OBJECTIVE:

To develop a technology data base for high-speed military and civil aircraft design concepts incorporating improved aerodynamic performance, advanced configurations, and propulsion system/airframe integration techniques.

- o Establish a supersonic aerodynamics technology base that permits improvement in L/D, reduction in drag, refinement of aircraft concepts, and optimization of aircraft characteristics over the full operating speed range.

- o Evolve and refine advanced military and civil aircraft configurations that provide advancements in performance, range, speed, volume, boom signature, fuel consumption, etc.

- o Establish an inlet/engine/nozzle/airframe integration data base and evolve design procedures and methodology for the installation and control of advanced multi-variable systems on high speed aircraft.

TARGETS:

- o Complete the subsonic inlet aerodynamic/ acoustic performance tests in the 9x15 tunnel. FY 1982

- o Initiate the inlet stability and control analysis program. FY 1982

- o Initiate advanced supersonic cruise configuration studies. FY 1982

- o Complete the supersonic leading edge thrust model studies begun in the SCR program. FY 1983
- o Complete the generic high lift/low speed leading edge devices study begun in the SCR program. FY 1983
- o Complete the nozzle/nacelle/airframe integration wind tunnel test program. FY 1983

JUSTIFICATION:

Achievement of high performance and efficiency in supersonic aircraft forces the designer to apply sophisticated aerodynamics, unique configurations and the careful integration of all subsystems to achieve a given level of performance or a mission capability. Work on this specific objective allows for the beneficial interaction of improved aerodynamics technology and the evolution of advanced configurations to provide improved high speed aircraft performance. The aerodynamics technology will continue analytical and experimental work on wing twist and camber, leading edge shape and contour, sweep angle and planform all directed at improved aerodynamic performance.

The aerodynamic configuration efforts are aimed at evolution of advanced concepts incorporating specific aircraft features such as long range, high density, maximum volume, low sonic boom or extremely light weight for application to future military or civil aircraft requirements.

Integration of functions and subsystems is often configuration peculiar but for the near term the most complex and most demanding area is the propulsion system/airframe integration area. This activity is not well established in the literature and has not been reduced to practice for design purposes. Therefore, the NASA efforts are directed to data base acquisition on inlet, nozzle, aerodynamic flow field effects and control.

SPECIFIC OBJECTIVE

TITLE: Support Operations

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/David A. Kier

SPECIFIC OBJECTIVE:

To provide support and operations of the high-speed wind tunnels at the Ames Research Center and flight vehicle support for required chase planes, flight readiness flying, remotely-piloted vehicle drops, and other support activities at the Dryden Flight Research Center.

- o Operate the high-speed wind tunnels (11-ft., 9x7-ft. and 8x7-ft. Unitary Plan Tunnels; 12-ft. pressure tunnel; 2x2-ft. and 14-ft. transonic tunnels; and 6x6-ft. supersonic tunnel) for aerodynamic tests including NASA research and technology programs and inter-agency and industrial assistance programs.
- o Modify the high-speed wind tunnel facilities for improved operational safety in order to minimize the risk of personnel injury and facility damage.
- o Modify the high-speed wind tunnel facilities for improved efficiency of operations.
- o Repair, replace or modify, as required, equipment associated with the high-speed wind tunnels to ensure their essential operation.
- o Provide flight support to remotely-piloted research vehicles such as HiMAT and Drones for Aerodynamic and Structures Testing (DAST).
- o Provide flight support for high performance manned vehicle flight programs such as the F-14 High Angle-of-Attack Testing, AFTI F-111 Mission Adaptive Wing Technology, and AFTI F-16 Envelope Expansion Tests.
- o Provide flight support for other research programs such as Jetstar Turboprop Tests, Wake Vortex Minimization, F-8 Digital Fly-By-Wire, and AD-1 Oblique Wing Tests.

TARGETS:

- o Conduct, in FY 1982, aerodynamic tests in the high-speed wind tunnels to support appropriate NASA research programs and to assist the Department of Defense, other Government agencies, and the aircraft industry.

- o Perform, in FY 1982, studies, repairs, replacements, and modifications to the high-speed wind tunnel facilities and associated equipment to ensure efficient and safe operation.

- o Complete, by FY 1983, the airframe/propulsion calibration laboratory.

- o Support, during FY 1982, principal flight research programs and experiments.

JUSTIFICATION:

The high-speed wind tunnel facilities at the Ames Research Center are of a unique nature and represent a capability that does not exist anywhere else in the country. Support and operation of these wind tunnels is essential to the successful advancement of the state-of-the-art in aerodynamics technology to enable the development of future civil and military aircraft and to maintain U.S. preeminence in aeronautics. The high-speed wind tunnels are essential to provide support, as required, for the basic research and technology programs of the Agency, the Agency's vehicle-specific programs, the developmental programs of the Department of Defense and other Government agencies, and the company-sponsored programs of the aircraft industry.

Flight research programs and experiments at the Dryden Flight Research Center require readiness training and chase/drop/communications aircraft support to adequately carry out safe, efficient, high-quality research. The work done under this specific objective provides that flight research support.

SPECIFIC OBJECTIVE

TITLE: High-Speed Aircraft Controls Technology

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To develop integrated airframe/propulsion control system technology essential for future high-speed aircraft.

- o Determine the best fully integrated digital airframe propulsion control system architecture for advanced high speed aircraft.
- o Identify the most promising new hardware concepts for all elements of an integrated system and established the benefits and advantages of their future utilization.
- o Perform appropriate integrated system ground facility validation research and assess the requirements for flight test and technology demonstration.

TARGETS:

- o Complete, by FY 1983, investigations of different system architectures having various degrees of integration, including assessments of benefits and disadvantages in terms of cost, maintainability, reliability, etc.
- o Complete, by FY 1986, ground facility validation research tests of an advanced integrated airframe/propulsion control system.

JUSTIFICATION:

Current military and civil aircraft have essentially no coupling or integration of airframe and propulsion control functions, and the historic separate development of airframe control systems and engine control systems has been reasonably logical. For high performance military and civil aircraft, the development of variable inlet control systems, uncoupled from the airframe control systems, has been under the cognizance of the airframe manufacturer, although the engine manufacturer has maintained cognizance of the variable area symmetric nozzle control function. For some future high-speed aircraft concepts, this overall situation will change dramatically, and coupling/integration of airframe and propulsion control functions will be essential. For example, high performance fighter aircraft with vectoring and reversing two-dimensional nozzles can have the pilot's control stick and rudder pedals commanding nozzle movements as well as aerodynamic surface movements. Strategic aircraft concepts for low radar and infrared signatures may achieve yaw stability and control by modulating vanes or other devices integral to the propulsion system. Highly optimized supersonic cruise aircraft also may have significant airframe and propulsion control integration to obtain the desired and necessary maximum flight efficiency. It is essential, therefore, to determine and validate the best overall fully integrated digital airframe/propulsion control system which will be required to allow successful development of these promising future high speed aircraft concepts.

SPECIFIC OBJECTIVE

TITLE: Hypersonic Vehicle Technolo

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/David A. Kier

SPECIFIC OBJECTIVE:

To carry out a program of applied research to develop key technologies to support future development of air-breathing aircraft and missiles in the Mach 3-8 class.

o From a wide range of vehicle types, identify the technology barriers in need of concentrated effort to achieve technical barriers.

o Develop and evaluate advanced technology approaches that will eliminate the barriers identified above.

TARGETS:

o Develop through analytical and experimental methods, design techniques applicable to the propulsion/airframe integration area for this class of vehicles. - FY 1983

o Identify and evaluate promising vehicles concepts for hypersonic airbreathing aircraft.

o Validate analytical predictions with ground tests of propulsion systems, configurations (i.e., wind tunnel models) and structural components, the technology options for hypersonic airbreathing missiles. - FY 1984

JSUTIFICATION:

The technology developed by this program will provide the United States with new advanced aircraft and missile options which will be important to future military needs. Aircraft operating at hypersonic speeds and high altitudes offer the potential of new higher levels of survivability for military missions. Missiles capable of hypersonic speeds offer new long range but short flight times that open a new class of missions heretofore extremely difficult or impossible.

SPECIFIC OBJECTIVE

TITLE: High-Speed Propulsion Systems

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Gordon Banerian

SPECIFIC OBJECTIVE:

To develop the critical advanced propulsion component technologies necessary for future civil/military, high-speed cruise aircraft. Components that operate at sustained high temperatures and stresses with variable cycle features that will permit efficient operation over the speed range and to meet environmental requirements for civil applications under static and flight conditions.

- o Conduct subscale model screening tests of candidate components.
- o Design, fabricate and test advanced components, i.e., high flow fans, compressors, turbines, and combustors having the necessary features for variable cycles that will offer significant performance, economic and environmental benefits.
- o Demonstrate the capability of these advanced components to meet the challenging performance and environmental goals operating in a realistic simulation of the operational engine environment.
- o Substantiate aero/acoustic performance in a forward velocity field.
- o Substantiate the performance of turbines operating at high temperatures and stresses for extended durations.
- o Conduct advanced propulsion studies to update data base and identify advanced concepts that need study.

TARGETS:

- o Complete ejector nozzle performance tests in 8x6 tunnel in FY 1982.

- o Complete thermal shield aero acoustic evaluation in FY 1982.
- o Complete thermal aero acoustic performance in FY 1983.
- o Complete outer stream suppressor acoustic evaluation in FY 1983.
- o Complete outer stream suppressor performance in FY 1984.
- o Complete hot section identification study in FY 1983.
- o Initiate high temperature turbine component technology in FY 1982.
- o Conduct advanced propulsion cycle studies applicable to high speed, V/STOL aircraft to identify optimum propulsion concepts in FY 1983.

JUSTIFICATION:

The NASA engine cycle concepts enable an aircraft to fly supersonically long distances. This is made possible by several factors; one, the variable cycle features that change the by-pass ratio for better propulsive efficiency over the flight speed range; secondly, by use of no afterburning (or very little) under supersonic cruise conditions, and thirdly, by use of low turbine cooling flow rates. These features are in contrast to current military engines designed to meet only short supersonic dash requirements. Furthermore, the NASA concepts are designed for low noise and emissions.

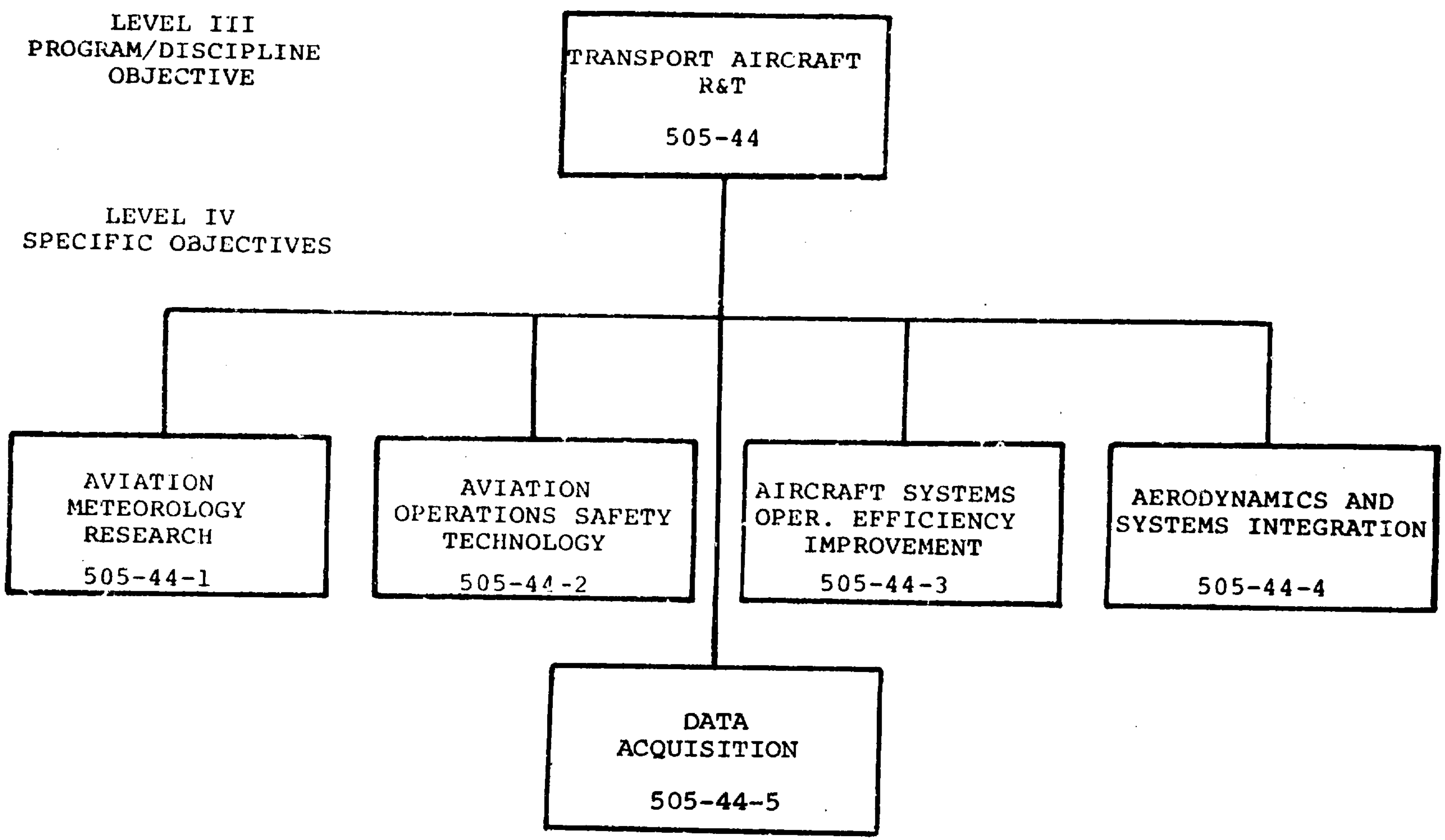
The NASA engine concepts are therefore useful for civil applications, military supercruiser, bomber or supersonic cruise missile designed for long range flight.

TRANSPORT AIRCRAFT R&T

13

TRANSPORT AIRCRAFT R&T WORK BREAKDOWN STRUCTURE

LEVELS II¯ & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Transport Aircraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Roger L. Winblade

PROGRAM/DISCIPLINE OBJECTIVE:

To provide, through a continuing program of research and concept development, improved knowledge of aviation meteorology, a technology base for improved safety, improved aircraft systems operating reliability and efficiency, and increased understanding of aerodynamics and systems integration in advanced transport aircraft.

SPECIFIC OBJECTIVE:

- o Aviation Meteorology Research: To obtain a better understanding of atmospheric processes and how they affect the design and safe, efficient operation of aircraft and component systems.
- o Aviation Operations Safety Technology: To develop a continuum of technology which can be applied to reduce aviation accident opportunities and to minimize the fatalities and damage resulting from accidents.
- o Aircraft Systems Operating Efficiency Improvement: To examine new concepts and techniques which offer potential for reducing both operational complexities and costs of aircraft systems with a view toward safe use of the improved systems by large and small civil aircraft.
- o Aerodynamics and Systems Integration: To develop, through analyses and experiments, an increased understanding of the integration of aerodynamics, propulsion, stability and control, and other configuration-sensitive aspects of transport aircraft.
- o Data Acquisition: To provide safe and productive acquisition of flight research data.

SPECIFIC OBJECTIVE

TITLE: Aviation Meteorology Research

Program/Discipline Objective Titel: Transport Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To obtain a better understanding of atmospheric processes and how they affect the design and safe, efficient operation of aircraft and component systems.

- o Characterize wind shear, high-altitude clear-air turbulence, severe storm outflows, and low-altitude turbulence in utilitarian terms.
- o Characterize fog and atmospheric electrical phenomena.
- o Identify advanced meteorological instrumentation technology needs unique to airborne research and operational systems.
- o Advance aircraft ice protection technology.
- o Develop improved procedures for aircraft operations in the vicinity of storms.

TARGETS:

- o Measure spanwise gust gradients encountered in terminal area operations, in support of flight simulation studies and updated gust design criteria for large aircraft. FY 1982-1983
- o Investigate high-altitude clear air turbulence avoidance concepts, using passive microwave techniques. FY 1982-1983
- o Study modern airfoil performance under icing conditions. FY 1982-1984
- o Explore effectiveness of new ice protection concepts. FY 1982-1983

- Explore electrodynamic warm-fog modification concepts. FY 1982-1984
- Develop and verify icing scaling relationships and evaluate icing cloud instrumentation. FY 1982-1984
- Investigate the use of pneumatic boots for helicopter rotor de-icing. FY 1982-1983
- Assess usefulness of passive microwave techniques for the ground-based monitoring of overhead icing hazards. FY 1982
- Characterize natural lightning strikes to aircraft in functional engineering terms, in order to provide a basis for design criteria of use to researchers and designers concerned with vulnerability of avionics, electrical power, flight controls, materials and structures, fuel, and propulsion systems. FY 1983

JUSTIFICATION:

Aviation atmospheric research at NASA is specifically directed at the avoidance, reduction, or elimination of environmentally-created aviation operating problems which enables the operator to achieve maximum efficiency and safety in air vehicle performance. Fundamental to this research is the improvement of our understanding of atmospheric processes and the real and potential hazards to aircraft operations which they create. Improved weather reporting and forecasting, greater understanding, and today's highly refined aircraft and systems have greatly reduced the adverse impact of weather on aircraft operations. Nevertheless, unfavorable weather is still a principal factor in over one-half of approach and landing accidents.

In addition, the specification of atmospheric processes in sufficient meso- and micro-scale resolution is a continuing process as aircraft aerodynamics, control systems, and flight characteristics become more sophisticated, and as new operational environments (e.g., low-speed STOL and VTOL, and high altitude) are entered and as the need for design data to extract maximum performance from the vehicle and operation is identified.

It is necessary to develop technology based on improved knowledge of atmospheric processes to be able to: (1) predict hazards for aircraft operations, (2) define hazards so as to enable possibly "designing out" their adverse effects on future airplanes or airports or to improve hazard avoidance, (3) simulate hazards so as to determine if they were causative factors in aircraft accidents and to train pilots to cope with atmospheric anomalies, and (4) eliminate or reduce hazards by modification of the environment. This technology development is a paramount importance for the design of aircraft and aviation facilities and the safe operation of aeronautical systems.

This Specific Objective is to be coordinated closely with NASA's Office of Space and Terrestial Application's Meteorology Programs to insure the maximum possible cooperation and program synergism. Similarly, NOAA, FAA, and DOD Meteorological efforts must be taken into account to avoid duplicative and wasteful effort.

SPECIFIC OBJECTIVE

TITLE: Aviation Operations Safety Technology

Program/Discipline Objective Title: Transport Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To develop a continuum of technology which can be applied to reduce aviation accident opportunities and to minimize the fatalities and damage resulting from accidents.

TARGETS:

- Develop modeling techniques for fire development and spread which can be used in preventive design, experiment design and test and accident development. FY 1981-1984
- Determine compatibility of prototype anti-misting kerosene (AMK) with critical current and future propulsion components and engines. FY 1982
- Develop means of manipulating AMK to retain safety features while at the same time permitting efficient combustion in engines. FY 1982-1984
- Identify new fire control concepts (e.g., extinguishment systems, extinguishants, fire detection/warning, "fusing," etc.) which offer potential for aircraft design applications. FY 1982
- Determine detectability and define environmental hazards associated with IFR operations of rotorcraft and V/STOL aircraft. FY 1982
- Provide a data base for continuous knowledge of the usage of various types of aircraft relative to their original design criteria using current and advanced on-board data recorders. FY 1982-1984

- To provide a data base of fire resistant materials which would have possible application in aircraft interiors and to provide a similar data base to FAA for current/state-of-the-art materials. FY 1982

- Develop post-crash fire threat scenarios. FY 1982

- Develop fireworthy materials screening model that will match materials performance and flammability criteria. FY 1982

- Initiate development of human survivability model in post-crash fire accidents using previously developed fire scenarios and cabin interior materials performance and human tolerance criteria. FY 1982

- Determine and optimize design parameters which, taking advantage of new fireworthy materials, AMK, and various modeling capabilities, can greatly reduce the likelihood of in-flight, post-crash, and ramp aircraft fires. FY 1984

- Develop improved equipment, techniques, and criteria for aircraft operations in wind shear and turbulence for improved flight control. FY 1982-1984

- Establish the technology for providing improved protection of aircraft and systems from severe storm hazards to include lightning, turbulence and wind shear. FY 1984

- Provide on an ad hoc continuing basis, support to National Transportation Safety Board (NTSB) in accident investigation and analyses of those circumstances where unique capabilities and knowledge found in NASA can assist in the determination of how the chain of events operated in specific accidents. Upon request.

JUSTIFICATION:

Aircraft safety research is necessary to provide a technology base which can be used to reduce accident circumstances and to minimize the consequences of accidents which inevitably occur. Solutions to aircraft operating problems and the causes of accidents require a new level of knowledge and understanding of the hazard and its disenabling factors. The effects of employing different solutions must be considered in order to avoid creating additional problems.

Because of the very nature and diversity of aircraft operating problems and accident causes, aviation safety research is a multidisciplinary process. A high degree of coordination with other agencies and the private sector is required in order to assure a minimum of duplication, a focus on the truly critical problems, and timely recognition of potential problem areas which merit the researcher's attention. The Aviation Safety Reporting System, in support of accident investigations, has provided substantiation of the subtleness of accident events, and a useful source of identification of research tasks.

Safety of aircraft occupants is of fundamental importance in an air transportation system. Throughout the 60-plus year history of operations, accidents have provided indications and warnings of hazard areas which are amenable to research solutions. With the advent of the more reliable jet engine, takeoff and enroute accidents due to piston engine failure have diminished, although enroute and terminal-area operations still account for more than half the fatal accidents. Offsetting the higher approach and landing impact speeds as threats is the improved passenger seat retention. Control systems are more sophisticated, and navigation/communication is exceedingly complex by 1950 standards. Decision times for critical events in the landing process are short. Thus, application of these new technologies can be extremely effective in improvement of safety.

All of this adds up to more stress on the human judgment and decision processes in the aeronautical system. This makes an error in judgment potentially more dangerous in terms of an accident. A continuing systems analysis process is needed to provide an ongoing rational assessment of potential accident-prone areas in the flight operations, in order to keep the safety R&T program as vital and responsive as possible.

SPECIFIC OBJECTIVE

TITLE: Aircraft Systems Operating Efficiency Improvement

Program/Discipline Objective Title: Transport Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To examine new concepts and techniques which offer potential for reducing both operational complexities and costs of aircraft systems with a view toward safe use of the improved systems by large and small civil aircraft.

- o Advance the technology for safe, economical all-weather aircraft ground operations, including the development of new landing system concepts.
- o Evaluate the impact of real time, high resolution, meteorological data on aircraft fuel savings.

TARGETS:

- o Evaluate elastomeric aircraft tire treads - FY 1982.
- o Evaluate potential of high resolution measurement techniques to provide accurate enroute wind/temperature data for on-board fuel management systems and preflight planning - FY 1982-1983.
- o Determine operating characteristics of braking systems and validate with flight tests - FY 1982.
- o Develop analytical tire model - FY 1982.
- o Evaluate thermal effects on tire carcass strength - FY 1982.
- o Define the dynamics and effects on runway performance of blown tires and failed wheels - FY 1982-1983.
- o Initiate tire behavior studies and design optimizations - FY 1982-1985.

- Complete tire/runway friction studies - FY 1982.
- Initiate engine spray ingestion research - FY 1982-1984.
- Advanced antiskid system development - FY 1982-1984.
- Conduct ground tests of an advanced air cushion landing system - FY 1982.
- Complete modified flight simulator for research on aircraft ground operational problems - FY 1982.
- Develop and validate software simulation of active control landing gear behavior - FY 1983.
- Support accident investigations using unique expertise and facilities - Continuing.

JUSTIFICATION:

Research related to improvement of aircraft systems efficiency has direct relevance to the renewed OAST emphasis on strengthening the aeronautical R&T base. Since all aircraft types would benefit by improvements in aircraft systems efficiency, this program lends strong support to many other aeronautical program objectives.

The viability of the air transportation system can be significantly increased through even small (5%) improvements in the operational efficiency of the aircraft, which otherwise compromises the system.

Basic and applied research to increase the versatility and reliability of aircraft systems, particularly the landing-gear systems, would be a significant step in this direction. The great challenge is to improve the systems efficiency without compromising safety.

Jet fuel accounts for over 40% of airline operating costs. Knowledge of the location and intensity of high speed winds (100-200 knots) can be used for determining the flight plan which will result in fuel savings. Preliminary results indicate the potential saving is in excess of 3% for long duration trans-Atlantic flights.

SPECIFIC OBJECTIVE

TITLE: Aerodynamics and Systems Integration

Program/Discipline Objective Title: Transport Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Paul G. Johnson

SPECIFIC OBJECTIVE:

To develop, through analyses and experiments, an increased understanding of the integration of aerodynamics, propulsion, stability and control, and other configuration-sensitive aspects of transport aircraft.

TARGETS:

- Obtain aerodynamic and aeroacoustic design data base for transport propulsion system installation, including effects of both propeller and/or engine position relative to wing, empennage, and fuselage and effects of nacelle or pylon shape.

  Conventional turboprop/turbofan, wing mount - FY 1984.

  Conventional turboprop/turbofan, empennage or aft-fuselage mount - FY 1985.

  Pusher propeller, single-rotation, wing mount - FY 1985.

  Tractor propeller, counter-rotation, wing mount - FY 1986

- Complete analysis and test of advanced propeller side force and whirl flutter characteristics - FY 1983.

- Complete analysis and test of several turboprop inlet configurations, providing a design data base for non-symmetric, non-circumferential, high diffusion rate inlets subjected to dynamic distortion at inlet lip and containing submerged asymmetric bodies - FY 1985.

JUSTIFICATION:

The attainment of potential performance gains from advanced propulsion systems and airframe configurations requires the generation of a design data base incorporating the effects and interactions of many variables. Included in these variations are engine placement relative to the airframe -- especially true of propeller installations. Also important is the effect of airframe configuration on the propulsion system, as in aft engine mount and pusher propeller installations.

Applications of turboprop propulsion will require the understanding of unique system characteristics, such as side force and whirl flutter. Turboprop inlets also require analysis and test to assure achievement of engine inlet flow conditions compatible with stable compression system operation. In all these areas, NASA's role is to develop an understanding of the phenomena, design methodology based on experiments and theory, and sensitivity data for use in design tradeoffs.

SPECIFIC OBJECTIVE

TITLE: Data Acquisition

Program/Discipline Objective Title: Transport Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason (Jack Levine focal point)

SPECIFIC OBJECTIVE:

To provide safe and productive acquisition of flight research data.

TARGET:

- To provide support of approved facility upgrading to DFRC including the Simulation/RPRV Facility and the Flight Loads Facility.

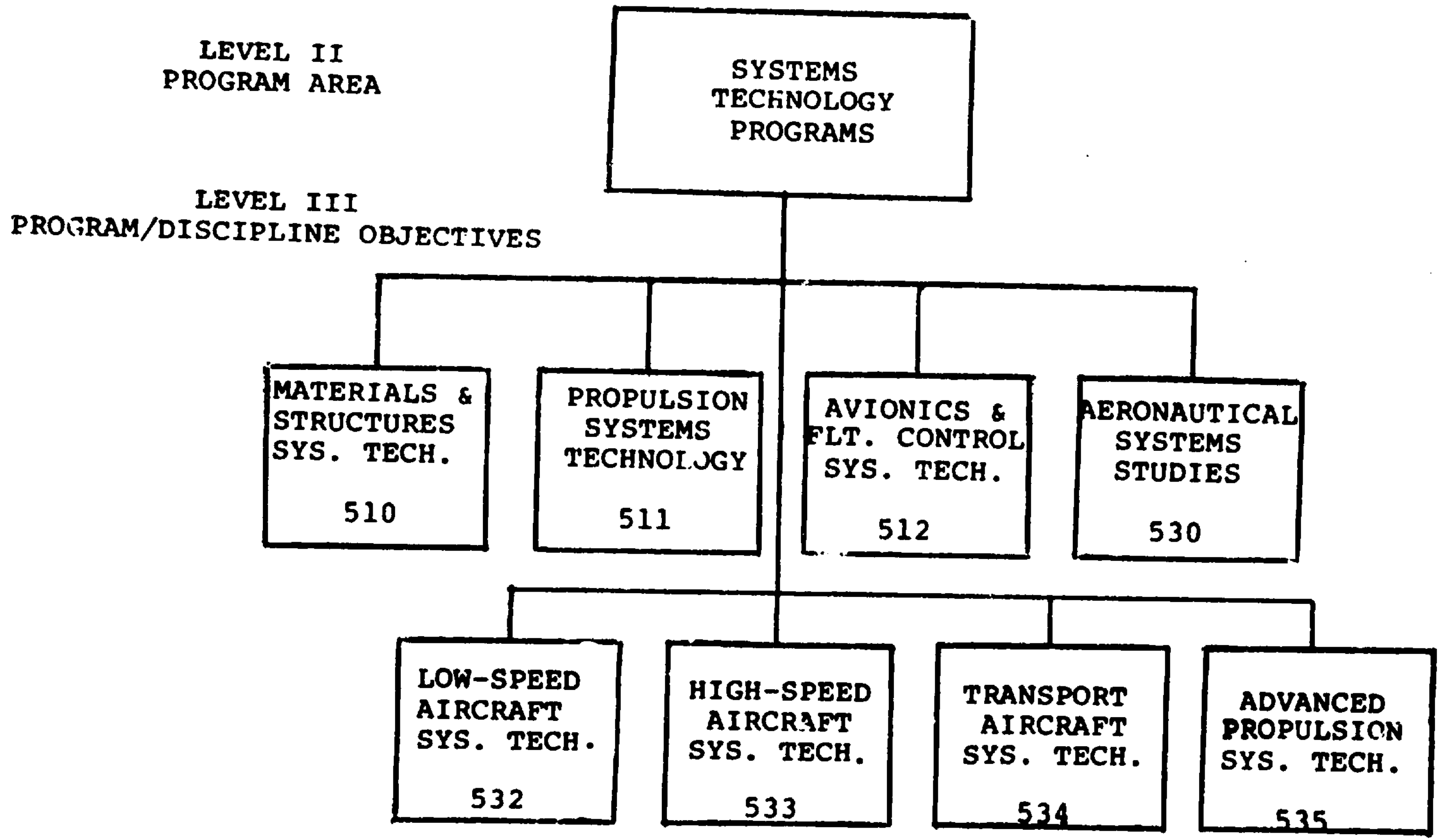
JUSTIFICATION:

Flight test of advanced aeronautical vehicles requires highly productive ground-based and flight data systems. The productivity of such systems is dependent on the rapid acquisition of accurate data from carefully planned and executed flights of research aircraft. Important precursor activities include accurate calibration of flight instrumentation, including flight loads measurement systems. In addition, advanced simulation and RPRV techniques may be coupled to increase the productivity of high-risk flight investigations.

SYSTEMS TECHNOLOGY PROGRAMS

14

SYSTEMS TECHNOLOGY PROGRAMS WORK BREAKDOWN STRUCTURE
LEVELS II & III



C-2

PROGRAM AREA GOAL

TITLE: Systems Technology Programs

Program Goal Title: Aeronautics Research and Technology

PROGRAM AREA GOAL:

To provide technology demonstration/proof of concept for systems which have matured under the Research and Technology Base, to demonstrate the technical readiness of innovative systems through experimental testing and verification in a realistic environment, to design, fabricate and test multidisciplinary concepts thereby greatly reducing the technical and economic development risks and decreasing the excessive time lag between technology development and its application in the marketplace, and to design and fabricate major aeronautical research vehicles which serve as test-beds for evaluating innovative subsystem concepts.

PROGRAM/DISCIPLINE OBJECTIVES:

- Materials and Structures Systems Technology: To accelerate the transfer of advanced materials and structures technologies to application in design of aircraft structures and engines through a program which utilizes the development of large-scale components for laboratory and flight evaluations and computer-aided design techniques.
- Propulsion Systems Technology: To advance the technology of aeronautical propulsion systems in selected areas, as individual component technology progresses. This systems technology approach seeks to identify and investigate interactions between combinations of components not addressed in research on discrete components. Propulsion systems technology programs explore effects of interactions in a variety of areas: environmental, energy conservation, and size and weight reduction.
- Avionics and Flight Control Systems Technology: To design, develop and demonstrate advanced avionics and control systems technology in order to both validate the potential application of advanced concepts to future aircraft and enhance the acceptance and transfer of emerging technology to the aircraft industry, resulting in increased safety and efficiency

and higher performance capabilities.

- Aeronautical Systems Studies: To determine from mission, systems and conceptual studies the technology requirements, costs, benefits and impacts of advanced civil and military aeronautical systems as a basis for the planning of future technology programs.

- Low-Speed Aircraft Systems Technology: To advance, and accelerate the transfer of technology for low-speed aircraft including rotorcraft and vertical and short take-off and landing (V/STOL) aircraft.

- High-Speed Aircraft Systems Technology: To perform required research, using ground based simulators, wind tunnels and flight tests, to generate engineering and design data necessary to advance high-performance aircraft for civil and military applications.

- Transport Aircraft Systems Technology: To provide, for subsonic transport aircraft, demonstration/proof of concept for systems technology which has matured under the Research and Technology Base; to demonstrate/validate the technical readiness of innovative systems through experimental testing and verification in a realistic environment; and to conduct the definition phases of potential future aeronautical research programs for attainment of enhanced aircraft energy efficiency, operational compatibility with the future National Aviation System, and accelerated application of advanced materials technology for improve fire-worthiness.

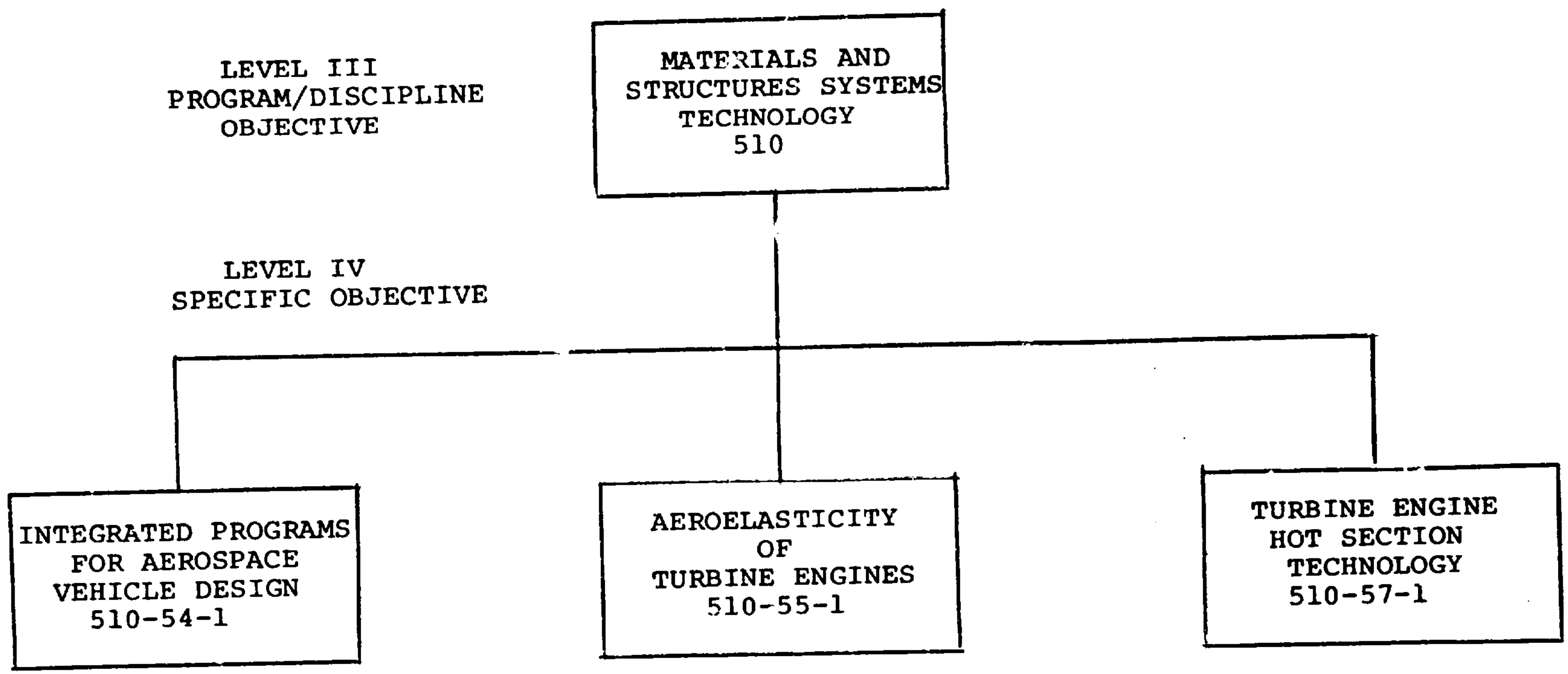
- Advanced Propulsion Systems Technology To advance the technology of aeronautical propulsion systems for the attainment of improved performance, lower fuel consumption and reduced noise and emissions in advanced engines for future aircraft systems. This systems technology approach seeks to uncover interactions between combinations of components not possible by research on discrete components. Major emphasis is focused on the development and demonstration of propulsion technology for improving the energy efficiency of future civil transport aircraft and on the demonstration of variable cycle engine system feasibility for future supersonic cruise and high-performance aircraft.

MATERIALS AND STRUCTURES SYSTEMS TECHNOLOGY

15

MATERIALS AND STRUCTURES SYSTEMS TECHNOLOGY WORK BREAKDOWN STRUCTURES

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Materials and Structures Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Research and Technology Division/Leonard A. Harris

PROGRAM/DISCIPLINE OBJECTIVE:

To accelerate the transfer of advanced materials and structures technologies to application in design of aircraft structures and engines through a program which utilizes the development of large-scale components for laboratory and flight evaluations and computer-aided design techniques.

SPECIFIC OBJECTIVES:

- Integrated Programs for Aerospace Vehicle Design (IPAD): To develop the preliminary design and a limited capability prototype (First Level IPAD) of a computer software system for total management of aerospace vehicle design processes to be operational in the 1980's and providing reductions of 50 percent or more in design cycle time and 25 percent or more in design cost.

- Aeroelasticity of Turbine Engines (ATE): To provide improved aeroelastic stability criteria for the design of turbine engines and to develop a fundamental understanding of the mechanisms involved in aeroelastic instabilities of these engines and improved analytical methods of predicting them. The criteria and analytical methods are to provide a rational basis for reliable prediction and avoidance of instability regions in the design of future engines.

- Turbine Engine Hot Section Technology (HOST): To develop analytical models and predictive tools for durability and life assurance design of hot section components of advanced aircraft turbine engines.

SPECIFIC OBJECTIVE

TITLE: Integrated Programs for Aerospace Vehicle Design (IPAD)

Program/Discipline Objective Title: Materials and Structures Systems Technology

Responsible Organization/Individual: Research and Technology Division/Leonard A. Harris

SPECIFIC OBJECTIVE:

To develop the preliminary design and a limited capability prototype (Phase One IPAD) of a computer software system for total management of aerospace vehicle design processes to be operational in the 1980's and providing reductions of 50 percent or more in design cycle time and 25 percent or more in design cost.

To develop an advanced design capability system (Phase Two IPAD) that could define the total design and manufacturing process representative of a company-wide system.

- o Provide significant system design which attains advances in the areas of engineering data base management and distributed computer network communication.
- o Demonstrate that the Phase One IPAD will provide the above advances, as well as provide proof-of-concept software modules, in these advanced technology areas for use by the industry as components of in-house developments.
- o Demonstrate that the Phase Two IPAD system has general integrated system capabilities.

TARGETS:

- o Release a preliminary version of Phase One IPAD with enhanced DBM by end of FY 1982.
- o Release final version of Phase One IPAD by end of FY 1983.

- o Release preliminary version of Phase Two IPAD with network DBM by end of FY 1984.
- o Release completed prototype IPAD system by end of FY 1985.

JUSTIFICATION:

The design of advanced aerospace vehicles typically involves the generation, transfer, storage, and constant updating of large amounts of information by large numbers of design support technical and management groups generally located in distributed geographic locations. The management of this information, including the communication among the various groups by current manual or semi-automated means, has demanded a large portion of the total design time and funds. This objective seeks to accelerate the development of software systems by the industry to automate large portions of this information management as a means of achieving the stated goals of cost and schedule improvements within the stated time frame.

SPECIFIC OBJECTIVE

TITLE: Aeroelasticity of Turbine Engines (ATE)

Program/Discipline Objective Title: Materials and Structures Systems Technology

Responsible Organization/Individual: Research and Technology Division/Leonard A. Harris

SPECIFIC OBJECTIVE:

To provide improved aeroelastic stability criteria for the design of turbine engines and to develop a fundamental understanding of the mechanisms involved in aeroelastic instabilities of these engines and improved analytical methods of predicting them. The criteria and analytical methods are to provide a rational basis for reliable prediction and avoidance of instability regions in the design of future engines.

TARGETS:

- Develop, by FY 1982, a capability for predicting the flutter boundaries of fan and compressor bladed systems for turbine engines which correlate with available data within 5 percent.
- Develop, by FY 1982, the capability of predicting with a 95 percent confidence level the unsteady forces due to inlet and exit distortions and their effect on the forced vibration levels of the turbo-machine blading.
- Complete, by FY 1983, a compendium document for all the analytical methods, experimental data, and correlation studies generated under the program.

JUSTIFICATION:

To provide performance improvements and competitive designs for advanced military and commercial aircraft engines, low-weight high-speed fans and compressors are required. The levels of aerodynamic loading and the structural design approaches used in contemporary engines have resulted in aeroelastic problems. These problems, in the form of blade flutter, have been solved by extensive modifications, redesign, and testing. All of this resulted in considerable cost increases and delays in engine development programs. The fact that the occurrences of flutter have persisted in new fans and compressors indicates that the design criteria presently being used are inadequate. This has also resulted in considerable reluctance to incorporate advanced levels of fan and compressor technology into engine developments. The subject program is directed toward obtaining a better understanding of the fundamental relationships which control fan and compressor blade flutter. This information will be used to generate improved criteria to provide a sound basis for the reliable prediction and the avoidance of instability regions in advanced aircraft propulsion systems.

Most recent advanced engine designs aimed at improved performance have encountered serious flutter problems. Investigation of each occurrence and the implementation of procedures to alleviate the problem in each case have added considerably to the development costs and expanded the development time.

The seriousness of these incidences prompted the formation of a joint NASA-Air Force panel to develop a coordinated research program for eliminating the causes of difficulty. This program is to be implemented jointly by the two agencies with specific tasks being assumed by one or the other of the agencies.

SPECIFIC OBJECTIVE

TITLE: Turbine Engine Hot Section Technology (HOST)

Program/Discipline Objective Title: Materials and Structures Systems Technology

Responsible Organization/Individual: Research and Technology Division/Leonard A. Harris

SPECIFIC OBJECTIVE:

To develop analytical models and predictive tools for durability and life assurance design of hot section components of advanced aircraft turbine engines.

- o To establish predictive methods for strength and life prediction of hot section components.
- o To establish predictive methods and/or test verification of environment, thermal and mechanical loading, material constitutive behavior and structural damage and failure modes.

TARGETS:

- o Demonstrate, by FY 1983, the combustor visualization system.
- o Demonstrate, by FY 1983, thin film heat flux sensors and thin film thermocouples capable of operating in a combustor environment
- o Demonstrate, by FY 1986, combustor liner life prediction methodology on simulated hardware.
- o Demonstrate, by FY 1986, vane life predictive methodology on simulated hardware.

JUSTIFICATION:

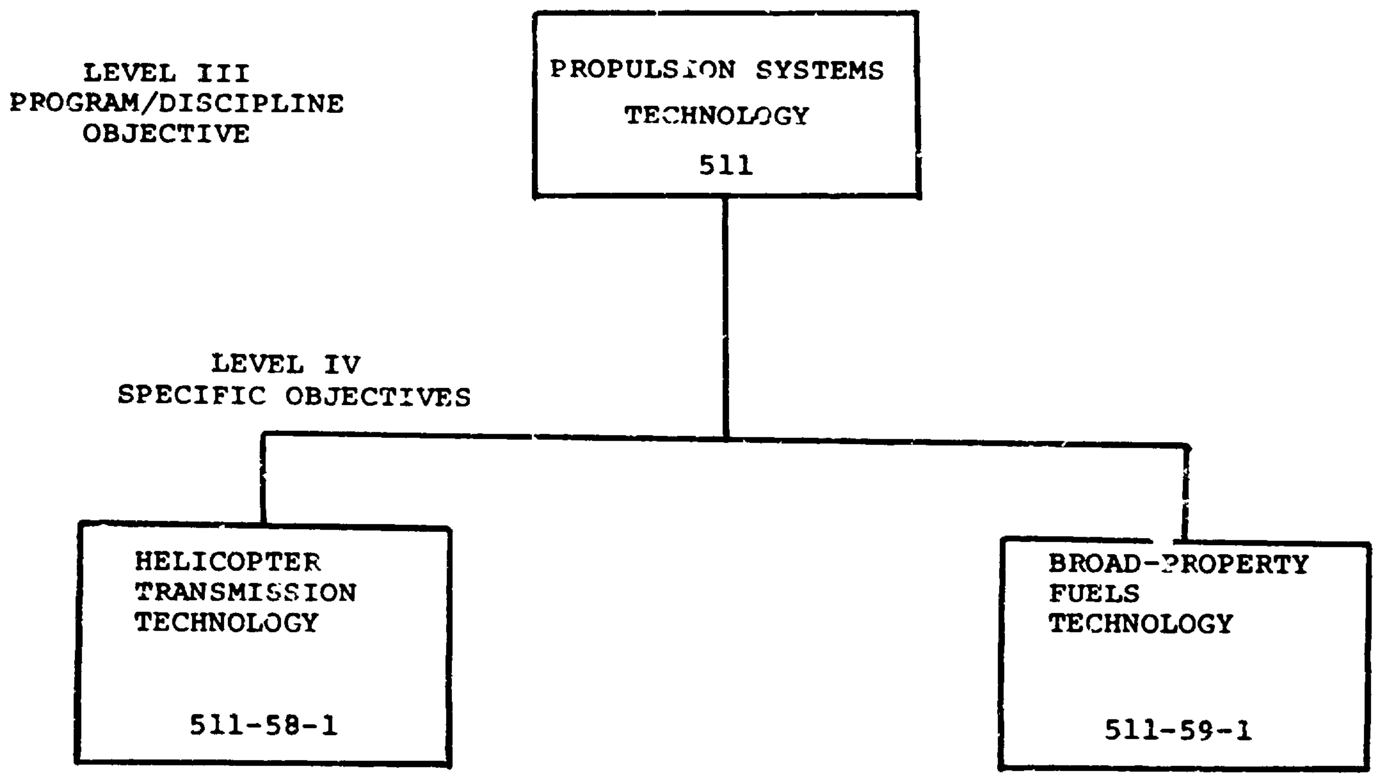
Engine maintenance cost is a major economic factor in the viability of today's high performance turbine engines. In 1978, maintenance for aircraft engines was in excess of 400 million dollars. This is expected to increase to 2 billion dollars by 1990 as engine turbine performance is pushed to higher temperatures and pressures for greater fuel economy. There is a great need for the development of technology to design durability into future engine components. This can only be done after suitable analytical models of the turbine environment have been developed. The trial and error methods of component design of the past are too costly and too unreliable for the future. The objective and scope of this program address this need.

16

PROPULSION SYSTEMS TECHNOLOGY

PROPULSION SYSTEMS TECHNOLOGY WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Propulsion Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Research and Technology Division/ Cecil C. Rosen

PROGRAM/DISCIPLINE OBJECTIVE:

To advance the technology of aeronautical propulsion systems in selected areas, as individual component technology progresses. This systems technology approach seeks to identify and investigate interactions between combinations of components not addressed in research on discrete components. Propulsion systems technology programs explore effects of interactions in a variety of areas: environmental, energy conservation, and size and weight reduction.

SPECIFIC OBJECTIVE:

- Helicopter Transmission Technology: To develop and demonstrate technology to improve weight, maintenance, cost, and size of helicopter transmissions through application of advanced technology power-transfer components.

- Broad-Property Fuels Technology: To evolve and evaluate the capability of selected combustor concepts to use broad-property fuels in advanced commercial high-bypass, high-pressure ratio turbofan engines and to verify those concepts in full-scale engine tests.

SPECIFIC OBJECTIVE

TITLE: Helicopter Transmission Technology

Program/Discipline Objective Title:
Propulsion Systems Technology

Responsible Organization/Individual:
Research and Technology Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To develop and demonstrate technology to improve weight, maintenance, cost, and size of helicopter transmissions through application of advanced technology power-transfer components.

- Gear Transmissions - develop advanced concepts and demonstrate, in transmission system tests, improved mechanical components and the system technology for advanced drive systems.
- Hybrid Transmissions - demonstrate the compactness, reliability, and low noise of hybrid traction drive transmissions.

TARGETS:

- Demonstrate advanced mechanical component technology in standard type transmissions in which transmission life is increased by 200%, load carrying capacity is increased by 50%, and survivability is increased by 400% compared to current production transmissions - FY 1983.
- Demonstrate hybrid traction drive systems which are 10% more compact, more reliable, less costly, and quieter than current standard transmissions - FY 1983.

JUSTIFICATION:

It has long been a requirement for commercial helicopter applications to provide technology for long-life, efficient, low-cost, lightweight, compact, quiet mechanical power transmission systems. In general, current state-of-the-art transmission systems are disturbingly noisy to the pilot and passengers. The maintenance rate on these transmission systems is unacceptably high and, as a result, their reliability for long-life application is relatively low. The time between overhaul (TBO) and mean time between failure (MTBF) on present-day helicopters is much lower than that required for economical commercial operation. The helicopter drive system is generally heavier than desired.

The realization of reduced operating cost, reduced weight, improved operating life and reliability for future generation helicopter drive systems can only be obtained through advanced research and development. These helicopter transmission activities will provide a solid technology base for the development of advanced civil and military helicopter technology as well as provide a generic base for advances in gear technology for high-speed turboprop systems of the future.

SPECIFIC OBJECTIVE

TITLE: Broad-Property Fuels Technology

Program/Discipline Objective Title:
Propulsion Systems Technology

Responsible Organization/Individual
Research and Technology Division/Stephen M. Wander

SPECIFIC OBJECTIVE:

To evolve and evaluate the capability of selected combustor concepts to use broad-property fuels in advanced commercial high-bypass, high-pressure ratio turbofan engines and to verify those concepts in full-scale engine tests.

- o Combustor Screening Evaluations - experimentally evaluate a range of conceptual combustor concepts and assess their potential for operation on broad-property fuels.
- o Combustor Optimization - refine preliminary fuel-flexible combustor designs.
- o Engine Verification - verify, in an engine environment, the capability of two selected fuel flexible combustor concepts to satisfy steady-state and transient CTOL mission needs and environmental requirements.

TARGETS:

- o Refine and optimize the most promising combustor design identified in Phase I - FY 1982.
- o Establish system compatibility for the selected combustion system(s) with other engine components - FY 1983.
- o Verify, in full-scale engine test cell evaluations, the capability of the evolved fuel flexible combustor concepts to meet required steady-state and transient performance and emissions requirements - FY 1984.

JUSTIFICATION:

Periodic disruptions in the supply of aircraft jet fuels are the source of major concern to the airline industry. Potential shortages in petroleum-based fuels before the end of the century are viewed as a real possibility. Projected increases in the demand for middle distillate petroleum products throughout the remainder of the century are expected to create substantial additional pressures on the supply and availability of specialty jet fuels. Broad-property jet fuels derived from petroleum or from shale oil, coal, or tar sands could provide a more flexible and reliable supply as well as reduce the refinery energy consumption and costs relative to current jet fuels. The physical properties and combustion characteristics of fuels derived from alternative sources will have adverse impacts on the performance and durability of current engine combustors and aircraft fuel systems.

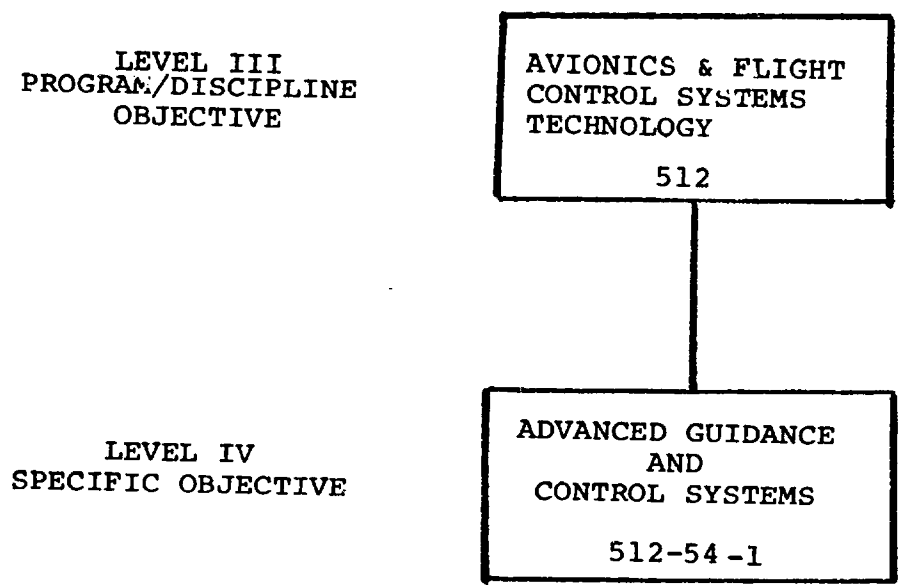
Derivatives of current engines (JT9D, CF6), as well as advanced technology engines (E^3), which would be operational in 1990 and beyond could be using broad-property fuels in order to control fuel costs and assure greater fuel availability. It is therefore desirable to develop the combustor and fuel system technology in readiness for this distinct possibility.

17

AVIONICS AND FLIGHT CONTROL SYSTEMS TECHNOLOGY

AVIONICS AND FLIGHT CONTROLS SYSTEMS TECHNOLOGY
WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Avionics and Flight Controls Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual:
Research and Technology Division/Herman A. Rediess

PROGRAM/DISCIPLINE OBJECTIVE:

To design, develop and demonstrate advanced aircraft control and guidance systems technology in order to both validate the potential application of advanced concepts to future aircraft and enhance the acceptance and transfer of emerging technology to the aircraft industry, resulting in increased safety and efficiency and higher performance capabilities.

SPECIFIC OBJECTIVES:

- Advanced Guidance and Control Systems: To conduct laboratory and flight evaluations of advanced guidance and control concepts to demonstrate and verify significant improvements in capability, performance and cost afforded through the application of innovative techniques.

SPECIFIC OBJECTIVE

TITLE: Advanced Guidance and Control Systems

Program/Discipline Objective Title:
Avionics and Flight Controls Systems Technology

Responsible Organization/Individual:
Research and Technology Division/ Herman A. Rediess

SPECIFIC OBJECTIVE:

To conduct laboratory and flight evaluations of advanced guidance and control concepts to demonstrate and verify significant improvements in capability, performance and cost afforded through the application of innovative techniques.

- Develop conceptual system designs and models.
- Investigate and establish design process validation methods.
- Conduct flight evaluations and system verifications.

TARGETS:

- Conduct evaluations of novel architecture concepts for improved system reliability and maintainability - FY 1982.
- Perform quantitative analysis of the technical capability and cost effectiveness of advanced, automated software verification tools when applied to a representative redundant digital flight control system - FY 1982.
- Develop design criteria and plans for an ultra-reliable flight control system to demonstrate the practical application and benefits in performance and efficiency - FY 1983.
- Design and demonstrate a verification methodology which integrates the individual verification tools and consistantly produces high test coverage cost effectively - FY 1984.

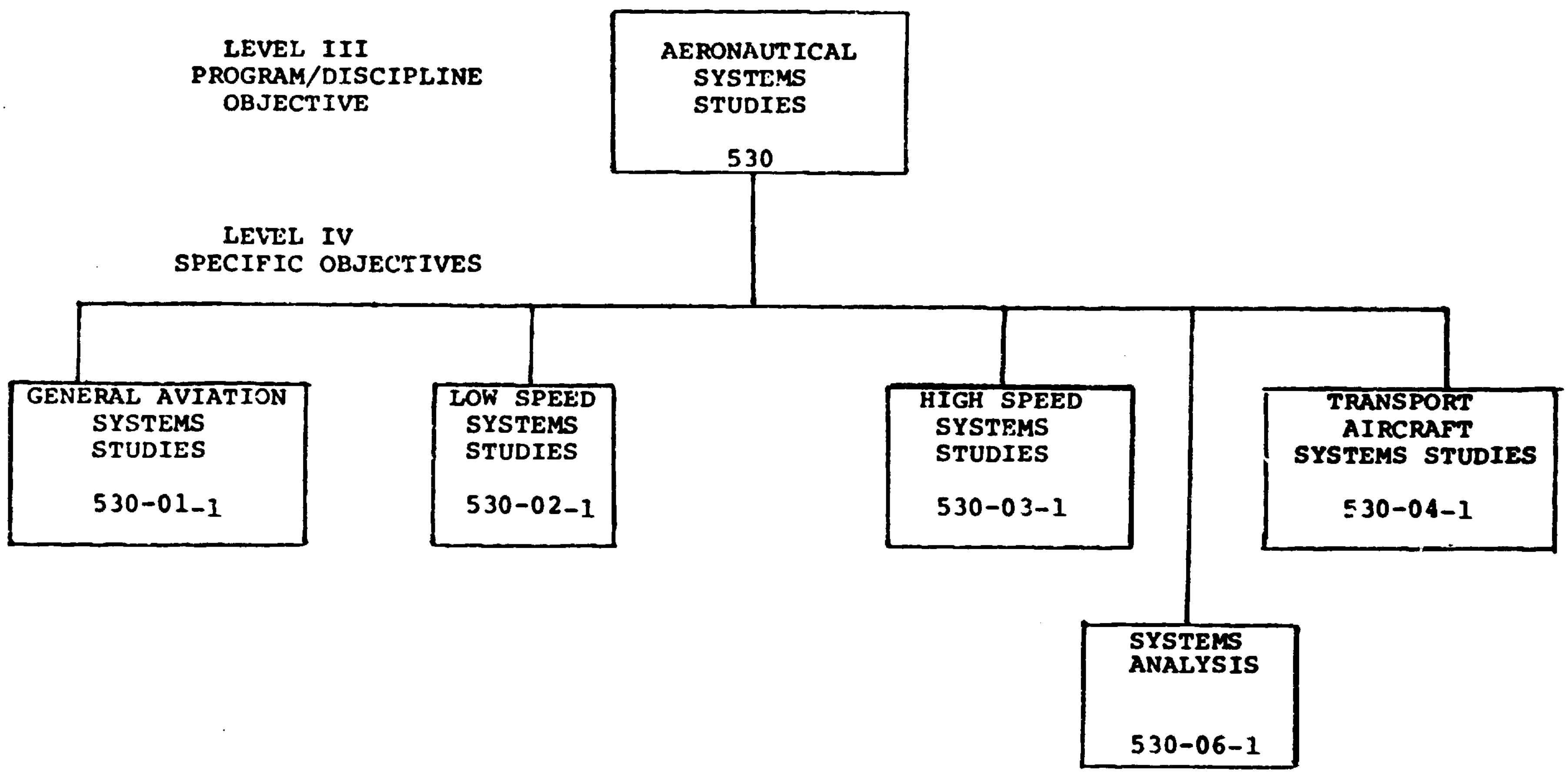
- o Complete development and preliminary analysis of an ultra-reliable flight control concept - FY 1985.
- o Extend a verification methodology to include advanced development techniques, microprocessor-based configurations of digital flight control systems and advanced software languages - FY 1986.

JUSTIFICATION:

This program affords the opportunity of undertaking the development and demonstration of novel concepts in guidance, control and associated technology so that the transfer and application is greatly enhanced. For example, with the increased use of digital electronics in civil aircraft systems, it was found that the process for verifying and validating these systems is extremely costly in flight test time and the results unrepeatable and unstructured. Experience with digital systems and associated simulations is being applied to establish a greatly improved technique based on the use of simulation methodology and automated procedures to reduce the costly flight test time. This will be especially beneficial as digital systems are applied to flight critical functions. Entirely new approaches to flight control system designs will be investigated and promising concepts evaluated. Current designs are based on centralized architecture with excessive maintenance burdens and costs for large expensive "line replaceable units." New distributed architecture using advanced microelectronics will provide massive redundancy, hardware and software reconfiguration to meet the required level of reliability for civil applications. Hybrid navigation and guidance concepts will be developed and evaluated to provide the best features of different systems under particular conditions of flight and environment.

AERONAUTICAL SYSTEMS STUDIES

AERONAUTICAL SYSTEMS STUDIES WORK BREAKDOWN STRUCTURE
LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Aeronautical Systems Studies

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/G. G. Kayten

PROGRAM/DISCIPLINE OBJECTIVE:

To determine from mission, systems and conceptual studies the technology requirements, costs, benefits and impacts of advanced civil and military aeronautical systems as a basis for the planning of future technology programs.

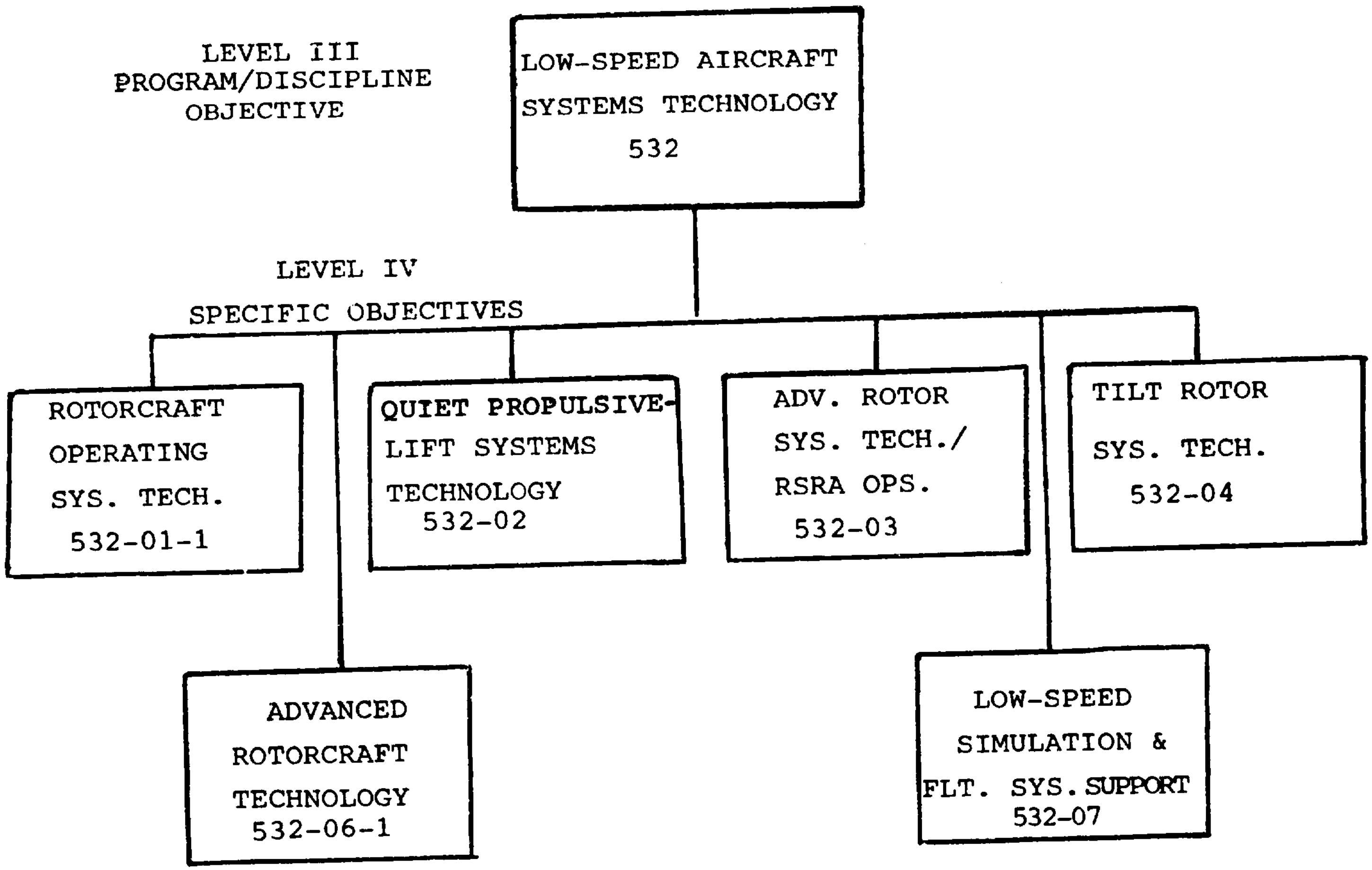
SPECIFIC OBJECTIVES:

- General Aviation Systems Studies: To evaluate missions and alternative vehicle and system concepts; identify requirements for, and impacts of, technology advancement; and build an information base for technology program planning in support of general aviation, including aerial application.
- Low-Speed Systems Studies: To evaluate missions and alternative vehicle and system concepts; identify requirements for, and impacts of, technology advancement; and build an information base for technology program planning in support of civil and military systems utilizing vertical- and short-takeoff-and-landing (V/STOL) aircraft, rotorcraft, and fully or partially buoyant vehicles.
- High-Speed Systems Studies: To evaluate alternative vehicle and systems concepts; identify requirements for, and impacts of, technology advancements, and establish an information base for planning technology programs in support of future civil and military high-speed aircraft and missile systems.
- Transport Aircraft Systems Studies: To assess the feasibility, advantages, and limitations of promising new technologies as applied to new transport designs and future systems satisfying particular air transportation needs.

- Systems Analysis: To identify and clarify economic and government policy issues affecting aviation and transportation, assess technology impacts and benefits and develop methods and an information base for use in aeronautical R&T and systems technology program planning.

LOW-SPEED AIRCRAFT SYSTEMS TECHNOLOGY

LOW-SPEED AIRCRAFT SYSTEMS TECHNOLOGY
LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Low-Speed Aircraft Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

PROGRAM/DISCIPLINE OBJECTIVE:

To advance and accelerate the transfer of technology for low-speed aircraft including rotorcraft and vertical and short take-off and landing (V/STOL) aircraft.

SPECIFIC OBJECTIVES:

- Rotorcraft Operating Systems Technology: To provide the technology for innovative navigation, guidance, flight control, and display systems, and operating techniques that will afford rotorcraft the capability of safely, quietly, and efficiently making steep, slow, and even spiraling Visual Flight Rules (VFR) type approaches to a small remote landing site under Instrument Flight Rules (IFR) and nighttime conditions.

- Quiet Propulsive-Lift Systems Technology: To obtain flight research data from propulsive-lift aircraft applicable to design and certification criteria for future short-haul transports.

- Advanced Rotor Systems Technology/RSRA Operations: To validate rotor system technology through studies of novel concepts, system investigations, methodology improvement, and support of generic tests in the wind tunnel and in flight on the Rotor Systems Research Aircraft. Such generic research documents the behavior of current and advanced rotor systems and identifies problem areas and design requirements. To conduct systematic variation of rotor parameters to form the basis for improvements in performance blade dynamics, loads, stability, and control. To increase the understanding of rotor systems through pre- and post-test analytical methodology.

- Tilt Rotor Systems Technology: To improve, demonstrate, and document tilt rotor technology for military and civil applications, and to provide flight test vehicles for flight systems research.

- Advanced Rotorcraft Technology: To provide the technology for the low-risk design of advanced rotorcraft systems and subcomponents based on verified design tools and experimental methods with emphasis on rotor and rotor/airframe detailed aerodynamic and aeroelastic prediction for control of vibration and noise; advanced materials application; advanced all-weather guidance, navigation and control systems concepts; advanced propulsion systems; and advanced vehicle concepts which have significant potential gains in productivity. The activity involves focused and coordinated research in analysis, model and large-scale ground testing, and flight testing. This program encompasses civil and military roles for advanced rotorcraft.

- Low-Speed Simulation and Flight Systems Support: To provide support for Ames research aircraft flight experiments in low-speed aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems for advanced rotorcraft, V/STOL aircraft, and STOL aircraft and to provide support of flight simulation programs in guidance, navigation, control, and handling qualities of these classes of aircraft and for the low-speed flight regime of other classes of aircraft.

SPECIFIC OBJECTIVE

TITLE: Rotorcraft Operating Systems Technology

Program/Discipline Objective Title: Low-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Jeffery H. Godfrey

SPECIFIC OBJECTIVE:

To provide the technology for innovative navigation, guidance, flight control, and display systems, and operating techniques that will afford rotorcraft the capability of safely, quietly, and efficiently making steep, slow, and even spiraling VFR type approaches to a small remote landing site under Instrument Flight Rules (IFR) and nighttime conditions. This objective encompasses military and civil roles for rotorcraft with emphasis on:

- o Improving safety.
- o Increasing vehicle productivity.
- o Expanding mission capabilities.
- o More fuel-efficient operations.
- o Operations in air traffic control (ATC) systems without conflict with conventional aircraft.
- o Flight profiles for low community noise operation.

TARGETS:

- o Complete the evaluation of performance and operational procedures of advanced rotorcraft (XV-15 tilt rotor) with an integrated guidance, navigation, and control system (V/STOLAND) over a range of control configurations from manual to completely automatic in a terminal area environment:
  - Complete the installation and checkout of the V/STOLAND system in XV-15 -- FY 1982.
  - Develop flight director for XV-15 Tilt Rotor Airplane and Helicopter flight phases -- FY 1983.
  - Demonstrate straight and helical path autoland in Category III conditions -- FY 1984.

Demonstrate the technology to improve the all-weather sea-going helicopter capabilities from the current limitation of a 400-ft. ceiling and ½ n.m. visual range with a sea state of 3, to sea state 5 landing under zero ceiling and 1/8 n.m. visual range on small ships with 70 x 70-ft. landing pads--FY 1984.

JUSTIFICATION:

Today's helicopter and tomorrow's high-performance V/STOL aircraft will fulfill their role in enhancing the U.S. total air transportation capability and military effectiveness only if they have full all-weather capabilities. All-weather rotorcraft operations are currently quite limited. Although some helicopters, especially in the military, are being flown today under IFR conditions, the equipment and techniques used are basically spinoffs from conventional take-off-and-landing (CTOL) applications. Rotorcraft have not taken advantage of new technology such as programmable computers to perform multisystem tasks, electronic displays, time sharing data transmission, and strapdown inertial measurement units which could provide low cost, improved reliability, and increase capability.

SPECIFIC OBJECTIVE

TITLE: Quiet Propulsive-Lift Systems Technology

Program/Discipline Objective Title: Low-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

SPECIFIC OBJECTIVE:

To obtain flight research data from powered-lift aircraft applicable to design and certification criteria for future short-haul transport and combat aircraft.

- o Determine requirements and criteria for approach path performance, stability and control, handling qualities, operation safety margins, and noise certification rules for short haul powered lift transport aircraft when operating at high lift.
- o Define criteria for the flying qualities, control system design and IMC guidance and navigation for future powered lift combat aircraft.
- o Establish guidance, navigation, control system, and air traffic control interface requirements.
- o Provide information to enable upgrading of tentative criteria for certification and airworthiness of civil short-takeoff-and-landing (STOL) transports through test-case, relevant flight experience.
- o Continue on-call QSRA airframe and YF-102 engine contractor support (including spares and possible modifications) required to carry out the technical objectives of the QSRA flight research program.
- o Provide, through wind-tunnel model studies, data for design of powered-lift transport aircraft with high lift characteristics in combination with efficient high speed cruise and good handling qualities.

TARGETS:

- o Complete QSRA flying qualities experiments - FY 1982.
- o Complete input to development of STOL handling qualities certification criteria - FY 1983.

- o Complete operating systems flight experiments using QSRA - FY 1984.
- o Provide contractor support of QSRA operation, of YF-102 engine maintenance, inspection, and refurbishment, and possible non-propulsion airframe modifications required to carry-out technical objectives of the QSRA flight research program.
- o Define a high-performance powered lift flight research program, and the associated modifications to the YAV-8B Harrier aircraft to be used for the program (ARC) - FY 1982.

JUSTIFICATION:

Powered-lift technology is needed by government and industry to develop options for future U.S. civil short-haul transportation, to compete effectively in foreign markets, and to improve military tactical airlift and combat capability. This program will significantly reduce the technical risk associated with the development by industry of civil and military powered-lift transport and combat aircraft, will provide data with which government regulatory agencies can establish realistic criteria for certification of commercial powered-lift aircraft, and will provide data to reduce excess military pilot workload in IMC conditions and to improve operational flexibility of powered lift combat aircraft.

SPECIFIC OBJECTIVE

TITLE: Advanced Rotor Systems Technology/RSRA Operations

Program/Discipline Objective Title: Low-Speed Aircraft Systems Technology

Responisble Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To validate rotor system technology through studies of novel concepts, system investigations, methodology improvement, and support of generic tests in the wind tunnel and in flight on the Rotor Systems Research Aircraft. Such generic research documents the behavior of current and advanced rotor systems and identifies problem areas and design requirements. To conduct systematic variation of rotor parameters to form the basis for improvements in performance blade dynamics, loads, stability, and control. To increase the understanding of rotor systems through pre- and post-test analytical methodology.

- o Allocate a small effort to study novel concepts and pursue the most promising ones to determine feasibility.
- o Expand the data base in ground-based testing of rotors of opportunity, and on a family of new blades and hubs having systematic variations in aerodynamic and structural design parameters.
- o Where indicated, expand the flight data base on existing rotors that may become available from other programs, that can be readily adapted for the detailed evaluation that is available through RSRA testing.
- o Operate the two RSRA and maintain and improve their capability as a national flight test facility.

TARGETS:

System Investigations

- o Conduct advanced rotor concept studies to define their merits and feasibility with small initial efforts -- ARC, FY 1982.

Wind Tunnel Investigations

- o Test a Bearingless Main Rotor (second entry) in the full-scale wind tunnel to provide an expanded data base of the dynamic characteristics for several configuration changes -- ARC, FY 1983.

- o Test an existing modern helicopter rotor in model and full-scale at high speed to measure performance, loads, blade dynamics, and static stability and control -- ARC, FY 1983.

- o Evaluate additional promising rotors that may become available from other U.S. helicopter programs and warrant a joint program of testing in the full-scale wind tunnel -- ARC, FY 1982.

- o Conduct a full-scale wind tunnel test of a rotor, fuselage, and tail to investigate aerodynamic interference effects -- ARC, FY 1984.

- o Where appropriate, improve experimental techniques related to full-scale testing of rotorcraft in the wind tunnel -- ARC, FY 1982.

Flight Test Investigations

- o Complete the comprehensive documentation of the RSRA (helicopter) with the S-61 rotor -- ARC, FY 1983.

- o Complete the installation and check-out of a modern helicopter rotor on the RSRA (helicopter)-- ARC, FY 1984.

- o Complete the comprehensive documentation of the RSRA (compound) with the S-61 rotor -- ARC, FY 1987.

- o Provide general operating support for the two RSRA including ground support equipment to conduct specific tests on vibration, noise, aerodynamic interference, stability and control, augmentation systems, and multicyclic control -- ARC, FY 1982.

JUSTIFICATION:

R&T Base programs in such disciplinary areas as aerodynamics, acoustics, structural dynamics, handling qualities, materials, and structural design are of first-order importance in building the technology base for potential dramatic advancements in rotor systems. However, the technology disciplines are so interwoven in the rotor system dynamic environment that a broad-based systems technology program approach addressing rotor systems as entities is mandatory.

Some projected advanced rotor systems benefits are a 20 percent increase in payload, 10 percent increase in blockspeed, 10 PNdB reduction in noise, 10 percent reduction in fuel use, and 50 percent reduction in vibration and associated maintenance. These goals can only be achieved, however, through fully coordinated systems and engineering design studies, extensive interdisciplinary experimental and analytical technology investigations using ground-based facilities, and carefully selected generic flight experiments using sophisticated research aircraft such as RSRA.

SPECIFIC OBJECTIVE

TITLE: Tilt Rotor Systems Technology

Program/Discipline Objective Title: Low-Speed Aircraft Technology

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To improve, demonstrate, and document tilt rotor technology for military and civil applications, and to provide flight test vehicles for V/STOL flight systems research.

- o Thoroughly evaluate the flying qualities and terminal area capability of the XV-15 aircraft.
- o Evaluate the potential of the tilt rotor concept to perform military and civil missions.
- o Provide design and operational data upon which certification criteria and design standards can be based.
- o Operate the XV-15 aircraft as test beds for broad-based V/STOL flight systems research.
- o Perform preliminary design and ground-based experimental studies of improved tilt rotor systems which may warrant future flight investigations on the XV-15 aircraft.

TARGETS:

- o Complete the concept evaluation flight tests by 1983 to thoroughly evaluate the flying qualities and terminal area capabilities of the XV-15, to evaluate the potential of the tilt rotor concept to perform military and civil mission profiles, and to provide adequate design and operational data upon which certification criteria and design standards can be based -- ARC.
- o Provide operational support, including ground support equipment, for the XV-15 aircraft for all programs utilizing them from FY 1982 through FY 1985 -- ARC.

- On a continuing basis, conduct preliminary technology and design studies of system improvements on the XV-15 aircraft which may warrant incorporation and validation under other program elements -- ARC.

- Complete the installation and test of the V/STOLAND system to investigate IFR and terminal area operations -- ARC, FY 1982.

- Complete flight test evaluations of the tilt rotor concept in the specialized mission areas of low level maneuvers and electronic warfare -- ARC, FY 1982.

JUSTIFICATION:

Two XV-15 Tilt Rotor Research Aircraft were developed in a completed joint NASA/Army Experimental Program. The flight investigations, for which the aircraft was developed, are provided for by this Systems Technology Program.

The tilt rotor concept is very promising for a number of military and civil uses which demand V/STOL capability close to that of helicopters, and also speed, range and fuel efficiency capability approaching that of efficient turboprop aircraft. However, there are several dynamic and flying quality uncertainties concerning the concept which require thorough investigation in an extensive flight research program to provide the basis for sound operational aircraft design standards and certification criteria. Notwithstanding the fact that the XV-15 aircraft were developed with conservative technology, they are very efficient and productive vehicles for planned long term use as V/STOL flight research test beds. There is potential for marked further improvement in tilt rotor performance and flying qualities through application of focused advanced rotor system and aircraft control system technology, as will be investigated in this program.

SPECIFIC OBJECTIVE

TITLE: Advanced Rotorcraft Technology

Program/Discipline Objective Title: Low-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To provide the technology for the low-risk design of advanced rotorcraft systems and subcomponents based on verified design tools and experimental methods with emphasis on rotor and rotor/airframe detailed aerodynamic and aeroelastic prediction for control of vibration and noise; advanced materials application; advanced all-weather guidance, navigation and control systems concepts; advanced propulsion systems; and advanced vehicle concepts which have significant potential gains in productivity. The activity involves focused and coordinated research in analysis, model and large-scale ground testing, and flight testing. This program encompasses civil and military roles for advanced rotorcraft with emphasis on:

- Increased rotorcraft utility.
- Increased vehicle efficiency and durability.
- Reduced external & internal noise.
- Reduced vehicle vibration.
- Increased productivity.

TARGETS:

- Interior Noise: (LaRC)
  - Complete the criteria for passenger acceptance of cabin noise and vibration (FY 1982).
  - Identify sources of cabin noise and identify the transmission path of the noise (FY 1983).
  - Demonstrate possible suppression concepts and cabin treatments for the reduction of airborne and structure-borne noise (FY 1984).

o Exterior Noise:

- Complete correlations of theory and small scale test in rotor noise generated from dynamic stall (FY 1983).

- Expand the aeroacoustic data base for the development of noise prediction methodology through model scale tests of an AH-1G with pressure instrumented blades in the Langley 4 x 7 m (V/STOL Tunnel) - LaRC (FY 1983).

- Conduct subjective tests of recorded and synthesized helicopter community noise to improve quantification and acceptance criteria - LaRC (FY 1983).

- Instrument a four-bladed rotor similar to the two-bladed AH-1G (FY 1983); test one of its airfoil sections two-dimensionally (FY 1984); test the instrumented rotor in the 40 x 80 ft. wind tunnel (FY 1984); prepare it for flight tests on the RSRA (FY 1984) - ARC.

o Initiate configuration studies to quantify the research benefits and costs in developing quiet, efficient helicopters (FY 1982) - ARC.

Vibration (Aeromechanics, Dynamics)

o Conduct open loop multi-cyclic control investigations through 40 x 80 ft. wind tunnel tests (FY 1982); conduct closed loop investigations and develop multi-cyclic control concepts for vibration and load reduction (FY 1984) - ARC.

o Complete assessment and development of analytical models correlated with shake tests to be used in the design analysis of airframe vibration (FY 1983) - LaRC.

o Develop and demonstrate the capability to perform dynamic calibration of the RSRA to provide detailed rotor vibratory data; correlate RSRA shake tests data with NASTRAN; develop a higher harmonic controls system for the RSRA (FY 1984)- ARC.

o Complete a data base of the vibration limited boundaries of the highly instrumented AH-1G rotor in the wind tunnel (FY 1982) - ARC.

- In a joint effort with the Army, select the most promising advanced flight research rotor proposal and begin design and analysis for testing in the full-scale tunnel and on the RSRA (FY 1985) - ARC.

Composite Airframe Technology

- Initiate testing of optimally designed joints, attachments, and cutouts (FY 1982) - LaRC.
- Complete fatigue test of transmission support structure (FY 1983) - LaRC.
- Conduct energy absorption, crashworthiness, and damage tolerance tests on critical airframe components (FY 1985) - LaRC.
- Develop advanced composite materials technology for the next generation helicopter airframe (FY 1987); Coordinate with the U.S. Army Advanced Composites Airframe Program (ACAP) - LaRC.

All Weather Operations

- For rotorcraft de-icing, complete 2-D tests, wind tunnel, and flight testing of a pneumatic boot system on the UH-1H (FY 1983) - ARC.
- Complete flight evaluations of advanced all-weather guidance and navigation systems which allow low cost, reliable IFR operations in remote areas (FY 1985) - ARC.
- Initiate preliminary studies and tests to define a long term program and new facilities to investigate rotorcraft icing (FY 1982) - LeRC.

Configurations

- For multi-lift concepts, complete the requirements and conceptual design of a helicopter twin-lift control system (FY 1983) - ARC.
- For heavy lift concepts, complete the comparison of advanced finite-element analysis and ground-based testing for the prediction of stress levels in large, high-power gear systems (FY 1982) - LeRC; complete investigation of the control requirements for slung load operations that eliminate the need for ground crew assistance (FY 1983)- ARC.

- For the tilt rotor aircraft, complete full-scale wind tunnel testing of advanced composite blades for the XV-15 (FY 1985) - ARC.

Propulsion Efficiency

- Initiate studies in engine contingency power, diagnostics and noise to evaluate possibilities for design improvements - (FY 1984) - LeRC.
- Identify critical systems research and specific tasks which lead to the testing of a convertible (turbofan/shaft) engine, using the TF-34 (FY 1983) - LeRC.

JUSTIFICATION:

In order to adequately support the continued growth of civil rotorcraft utilization and the future needs of military rotorcraft designs, a focused systems technology effort is necessary to integrate research advances in aerodynamics, structures, materials, avionics, and propulsion so as to advance the technology to meet rotorcraft design opportunities. Key elements of this technology are verified design methods which allow the design of new systems with low risk. In order to achieve this level of design reliability, research must be conducted in a systematic fashion which correlates new design analyses with technical data obtained from a series of carefully planned ground and flight tests of advanced hardware systems and subsystems.

This effort is an initial start to demonstrate both quantum and evolutionary increases in several fields where the need for research is strongly driven by the user and the general public. Reliability and durability needs prompt research in vibration reduction and composite design. Increased utility and productivity drive the work in configurations, all-weather operations, and propulsion studies. Finally, community acceptance of rotorcraft noise makes research into this problem vital and overdue.

SPECIFIC OBJECTIVE

TITLE: Low-Speed Simulation and Flight Systems Support

Program/Discipline Objective Title: Low-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

SPECIFIC OBJECTIVE:

To provide support for Ames research aircraft flight experiments in low-speed aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems for advanced rotorcraft, V/STOL aircraft, and STOL aircraft and to provide support of flight simulation programs in guidance, navigation, control, and handling qualities of these classes of aircraft and for the low-speed flight regime of other classes of aircraft.

TARGETS:

- o Maintain and operate Ames research aircraft safely and efficiently to support scheduled research flight experiments - ongoing.
- o Establish a microwave link with the San Joaquin Valley Research area - FY 1982.
- o Maintain and operate simulation facilities in support of scheduled research flight simulation programs - ongoing.
- o Achieve operational status of VICCR - FY 1983.

JUSTIFICATION:

The Ames Research Center carries out a broad program of analytical and experimental research in aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems with emphasis on advanced rotorcraft, V/STOL, and STOL aircraft. This research is supported by a broad-based technical capability which combines wind tunnel investigation, flight simulation, and flight evaluation using a variety of special research aircraft. Flight evaluations and flight simulation therefore play a vital role in this integrated approach and the resulting data is a major factor in the Center's contribution to new technology.

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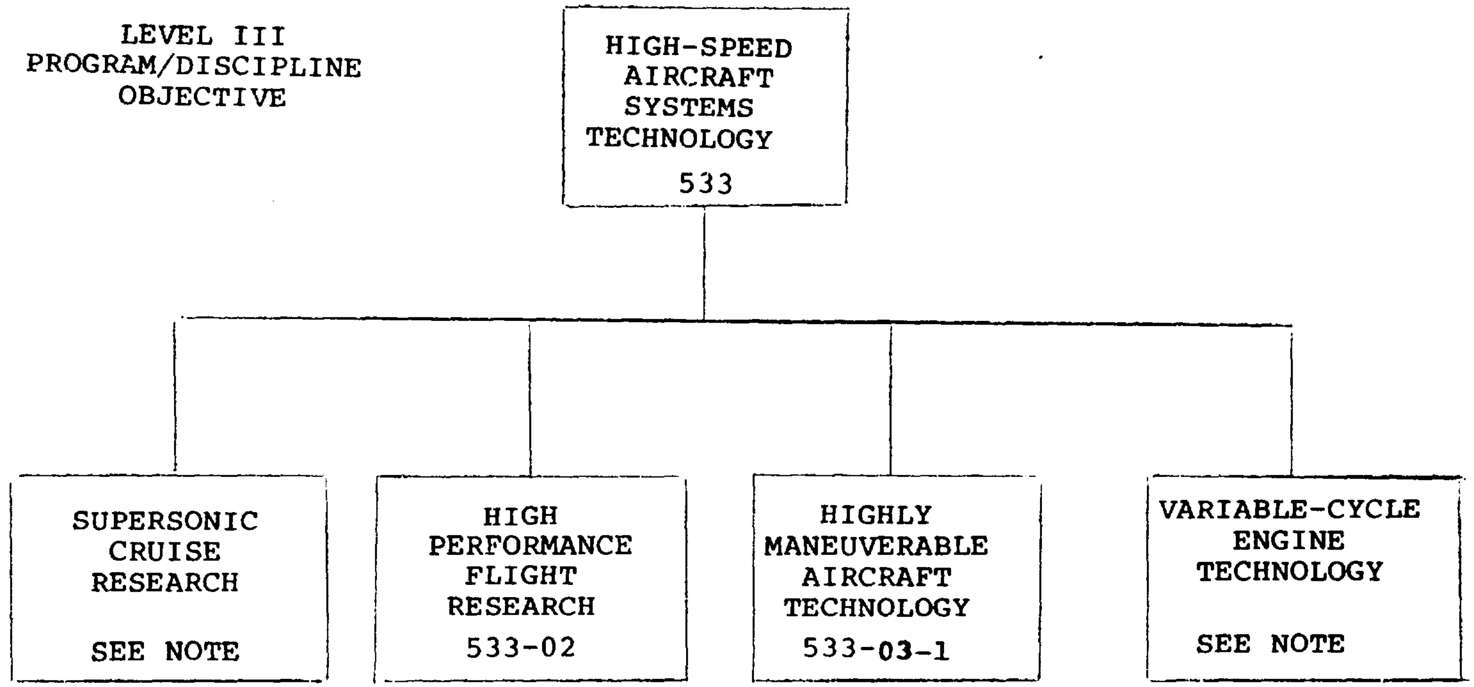
HIGH-SPEED AIRCRAFT SYSTEMS TECHNOLOGY

HIGH-SPEED AIRCRAFT SYSTEMS TECHNOLOGY

LEVELS III & IV



NOTE: THE SCR Systems Technology and VCE Systems Technology Programs were cancelled in the FY 1982 NASA budget. They are inactive and shown unnumbered in this PASO only for record. The elements of these two programs remaining in FY 1982 are contained in 505-43: High-Speed Aircraft R&T.

PROGRAM/DISCIPLINE OBJECTIVE

TITLE: High-Speed Aircraft Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine

PROGRAM/DISCIPLINE OBJECTIVE:

To perform required research, using ground-based simulators, wind tunnels, and flight tests, to generate engineering and design data necessary to advance high-performance aircraft for civil and military applications.

SPECIFIC OBJECTIVES:

- Supersonic Cruise Research: The SCR Systems Technology Program was cancelled in the FY 1982 NASA budget. It is inactive and shown unnumbered in this PASO only for record. The elements of the program remaining in FY 1982 are contained in 505-43: High-Speed Aircraft R&T.

- High Performance Flight Research: To conduct analyses, tests, and selected flight experiments using high-speed aircraft as necessary to explore and evaluate advanced technologies.

- Highly Maneuverable Aircraft Technology (HiMAT): To promote and stimulate the application of new (high-risk) technology in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of new technology for the design of future fighter aircraft; and to provide verification of the cost-effectiveness and technology transition efficiency of using the remotely-piloted research vehicle (RPRV) concept for conducting flight research, especially on advanced high-risk concepts.

- Variable-Cycle Engine Technology: The VCE Systems Technology Program was cancelled in the FY 1982 NASA budget. It is inactive and shown unnumbered in this PASO only for record. The elements of the program remaining in FY 1982 are contained in 505-43: High-Speed Aircraft R&T.

SPECIFIC OBJECTIVE

TITLE: High Performance Flight Research

Program/Discipline Objective Title: High-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division: David A. Kier/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To conduct analyses, tests, and selected flight experiments using high-speed aircraft as necessary to explore and evaluate advanced technologies.

- o Integrated Research Aircraft Controls Technology: Develop, evaluate, and demonstrate a generically applicable design methodology for integrated airframe/propulsion controls.
  - Demonstrate the viability of integrated airframe/propulsion controls to achieve system improvements.
  - Develop a flight hardware system capable of implementing advanced control concepts and algorithms.
  - Establish an initial methodology to guide the design of more complex integrated airframe/propulsion control systems required in future vehicles.
- o AFTI-16: Conduct the flight research portion of this joint Air Force/NASA program, and provide the data acquisition system and necessary instrumentation to gather flight data on the benefits of the multivariable digital flight control system and direct force control flight mode.
  - Determine the pilot-vehicle interaction and limits of control provided by the direct force control over the vehicle's flight envelope.
  - Compare flight-measured performance with predicted performance.
  - Evaluate the utility of the multivariable digital flight control system for a modern high-performance aircraft.

- Mission Adaptive Wing (AFTI-111): Verify, in the real and dynamic world of flight, the predicted performance gains for the variable sweep, smooth variable camber mission adaptive wing. Also, verify the performance of other advanced technology features, such as active controls for load alleviation and reduced static stability, that may be incorporated in the test vehicle. This activity is a joint NASA/Air Force program.

  - Determine the aerodynamic performance benefits of the mission adaptive wing.

  - Compare flight-measured performance with predicted performance of the mission adaptive wing.

  - Evaluate performance benefits of other advanced technology features.

- F-14 High Angle-of-Attack Characteristics with Stores: Evaluate the effects of external pylon-mounted stores on the stability of the F-14 at high angles-of-attack and assess the effects of the aileron-to-rudder interconnect (ARI) in enhancing the flying qualities of the stores-carrying F-14. This activity is a joint NASA/Navy program.

  - Determine the magnitude of the decrease in stability of the F-14 with stores over the angle-of-attack range.

  - Compare flight measured characteristics with the predicted characteristics.

  - Evaluate the benefits of the ARI on the stores-configured aircraft.

- Decoupler Pylon: Design, fabricate, and flight test a NASA-developed decoupler pylon to assess the performance improvements and alleviation of the stores flutter problem and evaluate the dynamic characteristics of the device.

  - Assess aircraft performance improvements achievable by using the decoupler pylon as a stores-carrying device.

  - Determine the increase in flutter speeds associated with using the pylon.

  - Evaluate the pylon's response to the dynamic maneuvers and characteristics obtained in flight.

- F-4C Spanwise Blowing: To identify and quantitatively determine the performance benefits of the spanwise blowing system installed in the F-4C.
  - Determine from wind-tunnel tests, the optimum location and flow rates for outboard spanwise blowing nozzles and replicate this system on the aircraft.
  - Establish from flight research, the benefits of spanwise blowing in terms of maneuverability improvements at high subsonic and transonic speeds.
  - Determine the effects of spanwise blowing on reducing takeoff and landing speeds and/or distances.
- Digital Electronic Engine Control: Conduct the flight test portion of a joint Air Force/NASA program to demonstrate and evaluate a digital electronic engine control (DEEC) on a modern high-speed fighter aircraft.
  - Assess engine control failure detection and accommodation logic.
  - Evaluate advanced augmentor performance and durability improvements.
  - Validate design and ground test procedures and results by comparing these with flight test results.
- Forward Swept Wing Flight Demonstrator: Assist the Defense Advanced Research Projects Agency and its technical agent during the acquisition of the flight demonstrator vehicle(s), and conduct the Government flight tests.
  - Provide technical advisory support including monitoring of quality assurance.
  - Within scheduling and resources constraints, perform wind tunnel tests of DARPA/contractor models in NASA facilities.
  - Provide for incorporation in the flight demonstrator vehicle(s) available NASA flight test instrumentation.
  - Conduct the Government flight tests of the flight demonstrator vehicle(s).

TARGETS:

- o Integrated Research Aircraft Controls Technology:
  - Initiate design, fabrication, and ground test phase of flight hardware system by FY 1982.
  - Initiate flight testing and research by FY 1985.
- o AFTI-16:
  - First flight of Integrated Fire/Flight Control System. FY 1982
  - Complete flight research activities. FY 1983
- o Mission Adaptive Wing (MAW) (AFTI-111):
  - Delivery of mission adaptive wing test aircraft. FY 1982
  - Initiate flight research activities. FY 1982
  - Complete flight research activities. FY 1985
- o F-14 High Angle-of-Attack Characteristics with Stores:
  - Initiate flight research activities to define the high angle-of-attack flow field. FY 1982
  - Complete flight program. FY 1983
- o Decoupler Pylon:
  - Begin final design and fabrication of flight qualified decoupler pylon. FY 1982
  - Initiate flight research activities. FY 1983
  - Complete flight program. FY 1984
- o F-4C Spanwise Blowing:
  - Initiate flight research. FY 1982
  - Complete program and return aircraft to the Air Force. FY 1982

- o Digital Electronic Engine Control:
  - Complete flight testing in FY 1982.
  - Complete analyses, comparisons of ground test data with flight test results, and final documentation and reporting in FY 1984.
- o Forward Swept Wing Flight Demonstrator:
  - Provide assistance to DARPA and its technical agent in FY 1982.
  - Complete preparations for a high fidelity ground-based dedicated simulation in FY 1983.
  - Complete preparations for receiving the flight demonstrator vehicle(s) in FY 1984.
  - Complete flight testing in FY 1986.

JUSTIFICATION:

- o Integrated Research Aircraft Controls Technology: Current airframe and propulsion control systems are developed separately because of the historical practice wherein engine controls have been developed by engine manufacturers and airframe controls have been developed by airframe manufacturers. In addition, currently there is an inability of existing accepted design processes to accommodate the interactive multiple input-multiple output systems. Future high speed vehicles will require fully integrated control systems, and it is therefore necessary to develop and validate a design methodology which can be used in their development.
- o AFTI-16: NASA's portion of this joint NASA/Air Force program is to conduct the wind-tunnel testing necessary to support the program and develop the basic performance predictions. This portion of the activity is expected to be completed in FY 1980. Subsequent to the Air Force providing the modified aircraft in FY 1981, NASA will conduct the flight research activities on the vehicle. The program will provide validated technology options in flight control for future military aircraft. The program directly supports the NASA objective to provide advanced technology to support military needs.
- o Mission Adaptive Wing (AFTI-111): NASA's portion of this joint NASA/Air Force program is to conduct the wind-tunnel testing necessary to support the program and develop the basic performance predictions, as well as to conduct the necessary flight research activities. The Air Force will provide the mission adaptive wing installed on a suitably modified test F-111 aircraft.

The program will provide validation of the variable camber and active control technology options for future military aircraft designs. The program directly supports the NASA objective to provide advanced technology to support military needs.

- F-14 High Angle-of-Attack Characteristics with Stores: NASA has developed and is currently flight testing an advanced aileron-to-rudder interconnect (ARI) on the F-14 as part of a joint NASA/Navy program. The Navy has requested that we extend the current activities to include an evaluation of the effects of external stores on the ARI effectiveness. The Navy will provide the pylons and stores as well as continued assistance in supporting the aircraft.

  This program will provide validated technology for potential inclusion on the F-14. The program directly supports the NASA objective to provide advanced technology to support military needs.

- Decoupler Pylon: NASA has developed and evaluat in the wind tunnel, a decoupler pylon which dynamically isolates the pylon and wing. This pylon has shown in wind-tunnel tests that large decreases in store-inducted flutter penalties are possible with its use. This program will validate the ground-based results in the real and dynamic world of flight.

  The program will provide validated technology options for future military aircraft. The program directly supports the NASA objective to provide advanced technology to support military needs.

- F-4C Spanwise Blowing: The potential improvements in aircraft maneuvering performance at high subsonic and transonic speeds from spanwise blowing have been documented in wind-tunnel tests for several years. This program will determine if these benefits also accrue in the real and dynamic world of flight and will correlate the flight results with the wind-tunnel predictions.

  This program will provide validated technology options for future military aircraft as well as for possible inclusion on the F-4C. The program directly supports the NASA objective to provide advanced technology to support military needs.

- Digital Electronic Engine Control: Advanced military and civil high speed aircraft will require more complex engine controls and integration of these controls with the flight control system. Digital technology is the only practical means to accomplish this integration. To date, engine controls technology has not progressed as fast as airframe controls technology, and only recently digital technology has been applied in a limited way to engine controls. The Pratt & Whitney DEEC for the F-100 engine is the most advanced system which has progressed to flight readiness, and in this cooperative Air Force/NASA program, the DEEC will be validated in flight on one of the F-100 engines in the F-15 aircraft loaned to NASA by the Air Force.

- Forward Swept Wing Flight Demonstrator: In May 1980, the Director of the Defense Advanced Research Projects Agency wrote to NASA suggesting a joint DARPA/NASA program for conducting the flight demonstration effort for the DARPA-funded forward swept wing flight demonstrator. NASA management replied that NASA could conduct the flight research and bear some share of the flight test support costs, and could also provide wind tunnel and technical advisory support during the acquisition and flight research phases. On April 22, 1981, a Memorandum of Agreement between NASA and DARPA was signed by both agencies establishing NASA's responsibility for the overall technical and operational portions of the Government conducted flight test and also NASA's responsibility to assist DARPA during the final design, fabrication, ground testing, and functional flight testing of the flight vehicle(s).

SPECIFIC OBJECTIVE

TITLE: Highly Maneuverable Aircraft Technology (HiMAT)

Program/Discipline Objective Title: High-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/David A. Kier

SPECIFIC OBJECTIVE:

To promote and stimulate the application of new (high-risk) technology in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of new technology for the design of future fighter aircraft; and to provide verification of the cost-effectiveness and technology transition efficiency of using the remotely-piloted research vehicle (RPRV) concept for conducting flight research, especially on advanced high-risk concepts.

- o Validate advanced aerodynamic technology and advanced design techniques.
- o Demonstrate the benefits of an all-composite aeroelastically tailored wing.
- o Verify operational concepts associated with the use of advanced RPRV configurations.

TARGETS:

- o Demonstrate the supersonic design condition and the transonic design condition with reduced static stability during FY 1982.
- o Verify an increase of 100% in aerodynamic efficiency over current vehicles by use of an advanced wing/canard configuration employing aeroelastic tailoring by end of FY 1982.
- o Complete the acquisition of the detailed flight research data relative to the advanced technologies incorporated in the HiMAT vehicles - FY 1983.

JUSTIFICATION:

In discharging its statute responsibility, NASA conducts aeronautical research and testing of experimental aircraft as required to support military and civil aviation objectives. In contrast with NASA's emphasis on research and basic technology, the military services must place emphasis on applied research and systems development. The instrument of coordination of the aeronautics program activity and interchange of information between the Services and NASA is the DOD/NASA Aeronautics and Astronautics Coordinating Board (AACB).

The Joint NASA/Air Force HiMAT/RPRV program is in direct response to the recommendations of the AACB developed by its Aeronautics Panel in a special study of research needs (November 1972) which found that "substantial improvements in maneuver capability will be needed for advanced fighters in the 1980's" and suggested that the opportunity to conduct flight research at low cost offered by RPRV's be exploited to bring new technologies to a state of application readiness.

A review of the 1972 study results was conducted in late 1975 to update the findings and recommendations. It was determined that the original conclusions and recommendations were still valid and should be pursued aggressively. The RPRV test technique with subscale vehicles is expected to yield cost reductions of approximately 70 percent over comparably manned vehicles.

TRANSPORT AIRCRAFT SYSTEMS TECHNOLOGY

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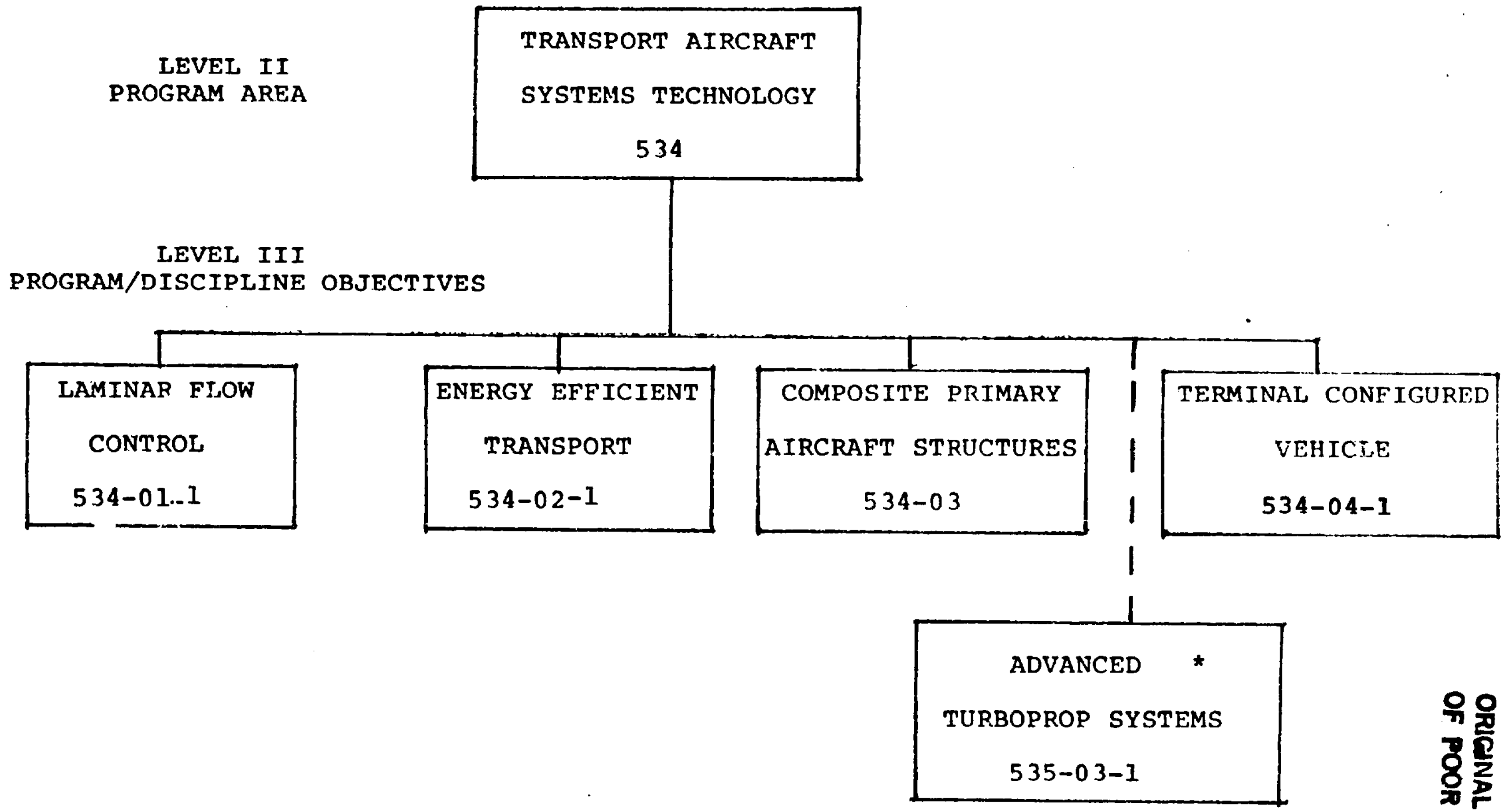
SYSTEMS TECHNOLOGY PROGRAMS WORK BREAKDOWN STRUCTURE



TITLE: Transport Aircraft Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/Roger L. Winblade

PROGRAM/DISCIPLINE OBJECTIVE:

To provide, for subsonic transport aircraft, demonstration/ proof of concept for emerging systems technology; to demonstrate/validate the technical readiness of innovative systems through experimental testing and verification in a realistic environment; and to conduct the definition phases of potential future aeronautical research programs for attainment of enhanced aircraft energy efficiency and operational compatibility with the future National Aviation System.

SPECIFIC OBJECTIVE:

- Laminar Flow Control: To develop and demonstrate a practical, reliable, maintainable boundary-layer control system for viscous drag reduction of future transport aircraft.
- Energy Efficient Transport: To develop and evaluate advanced aerodynamics, propulsion/airframe integration, and active controls technology for near-term application to derivative and new transport aircraft.
- Composite Primary Aircraft Structures: To accelerate the introduction of composite secondary and medium primary structures in future derivative and new commercial transport aircraft by designing, developing, and certifying six composite components.
- Advanced Turboprop Systems: To develop and demonstrate turboprop propulsion systems having high propulsive efficiencies at 0.7 to 0.8 mach number for application to commercial transport aircraft.
- Terminal Configured Vehicle: To identify and validate aircraft system and flight management technology that will benefit conventional takeoff and landing aircraft terminal-area operations.

SPECIFIC OBJECTIVE

TITLE: Laminar Flow Control

Program/Discipline Objective Title: Transport Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Lee D. Goolsby

SPECIFIC OBJECTIVE:

To develop and demonstrate a practical, reliable, maintainable boundary-layer control system for viscous drag reduction of future transport aircraft.

- o Evaluate alternative laminar flow control system concepts.
- o Develop practical solutions for surface contamination.
- o Investigate advanced materials and fabrication techniques.
- o Optimize airfoil and wing geometries.
- o Develop improved suction and roughness criteria.

TARGETS:

- o Conduct Leading Edge Flight Test (LEFT) critical design review - FY 1982.
- o Complete First Phase of LFC Swept Wing Model Wind-Tunnel Tests - FY 1982.
- o Conduct LFC wing surface system development (WSSD) critical design review - FY 1983.
- o Begin LEFT Testing - FY 1983.
- o Complete WSSD Ground Tests - FY 1984.
- o Complete LEFT - FY 1984.
- o Award LFC wing aerodynamic design contracts - FY 1984.

JUSTIFICATION:

- Laminar Flow Control offers the possibility of significant fuel savings for long-range civil and military aircraft. The technical feasibility of LFC was demonstrated in the mid-1960's with the USAF/ Northrop X-21 airplane; however, the program was terminated before full operational practicability in a realistic environment was established. In the decade since the X-21 program, major advances in materials, structures, aerodynamics and propulsion have enhanced the possibilities for development of a practical, reliable and maintainable LFC system. Increased effort is now required to exploit these advances to develop a sound technical basis for the application of LFC to future commercial transport aircraft. The promised fuel savings from laminar flow control is sufficient to warrant a continuing, concerted attack on the critical issues of wing-surface structural development and the integrated system flight test of leading-edge systems.

TITLE: Energy Efficient Transport

Program/Discipline Objective Title: Transport Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Don Maiden

SPECIFIC OBJECTIVE:

To develop and evaluate advanced aerodynamics, propulsion/airframe integration, and active controls technology for near-term application to derivative and new transport aircraft.

- o Establish aerodynamic data base for high-aspect ratio supercritical wings.
- o Define and demonstrate advanced high-lift systems.
- o Develop improved computer aided aerodynamic design methods.
- o Develop integrated analysis and design techniques for active controls systems.
- o Evaluate advanced flight control system concepts.

TARGETS:

- o Initiate aeroelastic wing/flight control system flight tests - FY 1982.
- o Complete advanced technology airfoil tests - FY 1982.
- o Complete winglet flight test on DC-10 - FY 1982.
- o Complete flight test of reduced static stability on L-1011 - FY 1983.

JUSTIFICATION:

A major factor in the continued health and growth of the air transportation industry is fuel efficiency. The competitive position of the U.S. transport manufacturers in international marketing is significantly enhanced by greater fuel efficiency and the resulting lower cost of operation. To match the growing demand for greater efficiency, significant advancement in the state-of-the-art in aerodynamic design for fuel efficiency is required. The Energy Efficient Transport program will provide the required advancement in the form of verified data, advanced design concepts and techniques and flight test experience with aerodynamics and active controls for both near-and far-term applications.

SPECIFIC OBJECTIVE

TITLE: Composite Primary Aircraft Structures

Program/Discipline Objective Title: Transport Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Havard Wood

SPECIFIC OBJECTIVE:

To accelerate the introduction of composite secondary and medium primary structures in future derivative and new commercial transport aircraft by designing, developing, and certifying six composite components.

- o Verify performance prediction.
- o Develop cost-competitive manufacturing processes.
- o Provide opportunity for airline acceptance.
- o Provide data to support durability prediction.

TARGETS:

- o DC-10 vertical fin - complete ground tests - FY 1982.
- o L-1011 vertical fin - complete durability evaluation - FY 1983.

JUSTIFICATION:

The NASA Aircraft Energy Efficiency program has the objective to support the continued economic viability of the commercial transport industry and to improve the energy efficiency of future U.S. aircraft so that substantial savings in fuel can be realized. One of the elements of this program is composite primary aircraft structures. Using composite materials can decrease aircraft structural weight by about 25%, resulting in a 10 to 15% reduction in fuel consumption. Design simplification with fewer parts and fasteners is a key factor in being able to achieve lower cost.

The CPAS program is directed toward research to develop the technology and confidence needed to exploit and accelerate composite structures in commercial transport aircraft. Without this effort, composite technology would not be widely used in U.S. manufactured aircraft structures until well into the 1990's. The additional extensive design, manufacturing and airline service experience is required to enable the airframe industry to commit to the extensive use of composites in earlier derivative or new production aircraft.

SPECIFIC OBJECTIVE

TITLE: Terminal Configured Vehicle

Program/Discipline Objective Title: Transport Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Lee D. Goolsby

SPECIFIC OBJECTIVE:

To identify and validate aircraft system and flight management technology that will benefit conventional takeoff and landing aircraft terminal-area operations, conducting research that will support improvements in:

- o Terminal area capacity and efficiency.
- o Approach and landing capability in adverse weather.
- o Noise environment.
- o Fuel-efficient operations.

TARGETS:

- o Validate integrated airborne flight management systems with which the aircraft can be maneuvered to acquire and track defined terminal area flight paths with sufficient accuracy in three spatial dimensions and time, using integrated area navigation-microwave landing system flight paths, to:
  - Improve automatic control and validate in windshear with same touchdown dispersion as no wind (±100') - FY 1982.
  - Demonstrate reduced runway occupancy time of 25 seconds for single aircraft - FY 1982.
  - Complete flight deck definition for TCV 737 aircraft for more efficient utilization of airplane and crew - FY 1982.

- Demonstrate capability for reducing lateral spacing of parallel runways for simultaneous approaches from 4300 feet to 2500 feet - FY 1982.

o Demonstrate noise and fuel efficient terminal-area operations technology.

- 3D digital-design capture throughout rollout - FY 1982.
- 3D digital-design capture throughout turnoff - FY 1983.
- Fuel efficient time-based descents from cruise to runway threshold - FY 1983.
- 4D curved path autoland through turnoff - FY 1984.

o Complete the investigation of, and demonstrate the capacity, efficiency, and safety potential of, Cockpit Display of Traffic Information with elements of the air traffic control (ATC) system.

- Effectiveness in simulated future ATC concepts utilizing advanced airborne system - FY 1982.
- Passive Role CDTI - FY 1984.
- Active Role CDTI - FY 1988.

o Demonstrate basic capability for instrument flight rules (IFR) landing rates approaching visual flight rules (VFR) rates - FY 1983.

o Complete B-737 experimental systems upgrade to integrate with advanced ATC system elements - FY 1983.

JUSTIFICATION:

The evolution of the present ATC system into an advanced system for the late 1980's is being accomplished by the FAA by upgrading the technology to accommodate anticipated increases in air traffic and related problems in the 1980's. Expected benefits are safety and performance improvement and operating cost reduction. The NASA TCV program is a companion effort, closely coordinated with the FAA, which concentrates on increasing the capabilities of Transport Aircraft.

ADVANCED PROPULSION SYSTEMS TECHNOLOGY

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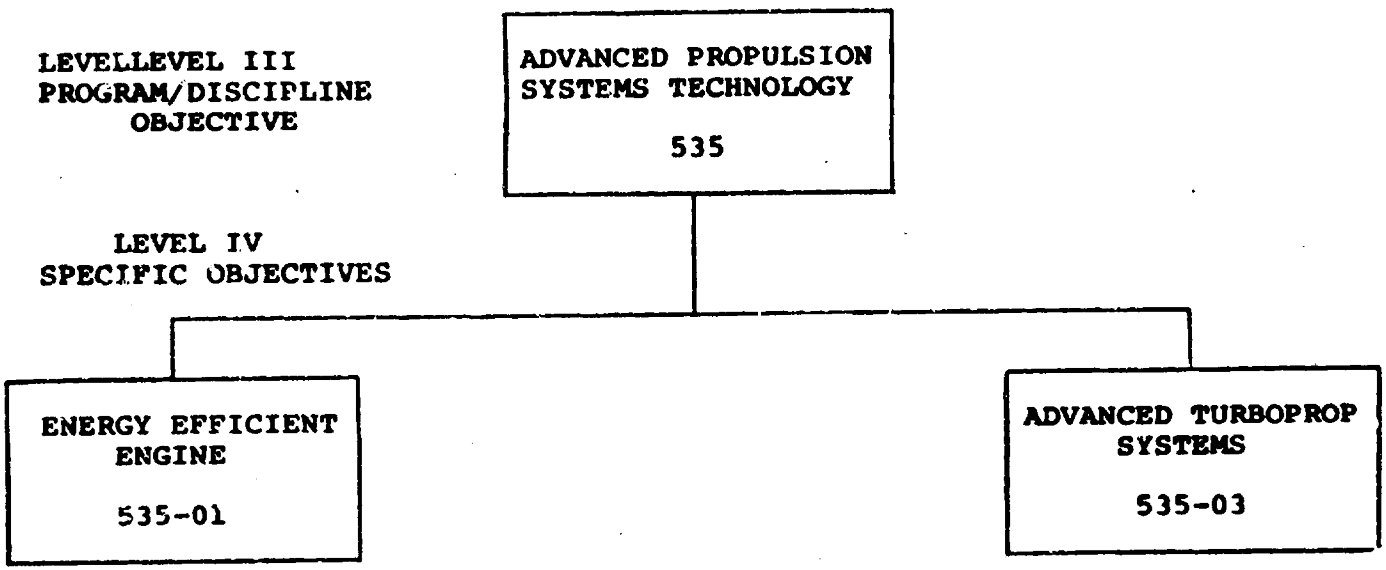
ADVANCED PROPULSION SYSTEMS TECHNOLOGY WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Advanced Propulsion Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/David J. Poferl

PROGRAM/DISCIPLINE:

To advance the technology of aeronautical propulsion systems for the attainment of improved performance, lower fuel consumption and reduced noise and emissions in advanced engines for future aircraft systems. This systems technology approach seeks to uncover interactions between combinations of components not possible by research on discrete components. Major emphasis is focused on the development and demonstration of propulsion technology for improving the energy efficiency of future civil transport aircraft and on the demonstration of variable cycle engine system feasibility for future supersonic cruise and high-performance aircraft.

SPECIFIC OBJECTIVES:

Energy Efficient Engine: To develop and demonstrate the technology for a next-generation turbofan engine having a 10- to 15-percent lower specific fuel consumption, at least a 5-percent reduction in direct operating cost, reduced emissions and noise levels, and a 50-percent improvement in performance deterioration rate as compared to current high-bypass turbofan engines.

Advanced Turboprop Systems: To develop and demonstrate the technology for advanced turboprop propulsion systems having high propulsive efficiencies at cruise speeds from Mach 0.7 to 0.8 which will provide fuel savings of 15 to 20 percent relative to high-bypass turbofan engines incorporating equivalent core engine technology while meeting reliability requirements and environmental noise constraints.

SPECIFIC OBJECTIVE

TITLE: Energy Efficient Engine

Program/Discipline Objective Title: Advanced Propulsion Systems Technology

Responsible Organization/Individual: Research and Technology Division/John R. Facey

SPECIFIC OBJECTIVE:

To develop and demonstrate the technology for a next-generation turbofan engine having a 10- to 15-percent lower specific fuel consumption, at least a 5-percent reduction in direct operating cost, reduced emissions and noise levels, and a 50-percent improvement in performance deterioration rate as compared to current high-bypass turbofan engines.

- o Define and evaluate advanced engine design concepts to expand enabling technology base.
- o Design and develop advanced engine components and verify performance of each component in full-scale rig tests.
- o Design, fabricate, and test the high-spool core system to evaluate its performance characteristics and to further modify and refine the design of the high-pressure components.
- o Develop and test the low-spool assembly integrated with the core to evaluate low-spool system performance.

TARGETS:

- o Complete all major engine component testing - FY 1982.
- o Initiate system integration test of core components - FY 1982.
- o Initiate system integration test of core and low-spool components - FY 1983.
- o Complete integrated core/low-spool test and the final update of the Flight Propulsion System design - FY 1984.

JUSTIFICATION:

The NASA Aircraft Energy Efficiency program has the objective of improving the energy efficiency of future U.S. aircraft to retain their dominant place in the commercial aircraft market. During 1975, the technology plan for implementing this program was submitted to the Senate Committee on Aeronautical and Space Sciences by the Task Force on Aircraft Fuel Conservation Technology. One of the elements of this plan is the Energy Efficient Engine (EEE) program. Technology readiness for future engine designs will be demonstrated by 1983 at the completion of the EEE program. This technology could be expected to be ready for use on new engines introduced into service in the late 1980's and early 1990's. Selected technologies could be incorporated in new or derivative engines introduced into service in the mid-1980's.

SPECIFIC OBJECTIVE

TITLE: Advanced Turboprop Systems

Program/Discipline Objective Title: Advanced Propulsion Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Paul G. Johnson

SPECIFIC OBJECTIVE:

To develop and demonstrate the technology for advanced turboprop propulsion systems having high propulsive efficiencies at cruise speeds from Mach 0.7 to 0.8 which will provide fuel savings of 15 to 20 percent relative to high-bypass turbofan engines incorporating equivalent core engine technology while meeting reliability requirements and environmental noise constraints.

- Document far- and near-field acoustic characteristics of advanced high tip-speed propellers and develop advanced design techniques to reduce propeller source noise and to reduce noise and vibration transmission to cabin interiors.
- Conduct turboprop/aircraft integration investigations and optimize flow interactions involving propeller, slipstream, nacelle, and wing.
- Optimize advanced propeller aerodynamic, acoustic, and aeroelastic design to demonstrate propulsive efficiencies of 80 percent or more at cruise conditions up to Mach 0.8 and 35,000 feet.

TARGETS:

- Initiate large-scale blade/disk fabrication - FY 1982.
- Initiate drive system acquisition and modification - FY 1982.
- Determine the noise attenuation characteristics of fuselage wall concepts optimized for turboprop transport applications - FY 1983.

- o Determine propeller-nacelle-wing aerodynamic interactions and develop a preliminary design methodology for minimum installation penalty - FY 1983.
- o Initiate tests to define stall flutter characteristics of large-scale propeller - FY 1984.
- o Determine the structural dynamic characteristics of the large-scale propeller - FY 1986.

JUSTIFICATION:

The NASA Aircraft Energy Efficiency program has the objective of demonstrating the technology that will improve the energy efficiency of future U.S. commercial and military aircraft so that U.S. aircraft can retain their dominant place in the commercial aircraft market. Advanced turboprops offer the promise of a major step toward achieving this objective. With their higher propulsive efficiency, advanced turboprops have the potential of a 15-to-20-percent savings in block fuel relative to advanced turbofans. Turboprops have provided lower fuel consumption for years at Mach 0.6 and 20,000 feet and below. However, to compete with current commercial transports, higher cruise Mach number and altitude with an acceptable cabin environment are necessary. The Advanced Turboprop program is structured to advance all of the interrelated technologies which must ultimately be integrated into an operational, fuel-conservative turboprop transport aircraft.

The Advanced Turboprop program will also contribute to the essential data base for advanced, efficient commuter and short-haul aircraft, which have become increasingly important since the recent airline deregulation and rise in aircraft operating costs.

END

DATE

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