

# Aerospace Technology Enterprise

## Mission

The Aerospace Technology (AST) Enterprise mission is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aerospace technologies. Research and development programs conducted by the Enterprise contribute to NASA's science and exploration mission, national security, economic growth, and the competitiveness of American aerospace companies. The Enterprise plays a key role in maintaining a safe and efficient national aviation system and enabling an affordable, reliable space transportation system. The Enterprise directly supports national policy in both aeronautics and space as directed in the President's Goals for a National Partnership in Aeronautics and Research Technology, the National Space Policy, and the National Space Transportation Policy.

## Implementation Strategy

The Enterprise manages a clearly defined portfolio of technology investments to ensure alignment with national policy, Agency goals, customer requirements, and budget availability. The investment strategies are focused on issues associated with future aviation and space systems. Enterprise objectives are outcome-focused and "stretch" beyond our current knowledge base. The outcome-focused nature of the objectives projects a preferred end-state within the air and space transportation systems. Designated Lead Centers have been assigned the responsibility to manage the implementation and execution phases of the technology programs. Enterprise programs are often conducted in cooperation with other Federal agencies, primarily the Federal Aviation Administration and the Department of Defense. These partnerships take advantage of the national investment in aeronautics and astronautics capabilities and eliminate unnecessary duplication.

The Enterprise supports the maturation of technology to a level such that it can be confidently integrated into current and new systems. In most cases, technologies developed by the Enterprise can be directly transferred to the external customer.

## Enterprise Resource Requirements

The President has requested the following budget for FY 1999 to FY 2002 to support the accomplishment of AST goals:

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>FY 2002</u>
NOA \$M	1,338.9	1,266.7	1404.1	1508.0
CS FTE	4,227	4,345	4,713	4,710

## Performance Metrics

**Goal: Revolutionize Aviation – Enable the safe, environmentally-friendly expansion of aviation.**

**Objective: Increase Safety – Make a safe air transportation system even safer.**

Public Benefit: Improved safety of air travel

Performance Goal 2R1: Complete the interim progress assessment utilizing the technology products of the Aviation Safety program as well as the related Aerospace Base R&T efforts and transfer to industry an icing CD-ROM, conduct at least one demonstration of an aviation safety related subsystem, and develop at least two-thirds of the planned models and simulations. Planned program products that support the accomplishment of the annual performance goal are:

### Aerospace Focused – Aviation Safety

- Complete a GA pilot survey.
- Conduct a fast-time simulation of system-wide risks.
- Model high error probability contexts and solutions.
- Demonstrate loss of control and recovery models.
- Flight demonstrate forward-looking turbulence warning systems.
- Demonstrate a National Aviation Weather Information Network (AWIN) capability.
- Demonstrate a national AWIN data link capability.
- Validate structural crash analysis tools.
- Complete an interim integrated program assessment.

### Aerospace Base R&T

- Develop and distribute a CD-ROM self-paced icing training modules for pilots.
- Develop a methodology for the design and verification of task driven human automation systems.
- Complete validation of new perceptual measurement tools for evaluating display effectiveness as it supports human performance.
- Generate initial model for flight crew Scheduling Assistant based on sleep and circadian cycles.
- Demonstrate prototype technologies for an aviation safety information system
- Assess the electromagnetic impact on critical flight control hardware through physics-based modeling of the Electromagnetic (EM) fields.
- Develop the methodology for improved radiographic inspection of complex structures with scanned x-ray source and multiple detectors to enable improved characterization of aerospace structures and detection of flaws critical to safety and reliability.

**Objective: Reduce Emissions -- Protect local air quality and our global climate.**

Public Benefit: Improved air quality and protection of the environment

Annual Performance Goal 2R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen (NOx) and carbon dioxide (CO<sub>2</sub>). The annual performance goal is to complete sector testing of a low-NOx combustor concept capable of a 70% reduction in NOx from the 1996 [International Civil Aviation Organization (ICAO)] baseline, and demonstrate at least one additional concept for the reduction of other emittants. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – Ultra-Efficient Engine Technology

- Complete sector evaluations of a combustor capable of 70% reductions in Oxides of Nitrogen.
- Select ceramic thermal barrier coating/process
- Demonstrate aspirating seal technology
- Develop an Integrated Component Demonstration Plan for collaborative tests of engine demonstrators incorporating UEET technologies for large and small thrust class engines.

Aerospace Base R&T

- Assess hybrid fuel cell and liquid hydrogen fueled optimized turbofan concepts.
- Demonstrate concepts for reduction in gaseous, particulate, and aerosol emissions.
- Identify revolutionary aeropropulsion concepts identified and assess preliminary performance .

**Objective: Reduce Noise – Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers.**

Public Benefit: Improved noise environment in communities near airports

Annual Performance Goal 2R3: NASA's research stresses reducing noise in the areas of engines, nacelles, engine-airframe integration, aircraft interiors and flight procedures. The annual performance goal is to assess and establish the strongest candidate technologies to meet the 10-decibel reduction in community noise. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – Quiet Aircraft Technology

- Identify community noise impact reduction technology required to meet 10 year, 10 decibel Enterprise goal.
- Deliver initial version of improved aircraft systems noise prediction code delivered

**Objective: Increase Capacity -- Enable the movement of more air passengers with fewer delays.**

Public Benefit: Reduced travel time, improved use of natural resources, and protection of the environment

Annual Performance Goal 2R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The annual performance goal is to develop at least two decision support tools for arrival, surface, and departure operations, and define requirements for future aviation system concepts. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – Aviation System Capacity

- Develop and evaluate inter-operability of decision support tools that address arrival, surface and departure operations.
- Develop and evaluate a traffic flow management decision support tool for system-wide prediction of sector loading.
- Develop, demonstrate initial functionality, and evaluate human factors for active terminal area decision support tool.

Aerospace Base R&T

- Define and document the requirements for a high-fidelity, real-time, human-in-the-loop simulation system to evaluate proposed aviation system concepts.
- Define and document a concept for the future aviation system as the basis for future modeling.
- Complete the Critical Design Review for the Blended Wing Body experimental vehicle.

**Objective: Increase Mobility – Enable people to travel faster and farther, anywhere, anytime.**

Public Benefit: Increased destinations reachable by air and reduced travel time

Annual Performance Goal 2R5: NASA's research stresses aircraft technologies which enable the use of existing small community and neighborhood airports, without requiring control towers, radar installations, and more land use for added runway protection zones. The annual performance goal is to baseline in partnership with the FAA, the system engineering documents for the Small Aircraft Transportation System concept. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – Small Aircraft Transportation System

- Complete preparation of the baseline System Engineering documents (including the Operational Requirements Document, Functional Architecture, and Technical Requirements Document) for SATS concept and place under configuration management.

Aerospace Base R&T

- Complete preliminary design of extremely slow takeoff and landing vehicle.

**Goal: Advance Space Transportation — Create a safe, affordable highway through the air and into space.**

**Objective: Mission Safety -- Radically improve the safety and reliability of space launch systems.**

Public Benefit: Expanded opportunities for near-Earth operations and commercialization through safe and reliable access to space

Annual Performance Goal 2R6: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews to support design and demonstration decisions. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – 2<sup>nd</sup> Generation RLV

- Conduct Risk Reduction Review.
- Conduct Interim Architecture Review to establish the candidate space transportation architectures.

**Objective: Mission Affordability – Create an affordable highway to space.**

Public Benefit: Expanded opportunities for near-Earth operations and commercialization through affordable access to space

Annual Performance Goal 2R7: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews and initial hardware demonstrations to support design and demonstration decisions. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Focused – 2<sup>nd</sup> Generation RLV

- Conduct Risk Reduction Review.
- Conduct Interim Architecture Review to establish the candidate space transportation architectures.

Aerospace Base R&T

- Demonstrate PDE-based combined/ hybrid cycle feasibility and baseline performance levels.
- Demonstrate advanced adhesives for non-autoclave composite processing.
- Complete Systems Requirements Review on Rocket Based Combined Cycle Demonstrator Engine.
- Demonstrate Reaction Transfer Molded Polymer Matrix Composite with 550°F use temperature.
- Conduct 2<sup>nd</sup> Mach 7 flight of the X-43 (Hyper-X).

- Conduct 1<sup>st</sup> Mach 10 flight of the X-43 (Hyper-X).

**Objective: Mission Reach – Extend our reach in space with faster travel times.**

Public Benefit: Expanded knowledge of the universe and its meaning to life on Earth

Annual Performance Goal 2R8: NASA's long term research emphasizes innovative propulsion systems. The annual performance goal is to conduct at least one electric propulsion test. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Base R&T

- Complete integration and wear test of 8 cm ion engineering model thruster and breadboard Power Processing Unit.
- Conduct integration test of 5-kW PPU with 5/10 kW next-generation ion engine.

**Goal: Pioneer Technology Innovation — Enable a revolution in aerospace systems.**

**Objective: Engineering Innovation -- Enable rapid, high-confidence, and cost efficient design of revolutionary systems.**

Public Benefit: Improved productivity of American aerospace workers and their contribution to the national economy

Annual Performance Goal 2R9: NASA's investments emphasize advances in experimental vehicles, flight testbeds, and computing tools to enable revolutionary designs. The annual performance goal is to conduct at least five demonstrations of revolutionary aerospace subsystems. Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Base R&T

- Develop prototype environments that are distributed across heterogeneous platforms, are dynamically extensible, and which support collaborative visualization, analysis, and computational steering.
- Demonstrate improvement in time-to-solution for aerospace applications through high-end computing and end-to-end networking capabilities.
- Develop capability to redesign aerospace vehicles during flight simulations exploiting high-end computing and advanced information management technologies.
- Demonstrate a prototype of a reliability and cost database of space transportation and exploration system mission failures including the definition of the appropriate taxonomy.
- Demonstrate a highly integrated simulation environment that facilitates the rapid development of future generation electronic devices for PetaFLOPS computing and onboard computing systems for autonomous intelligent vehicles.
- Demonstrate, in production facilities, tools and techniques for high-productivity aerospace test environment.
- Demonstrate automated software verification technology that scales to aerospace software systems.

- Develop system for real-time data acquisition and display of disparate instrumentation types.
- Integrate and demonstrate a Intelligent Flight Control (IFC) into a C-17 simulation.
- Integrate and test at least 4 flight experiments on the F-15B testbed aircraft
- Demonstrate turbo-prop remotely piloted aircraft (RPA) capabilities that exceed the minimum Earth Science Enterprise altitude and duration requirements.
- Demonstrate a Viscous, solution-adaptive, unstructured-grid Computational Fluid Dynamics (CFD).
- Develop conceptual high-level autonomy rover architecture.
- Complete a Mars Mission Software Verification Study
- Complete a case study demonstrating software verification and validation techniques that are applicable to Mars mission software.
- Apply human-centered computing analysis and modeling techniques to evaluate and improve the Mars Exploration Rover (MER) 2003 flight team man-machine system performance for operations and science.

**Objective: Technology Innovation -- Enable fundamentally new aerospace system capabilities and missions.**

Public Benefit: Continued U.S. competitiveness in the global marketplace, and quality of life from new discoveries

Annual Performance Goal 2R10: NASA's investments emphasize revolutionary technologies such as nanotechnology, information technology and biotechnology that could enable new missions and capabilities. The annual performance goal is to develop at least two new materials concepts and demonstrate the feasibility of at least two nanotechnology and two other concepts.

Planned program products that support the accomplishment of the annual performance goal are:

Aerospace Base R&T

- Demonstrate feasibility of nanotechnology-based chemical and biosensors and manufacturing approaches of low-power nanoelectronic components.
- Complete initial integrated concept study to assess adaptive vehicle control
- Demonstrate aligned carbon nanotubes for polymer matrix material.
- Develop and demonstrate in flight next generation neural flight control
- Demonstrate oscillatory flow control actuators
- Demonstration of Space Communication Link Technology Operating at 622 Mega-bit per second for Direct Space Data Distribution to Users.
- Demonstrate the methodology to produce physics based scaling laws to quantify Reynolds number sensitivities of aerodynamic flow separation on-set and progression.
- Demonstrate the ability to dynamically alter the localized flow instabilities over advanced lifting surfaces with micro-adaptive flow control devices.
- Develop concepts for design and analyses of algorithms for control of colonies of fluidic flow control effectors.

- Develop concepts for non-deterministic analyses of advanced composites, including nanotube reinforced polymers to characterize processing uncertainties on material properties.
- Develop concepts for advance sensory materials development and methodologies for imbedding sensors into aerospace structural materials.

**Goal: Commercialize Technology — Extend the commercial application of NASA technology for economic benefit and improved quality of life.**

**Objective: Commercialization — Facilitate the greatest practical utilization of NASA know-how and physical assets by U.S. industry.**

Public Benefit: Quality of life from direct aerospace contributions to the U.S. economy, as well as indirect contributions to the fields of medicine and education

Annual Performance Goal 2P7: Dedicate 10 to 20 percent of the Agency’s Research and development budget to commercial partnerships. (as noted, this goal is presented in the Provide Aerospace Products and Capabilities section of the plan since it crosscuts all NASA Enterprises)

Annual Performance Goal 2R11: Continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.

- Achieve a facility utilization customer satisfaction rating of 95 percent at “5” or better using a “10” point scale, and 80 percent “8” or better, based on exit interviews.
- Transfer at least twelve new technologies and processes to industry and other government agencies during the fiscal year.

Annual Performance Goal 2R12: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2002.

- Implementation examples from current education outreach plans.
- Documented plans for all new program activities initiated in FY 2002

**Goal: Space Transportation Management — Provide commercial industry with the opportunity to meet NASA’s future launch needs, including human access to space, with new launch vehicles that promise to dramatically reduce cost and improve safety and reliability. (Supports all objectives under the Advance Space Transportation Goal.**

**Objective: Utilize NASA’s Space Transportation Council (STC) in combination with an External Independent Review Team (EIRT) to assure agency-level integration of near and far-term space transportation investments.**

**Public Benefit:** Improved assurance that commercial capabilities and opportunities are appropriately examined in planning and developing new launch vehicle systems

**Annual Performance Goal 2R13:** Review results of NASA and commercial-sector performed launch system architecture studies, related requirements, and refinements in planned risk-reduction investments.

- Complete an assessment of the Space Launch Initiative architectures and requirements by an External Independent Review Team; the EIRT will submit a written report on their evaluation within 45 days following completion of the review.
- The Space Transportation Council will review progress and planning of the Space Launch Initiative at least twice during the fiscal year, including the report filed by the External Independent Review Team.

## **Addressing Technology Management Challenges**

The overall organizational and management structure of NASA technology development is built around its Strategic Enterprises, including specific program formulation and funding responsibility for all technology activities. This ensures that technology considerations are closely coupled with mission decisions, that technologies are relevant to Enterprise needs, and that mechanisms are provided to transfer successful maturing technologies into operational systems. NASA has undertaken sweeping changes in technology program management to strengthen and highlight the significance of advanced technology in NASA's future. These changes influence how NASA identifies new technology investments, how NASA defines new mission opportunities, and how NASA ensures the efficient transition of new technologies into missions. Overall, the adjustments have resulted in a closer alignment of technology investments with the goals identified in the NASA Strategic Plan.

Coordination and integration among all of the Agency's Enterprises is provided through the NASA Chief Technologist. The Chief Technologist advises the Administrator and other senior officials on matters relating to technology, assures an Agency-wide investment strategy for advanced innovative technology, and is the principal Agency advocate for advanced technology. The Chief Technologist also chairs the Technology Leadership Council, which includes the Associate Administrators for the Strategic Enterprises, the NASA Field Center Directors, the NASA Comptroller, and other senior NASA officials. This Council establishes the technology strategy for the Agency, addresses critical issues, and is responsible for formulating and advancing NASA's vision for technology.

This integrated planning process for technology development is described in detail in the NASA Technology Plan, and reviewed by the Technology and Commercialization Advisory Committee (TCAC), a standing committee of the NASA Advisory Council. The TCAC advises NASA on broad, Agency-wide issues associated with technology and commercialization activities. In addition, each Enterprise supports an advisory committee that is part of the NASA Advisory Council to review its programs and provide recommendations for improvement. These advisory committees include technologists or, in some cases, technology subcommittees to provide special focus on technology activities.

In February 2000, the NASA Administrator merged the Chief Technologist's Office with the Office of Aerospace Technology to better focus the Agency's strategy for maintaining its long-term technology base. The NASA Chief Technologist retains responsibility for serving as the Administrator's principal advisor on Agency-wide technology issues, while also serving as the Associate Administrator for Aerospace Technology. This merger centralized planning and execution of Agency-level technology within one organization while still providing for Enterprise-specific mission technology development by each of the other NASA Enterprises.

## **Verification/Validation**

The Aerospace Technology Enterprise regularly reviews its progress on achieving its performance targets using NASA's established policies and procedures for program and project management. Internal evaluation is provided by the governing Program Management Council, either at the Agency-level or at the designated Lead Center, which meet at least quarterly to execute their oversight responsibilities. The AST Enterprise also relies on the extensive Safety, Quality, and Reliability processes and Center organizations to assure that performance in our facilities is maintained to standards appropriate for research and technology development operations.

The Aerospace Technology Committee of the NASA Advisory Council also conducts annual assessments of the progress made by the AST Enterprise in achieving its near-term technology objectives. This committee, and its nine technical subcommittees consisting of nearly 150 members from other government agencies, industry and academia that meet two to three times a year, will provide a qualitative progress measurement (Green, Yellow, or Red). "Green" will indicate that the objective was met; "Yellow" will indicate a concern that an objective was not fully accomplished; and "Red" will indicate that events occurred that prevented or severely impaired the accomplishment of the objective. This external assessment includes commentary to clarify and supplement the qualitative measures.

**MULTI-YEAR PERFORMANCE TREND  
Aerospace Technology Enterprise (OAT)**

**Increase Safety - Make a safe air transportation system even safer.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R5: For the aviation safety areas of Controlled Flight into Terrain, runway incursion, and loss of control, identify the contributing causes to be addressed, potential solutions using current capabilities, and gaps that require technology solutions.	'OR3: Flight demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport..	1R1: NASA's research stresses aviation system monitoring and modeling, accident prevention and accident mitigation. The performance target is to complete 75% of the conceptual designs of systems for preventing and mitigating accidents, and to demonstrate tools for accident analysis and risk assessment.	2R1: NASA's research stresses aviation system monitoring and modeling, accident prevention, and accident mitigation. The annual performance goal is to complete the interim progress assessment utilizing the technology products of the Aviation Safety program as well as the related Aerospace Base R&T efforts and transfer to industry an icing CD-ROM, conduct at least one demonstration of an aviation safety related subsystem, and develop at least two-thirds of the planned models and simulations.
Assessment	Green	Yellow	TBD	TBD
Annual Performance Goal and APG #	9R2: Characterize the Super-cooled Large Droplets (SLD) icing environment, determine its effects on aircraft performance, and acquire and publish data to improve SLD forecasting confidence.			
Assessment	Yellow		TBD	TBD

**Reduce Emissions -- Protect local air quality and our global climate.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R1: Demonstrate an advanced turbine-engine combustor that will achieve up to a 50 percent reduction of Oxides of Nitrogen emissions based on 1996 International Civil Aviation Organization (ICAO) standards.	0R1: Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70% reduction of oxides of nitrogen emissions based on the 1996 ICAO standard.	1R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen and carbon dioxide. The performance target is to complete one system level technology benefit assessment, one component concept selection and one new material system.	2R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen (NOx) and carbon dioxide (CO2). The annual performance goal is to complete sector testing of a low-NOx combustor concept capable of a 70% reduction in NOx from the 1996 International Civil Aviation Organization (ICAO) baseline, and demonstrate at least one additional concept for the reduction of other emittants.
Assessment	Green	Blue	TBD	TBD

**Reduce Noise – Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers.**

<p>Annual Performance Goal and APG #</p>		<p>0R2: Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.</p>	<p>1R3: NASA's research has stressed reducing noise in the areas of engines, nacelles, engine/airframe integration, aircraft interiors and flight procedures. The performance target is completion of NASA's research in noise reduction through large-scale demonstration of a 2-5 decibel reduction in aircraft noise based on 1997 production technology, and initial assessments of concepts offering additional reduction.</p>	<p>2R3: NASA's research stresses reducing noise in the areas of engines, nacelles, engine-airframe integration, aircraft interiors and flight procedures. The annual performance goal is to assess and establish the strongest candidate technologies to meet the 10-decibel reduction in community noise.</p>
<p>Assessment</p>		<p>Green</p>	<p>TBD</p>	<p>TBD</p>

**Increase Capacity -- Enable the movement of more air passengers with fewer delays.**

Annual Performance Goal and APG #		OR4: Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12% increase over 1994 nonvisual operations for single-runway throughput.	1R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The performance target is to complete the civil tiltrotor project by validating databases for contingency power, flight paths, and noise reduction, as well as complete at least one demonstration of an airspace management decision support tool.	2R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The annual performance goal is to demonstrate at least two decision support tools for arrival, surface, and departure operations, and define requirements for future aviation system concepts.
Assessment		Green	TBD	TBD

**Increase Mobility - Enable people to travel faster and farther, anywhere, anytime.**

Annual Performance Goal and APG #	9R8: Conclude pre-flight ground testing of the general aviation piston and turbofan engines.	OR7: Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show.	1R7: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The performance target is to complete the Advanced General Aviation Transport Experiments project by validating transportation system concepts through flight test and publish design guidelines.	2R5: NASA's research stresses aircraft technologies which enable the use of existing small community and neighborhood airports, without requiring control towers, radar installations, and more land use for added runway protection zones. The annual performance goal is to baseline in partnership with the FAA the system engineering documents for the Small Aircraft Transportation System concept.
Assessment	Yellow	Yellow	TBD	TBD

**Increase Mobility - Enable people to travel faster and farther, anywhere, anytime.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R6: Produce a complete vehicle system configuration document that includes impact of technology validation efforts from 1990 through 1999. This document will support the evaluation of technology selection decisions for a future High Speed Civil Transport (HSCT).			
Assessment	Green			

**Mission Safety -- Radically improve the safety and reliability of space launch systems.**

Annual Performance Goal and APG #				2R6: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews to support design and demonstration decisions.
Assessment				TBD

**Mission Affordability - Create an affordable highway to space.**

	<b>FY 1999</b>	<b>FY 2000</b>	<b>FY 2001</b>	<b>FY 2002</b>
Annual Performance Goal and APG #	9R14: Continue the X-33 Vehicle Assembly in Preparation for Flight Testing.	0R9: Conduct the flight testing of the X-33 vehicle.	1R10: NASA's research stresses highly reliable, fully reusable configurations, advanced materials and innovative structures. The performance target is complete assembly of the third X-34 test vehicle, demonstrate 75% of supporting technology developments, and complete competitive solicitations for expanded 2nd generation reusable launch vehicle efforts.	2R7: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews and initial hardware demonstrations to support design and demonstration decisions.
Assessment	Green	Red	TBD	TBD
Annual Performance Goal and APG #	9R15: Complete Vehicle Assembly and Begin Flight Testing of the X-34.	0R12: Complete vehicle assembly and begin the flight test of the second X-34 vehicle.	1R11: NASA's research stresses technology for reusable, long life, high power electric and advanced, clean chemical engines for earth orbital transfer and breakthrough propulsion, precision landing systems and aero-capture systems for planetary exploration. The performance target is to commence X-37 vehicle assembly, and complete one Pathfinder flight experiment.	
Assessment	Yellow	Red	TBD	

**Mission Affordability - Create an affordable highway to space.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #		OR17: Complete small payload focused technologies and select concepts for flight demonstration of a reusable first stage (Bantam).		
Assessment		Red (project terminated 10/99)		

**Mission Reach - Extend our reach in space with faster travel times.**

Annual Performance Goal and APG #		OR10: Complete NASA Solar Electric Propulsion Technology Application Readiness (NSTAR) Mission Profile (100% design life) ground testing for Deep Space-1 (concurrent, identical firing of an NSTAR engine in a vacuum chamber with the actual firing sequence of the in-flight propulsion system).		2R8: NASA's long term research emphasizes innovative propulsion systems. The performance target is to conduct at least one electric propulsion test.
Assessment		Green		TBD

**Engineering Innovation -- Enable rapid, high-confidence, and cost efficient design of revolutionary systems.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R12: Demonstrate up to a 200-fold improvement over the 1992 baseline (reduction from 3,200 hours to 15) in the time-to-solution for a full combustor simulation on NASA's National Propulsion System Simulation advanced applications computational testbeds that can be increased to sustain teraFLOPS capability.	0R8: Demonstrate a prototype heterogeneous distributed computing environment.	1R8: Develop at least three new design tools, accomplish at least four demonstrations of advances in computation and communications, and complete the intelligent synthesis environment proof-of-concept system capability build to technology readiness level 3.	2R9: NASA's investments emphasize advances in experimental vehicles, flight testbeds, and computing tools to enable revolutionary designs. The annual performance goal is to conduct at least five demonstrations of revolutionary aerospace subsystems.
Assessment	Blue	Green	TBD	TBD
Annual Performance Goal and APG #	9R13: Demonstrate communication testbeds with up to 500-fold improvement over the 1996 baseline (increase from 300 kilobits per second to 150 megabits per second) in end-to-end performance.			
Assessment	Blue			

**Engineering Innovation -- Enable rapid, high-confidence, and cost efficient design of revolutionary aerospace systems.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R10: Complete low-altitude flights of an Remotely Piloted Aircraft (RPA) with a wingspan greater than 200 feet, suitable for flight to 100,000 feet in altitude once outfitted with high-performance solar cells.	OR11: Demonstrate improved remotely piloted aircraft science mission capability by increasing operational deployment time from 3 weeks to 9 with minimum airfield provisions and unrestricted airspace. (Original) Demonstrate continuous over-the-horizon command and control capabilities of an RPA that would extend the operating range from 40 to 200 nautical miles. (Replacement)		
Assessment	Green	Red (orig.); Green (replacement)		
Annual Performance Goal and APG #	9R11: Conduct RPA flight demonstration to validate the capability for science missions of greater than 4 hours duration in remote deployments to areas such as the polar regions above 55,000 feet.			
Assessment	Green			

**Engineering Innovation -- Enable rapid, high-confidence, and cost efficient design of revolutionary aerospace systems.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #		OR6: Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.	1R9: NASA's research stresses affordable flight demonstrations of revolutionary vehicle concepts (low-cost X-Planes) to accelerate technology advances in laboratory research, new design tools and advanced simulation. The performance target is to demonstrate two new concepts in flight and identify five new concepts for further examination.	
Assessment		Yellow	TBD	

**Technology Innovation -- Enable fundamentally new aerospace system capabilities and missions.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #				2R10: NASA's investments emphasize revolutionary technologies such as nanotechnology, information technology and biotechnology which could enable new missions and capabilities. The annual performance goal is to develop at least two new materials concepts and demonstrate the feasibility of at least two nanotechnology and two other concepts.
Assessment				TBD

**Commercialization — Facilitate the greatest practical utilization of NASA know-how and physical assets by U.S. industry.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R16: Complete 90 percent of all Enterprise-controlled milestones within 3 months of schedule.	OR13: Complete 90 percent of all Enterprise-controlled milestones within 3 months of schedule.		
Assessment	Yellow	Red		
Annual Performance Goal and APG #	9R17: Achieve a facility utilization customer satisfaction rating of 95 percent of respondents at "5" or better and 80 percent at "8" or better based on exit interviews.	OR14: Achieve a facility utilization customer satisfaction rating of 95% of respondents at "5" or better and 80% at "8" or better, based on exit interviews.		
Assessment	Blue	Green		
Annual Performance Goal and APG #	9R18: Complete the Triennial Customer Satisfaction Survey, and achieve an improvement from 30 percent to 35 percent in "highly satisfied" ratings from Enterprise customers.		1R12: Customer Feedback: Continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.	2R11: Continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.
Assessment	Green		TBD	TBD
Annual Performance Goal and APG #	9R19: Transfer at least 10 new technologies and processes to industry during the fiscal year.	OR15: Transfer at least 12 new technologies and processes to industry during the fiscal year.		
Assessment	Blue	Blue		

**Commercialization — Facilitate the greatest practical utilization of NASA know-how and physical assets by U.S. industry.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #	9R21: For all new program activities initiated in FY 99, develop an education outreach plan, which includes and results in an educational product. This product shall be consistent with current educational standards and use program content to demonstrate or enhance the learning objectives.	0R16: Continue the implementation of current education outreach plans and establish new plans for all new program activities initiated in FY 00.	1R13: Education Outreach: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2001.	2R12: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2002.
Assessment	Yellow	Blue	TBD	TBD
Annual Performance Goal and APG #	9R20: Establish an Aeronautics Education Laboratory in at least three new sites in the United States.			
Assessment	Blue			

**Utilize NASA's Space Transportation Council (STC) in combination with an External Independent Review Team (EIRT) to assure agency-level integration of near and far-term space transportation investments.**

	<b><u>FY 1999</u></b>	<b><u>FY 2000</u></b>	<b><u>FY 2001</u></b>	<b><u>FY 2002</u></b>
Annual Performance Goal and APG #				2R13: Review results of NASA and commercial-sector performed launch system architecture studies, related requirements, and refinements in planned risk-reduction investments.
Assessment				TBD

<b>Aerospace Technology Enterprise FY2002</b>	AEROSPACE FOCUSED							AEROSPACE BASE R&T				
	<b>Budget Category</b>	Aviation System Capacity	Aviation Safety Technology	Ultra-Efficient Engine Technology	Small Aircraft Transportation System	Quiet Aircraft Technology	2nd Generation RLV	Aero-Space Base R&T -- Computing, Information & Communication Technology	Aero-Space Base R&T -- Flight Research	Aero-Space Base R&T -- Propulsion & Power	Aero-Space Base R&T -- Vehicle System Technology	Aero-Space Base R&T -- Space Transfer & Launch Tech.
<b>Annual Performance Goal</b>												
2R1: NASA's research stresses aviation system monitoring and modeling, accident prevention, and accident mitigation. The annual performance goal is to complete the interim progress assessment utilizing the technology products of the Aviation Safety program as well as the related Aerospace Base R&T efforts and transfer to industry an icing CD-ROM, conduct at least one demonstration of an aviation safety related subsystem, and develop at least two-thirds of the planned models and simulations.			X				X		X	X		X
2R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen (NOx) and carbon dioxide (CO2). The annual performance goal is to complete sector testing of a low-NOx combustor concept capable of a 70% reduction in NOx from the 1996 International Civil Aviation Organization (ICAO) baseline, and demonstrate at least one additional concept for the reduction of other emittants.				X					X	X		X

Aerospace Technology Enterprise FY2002	AEROSPACE FOCUSED						AEROSPACE BASE R&T					
	Budget Category	Aviation System Capacity	Aviation Safety Technology	Ultra-Efficient Engine Technology	Small Aircraft Transportation System	Quiet Aircraft Technology	2nd Generation RLV	Aero-Space Base R&T -- Computing, Information & Communication Technology	Aero-Space Base R&T -- Flight Research	Aero-Space Base R&T -- Propulsion & Power	Aero-Space Base R&T -- Vehicle System Technology	Aero-Space Base R&T -- Space Transfer & Launch Tech.
<b>Annual Performance Goal</b>												
2R3: NASA's research stresses reducing noise in the areas of engines, nacelles, engine-airframe integration, aircraft interiors and flight procedures. The annual performance goal is to assess and establish the strongest candidate technologies to meet the 10- decibel reduction in community noise.						X			X	X		X
2R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The annual performance goal is to demonstrate at least two decision support tools for arrival, surface, and departure operations, and define requirements for future aviation system concepts.		X						X		X		X

Aerospace Technology Enterprise FY2002	Budget Category	AEROSPACE FOCUSED					AEROSPACE BASE R&T					R&PM
		Aviation System Capacity	Aviation Safety Technology	Ultra-Efficient Engine Technology	Small Aircraft Transportation System	Quiet Aircraft Technology	2nd Generation RLV	Aero-Space Base R&T -- Computing, Information & Communication Technology	Aero-Space Base R&T -- Flight Research	Aero-Space Base R&T -- Propulsion & Power	Aero-Space Base R&T -- Vehicle System Technology	
<b>Annual Performance Goal</b>												
2R5: NASA's research stresses aircraft technologies which enable the use of existing small community and neighborhood airports, without requiring control towers, radar installations, and more land use for added runway protection zones. The annual performance goal is to baseline in partnership with the FAA the system engineering documents for the Small Aircraft Transportation System concept.					X					X		X
2R6: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews to support design and demonstration decisions.						X	X				X	X

Aerospace Technology Enterprise FY2002	AEROSPACE FOCUSED							AEROSPACE BASE R&T				
	Budget Category	Aviation System Capacity	Aviation Safety Technology	Ultra-Efficient Engine Technology	Small Aircraft Transportation System	Quiet Aircraft Technology	2nd Generation RLV	Aero-Space Base R&T -- Computing, Information & Communication Technology	Aero-Space Base R&T -- Flight Research	Aero-Space Base R&T -- Propulsion & Power	Aero-Space Base R&T -- Vehicle System Technology	Aero-Space Base R&T -- Space Transfer & Launch Tech.
<b>Annual Performance Goal</b>												
2R7: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews and initial hardware demonstrations to support design and demonstration decisions.						X	X		X	X	X	X
2R8: NASA's long term research emphasizes innovative propulsion systems. The performance target is to conduct at least one electric propulsion test									X		X	
2R9: NASA's investments emphasize advances in experimental vehicles, flight testbeds, and computing tools to enable revolutionary designs. The annual performance goal is to conduct at least five demonstrations of revolutionary aerospace subsystems.							X	X	X	X	X	X

Aerospace Technology Enterprise FY2002	Budget Category	AEROSPACE FOCUSED					AEROSPACE BASE R&T					R&PM
		Aviation System Capacity	Aviation Safety Technology	Ultra-Efficient Engine Technology	Small Aircraft Transportation System	Quiet Aircraft Technology	2nd Generation RLV	Aero-Space Base R&T -- Computing, Information & Communication Technology	Aero-Space Base R&T -- Flight Research	Aero-Space Base R&T -- Propulsion & Power	Aero-Space Base R&T -- Vehicle System Technology	
<b>Annual Performance Goal</b>												
2R10: NASA's investments emphasize revolutionary technologies such as nanotechnology, information technology and biotechnology which could enable new missions and capabilities. The annual performance goal is to develop at least two new materials concepts and demonstrate the feasibility of at least two nanotechnology and two other concepts.							X		X	X	X	X
2R11: Continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.												X
2R12: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2002.												X
2R13: Review results of NASA and commercial-sector performed launch system architecture studies, related requirements, and refinements in planned risk-reduction investments.						X						X