

IG-00-053

**AUDIT
REPORT**

NASA'S AVIATION SAFETY PROGRAM

September 26, 2000



National Aeronautics and
Space Administration

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Acronyms

ASIST	Aviation Safety Investment Strategy Team
AvSP	Aviation Safety Program
FAA	Federal Aviation Administration
GAO	General Accounting Office
GPRA	Government Performance and Results Act
NTSB	National Transportation Safety Board

W

September 26, 2000

TO: A/Administrator

FROM: W/Inspector General

SUBJECT: INFORMATION: NASA's Aviation Safety Program
Report Number IG-00-053

The NASA Office of Inspector General has completed an audit of NASA's Aviation Safety Program (AvSP). We found that coordination between NASA, the Federal Aviation Administration (FAA), and other partners is adequate. However, NASA has not consistently portrayed the intended performance of its Aviation Safety Initiative. The Aviation Safety Initiative is a combination of redirected Research and Technology Base¹ activities and the creation of the focused² AvSP. Specifically, the Agency has been inconsistent in stating its goal for the Initiative³, identifying all baselines⁴ that will measure progress towards meeting the goal, emphasizing the risks⁵ involved with the development and implementation of the aviation safety technologies and the effects of those risks on achieving the goal, and integrating the goal and baseline with the FAA. As a result, NASA may not be able to measure its contribution towards meeting the National Aviation Safety Goal. In addition, NASA may not fulfill the expectations of the Congress, the aviation community,⁶ and the public relating to NASA's aviation safety efforts.

¹ Research and Technology Base programs enhance safety activities with tools and insights to fundamental principles and support the development of technologies that will address accidents involving hazardous weather, controlled flight into terrain, human error, and mechanical or software malfunctions.

² NASA selects specific technologies based on national needs for further development in focused programs, such as the AvSP, with a specified class of research for potential applications.

³ The goal of the Aviation Safety Initiative, to contribute to reductions in the fatal aviation accident rate, is inconsistently stated in Agency documents. These inconsistencies are identified in Appendix C.

⁴ The Aviation Safety Initiative established a baselines to measure performance for the aviation fatal accident rates. However, performance measures did not include baselines for aviation accident rates (nonfatal) or fatality rates. The baselines are identified in Appendix D.

⁵ The success of the AvSP is dependent on overcoming several risks or factors including the challenge of technical development, user implementation, and availability of resources.

⁶ As used in this report, the aviation community includes Government agencies, airlines, airline maintenance, and aviation-related manufacturers and suppliers.

Background

The commercial aviation accident rate is very low and has remained fairly constant. Air travel is currently one of the safest modes of transportation. However, the flat accident rate and the projected growth in air travel will inevitably produce a higher number of accidents in future years, unless the aviation community acts to reduce the rate of accidents. NASA is developing technology to make air travel safer through the Aviation Safety Initiative. Without the development of new technology, there could be a fatal airliner accident somewhere in the world almost weekly by the year 2015.⁷ The 1997 report, "White House Commission on Aviation Safety and Security," recommended a national goal to reduce the aviation fatal accident rate by a factor 5 (80 percent) within 10 years (2007). The AvSP consists of six projects that will provide research and technology needed to help the FAA and the aviation community achieve the national goal. The AvSP is an ambitious program that includes a partnership between NASA, FAA, other Government agencies, and the aviation industry. For fiscal years 2000 through 2004, NASA budgeted about \$500 million for the NASA Aviation Safety Initiative, of which about \$377 million is for AvSP.

Recommendations

We recommended that the Associate Administrator for Aerospace Technology (1) clarify the Agency's contribution toward the National Aviation Safety Goal to ensure a consistent representation of NASA's intended performance; (2) identify all baselines necessary to measure the Agency's performance in meeting the established goals; (3) revise program documentation available to stakeholders to adequately reflect the risks of development and implementation; and (4) coordinate with the FAA to resolve differences in baselines and metrics used to guide the national efforts on aviation safety. These improvements will allow NASA to appropriately measure NASA's contributions toward meeting the National Aviation Safety goal and provide a more accurate portrayal of its efforts and the risks involved to Congress, the aviation community, and the public.

Management's Response

Management concurred with all recommendations. The Associate Administrator for Aerospace Technology will revise all documentation to ensure that it consistently reflects the Agency's contribution toward the National Aviation Safety Goal. Management also identified the baselines necessary to measure its performance; agreed to communicate and stress to partners, customers, and stakeholders the facts concerning the risk of implementation; and adjusted its baseline to match the FAA baseline years.

⁷ The 1997 report, "White House Commission on Aviation Safety and Security," contains the projection by the Boeing Commercial Aircraft Group.

Details on the status of the recommendations are in the recommendations section of the report.

[Original signed by]

Roberta L. Gross

Enclosure

Final Report on Audit of NASA's Aviation Safety Program

FINAL REPORT
NASA'S AVIATION SAFETY PROGRAM

W

September 26, 2000

TO: R/Associate Administrator for Aerospace Technology

FROM: Assistant Inspector General for Auditing

SUBJECT: Final Report on the Audit of NASA's Aviation Safety Program
Assignment Number A0000100
Report Number IG-00-053

The subject final report is provided for your information and use. Please refer to the Executive Summary for the overall audit results. Our evaluation of your response is incorporated into the body of the report. Your comments on a draft of this report were responsive, and actions are sufficient to close recommendations 2 and 4. Recommendations 1 and 3 will remain open for reporting purposes until corrective action is completed. Please notify us when action has been completed on these recommendations, including the extent of testing performed to ensure corrective actions are effective.

If you have questions concerning the report, please contact Ms. Karen E. VanSant, Program Director, Aerospace Technology Audits, at (256) 544-1149, Ms. Carol A. St. Armand, Program Manager, at (301) 286-7269, or Ms. Sandra K. Leibold, Auditor-in-Charge, at (256) 544-0970. We appreciate the courtesies extended to the audit staff. The final report distribution is in Appendix F.

[Original signed by]

Russell A. Rau

Enclosure

cc:

B/Chief Financial Officer

B/Comptroller

BF/Director, Financial Management Division

G/General Counsel

JM/Acting Director, Management Assessment Division

RP/Director, Programs Division

LaRC/Director, Langley Research Center

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NASA Office of Inspector General

IG-00-053
A0000100

September 26, 2000

NASA's Aviation Safety Program

Executive Summary

Background. The 1997 report, "White House Commission on Aviation Safety and Security," recommended a national goal to reduce the aviation fatal accident rate by a factor of five (80 percent) within 10 years (2007). NASA responded to the report by initiating a major program planning effort to define the research the Agency will conduct. NASA initiated this effort with the Aviation Safety Investment Strategy Team (ASIST) and involved industry, Government, and academic organizations. The recommendations of the ASIST provided the foundation of the NASA Aviation Safety Initiative. The Initiative is a combination of redirected Research and Technology Base activities and the creation of the focused AvSP. The AvSP consists of six projects that will provide research and technology needed to help the FAA and the aerospace industry achieve the national goal.

For fiscal years (FY's) 2000 through 2004, NASA budgeted about \$500 million for the NASA Aviation Safety Initiative, of which \$377 million is for the AvSP. The AvSP is an ambitious program that includes a partnership between NASA, FAA, other Government agencies, and the aviation industry. The Langley Research Center (Langley) is leading the AvSP and works with personnel at Ames Research Center, Glenn Research Center, and Dryden Flight Research Center. Additionally, the AvSP works in concert with the full spectrum⁸ and general aviation⁹ industry manufacturers, suppliers, and operators in implementing this effort.

Objectives. The audit objectives were to assess the adequacy of NASA's coordination with FAA and other partners and the Agency's overall success in achieving program goals and objectives. Appendix A contains details on the objectives, scope, and methodology used for this audit.

Results of Audit. The coordination between NASA, FAA, and other partners is adequate. NASA has a memorandum of understanding with FAA for the overall AvSP. Also, NASA and

⁸ Commercial aviation includes both large air carrier operations and smaller commuter operations.

⁹ General aviation includes a wide variety of aircraft, ranging from corporate jets to small piston-engine aircraft as well as helicopters, gliders, and aircraft used in operations such as firefighting and agricultural spraying.

FAA established a Joint Working Group to ensure implementation and monitoring of the agreement and are preparing agreements for each of the six projects within the program. Further, FAA detailed a representative to NASA at Langley. NASA also has an agreement in process with the National Imagery and Mapping Agency to arrange for additional staff.

However, NASA has not consistently portrayed its goal and identified all the measurement baselines for its Aviation Safety Initiative. Further, NASA has not adequately emphasized the risks involved with developing and implementing various aviation safety technologies and how those risks affect the achievement of program success. The Agency is also inconsistent in integrating its goal and baseline with FAA. As a result, NASA may not be able to measure its contribution towards meeting the National Aviation Safety Goal. Also, NASA may not fulfill the expectations of Congress, the aviation community, and the public relating to NASA's aviation safety efforts.

Recommendations. NASA should clarify its contribution toward the national aviation safety goal and revise plans, including those with FAA, and goals accordingly to ensure various Agency documents and Web sites are consistent with NASA's intended performance. The Agency should establish baselines to measure its performance relative to its established goals. Also, NASA should place more emphasis on informing stakeholders about the development and implementation risks that could adversely affect program success.

Management's Response. Management concurred with all the recommendations. NASA management will update documentation to consistently state the AvSP goal. Management has also adjusted its baseline to match the FAA baseline and will ensure that the Agency's partners, customers, and stakeholders understand the development and implementation risks. The complete text of the response is in Appendix E. Management's comments are responsive to the recommendations.

Introduction

The commercial aviation accident rate is very low, but it has shown virtually no improvement over the last 20 years. The flat accident rate and the projected growth in air travel will inevitably produce a higher number of accidents as years pass, unless the aviation community takes action to reduce the rate of accidents. If left unchecked, there could be a fatal airliner accident somewhere in the world almost weekly by the year 2015. This provides a strong motivation for aggressive efforts to lower the accident rate. Given the visible, damaging, and tragic effects of even a single major accident, approaching this number of accidents would clearly have an unacceptable effect on the public's confidence in the aviation system and impede the anticipated growth of the commercial air travel market.

General aviation accounts for the largest number of accidents and fatalities, but the focus of the national goal is fatal accidents in commercial operations. The commercial airlines are the primary mode of air transportation for most Americans, and airline accidents have the potential for significant loss of life. The principal causes of general aviation accidents are similar to commercial aviation accidents, therefore, the White House Commission recommendations will also help address the safety of general aviation.

NASA has contributed to aviation safety for 40 years through its research and development efforts in aeronautics. The achievement of the safety goal requires the continuing efforts of Research and Technology Base programs¹⁰ and the focused AvSP. The AvSP is NASA's most recent effort in aviation safety. The AvSP is structured around eight core technologies that address the three investment areas identified by the ASIST. Appendix B contains details on the core technologies under development and additional information on AvSP's contributions toward the National Aviation Safety Goal. The three investment areas and their respective percentage of AvSP resources are Accident Prevention (65 percent); Accident Mitigation (10 percent); and Aviation System-Wide Monitoring, Modeling, and Simulation (25 percent). Full system-wide implementation of the technologies under development will not be completed by AvSP program end in 2004¹¹ and may not be completed by the targeted goal of 2007. Success of the program will be based on delivering the planned program milestones, typically with technology that has been demonstrated through models or prototypes.

¹⁰ Research and Technology Base programs involved in work supporting aviation safety include Information Technology, Aerospace Operations Systems, Rotorcraft, Aerospace Propulsion and Power, Aerospace Vehicle Systems Technologies, and Flight Research.

¹¹ The AvSP runs from FY's 2000-2004.

Finding and Recommendations

NASA's Aviation Safety Goal

NASA has not clearly defined the intended performance of its Aviation Safety Initiative. Specifically, the Agency has been inconsistent in: (1) stating its goal for the Initiative, including its role in the accomplishment of the National Aviation Safety Goal and the accident rates it is trying to affect; (2) identifying all baselines it will use to measure progress towards meeting its goal; (3) emphasizing the risks involved with the development and implementation of its aviation safety technologies and explaining how those risks affect achieving its aviation safety goal; and (4) integrating its goal and baseline with FAA. These conditions exist because NASA management publishes a variety of documents on this subject and has not consistently stated in the various documents what the Agencywide Aviation Safety Initiative will accomplish. As a result, NASA may not be able to measure its contribution toward meeting the National Aviation Safety Goal. Also, Congress, the aviation community, and the public may draw inaccurate conclusions about NASA's aviation safety efforts, and the President's overall national aviation safety goal may not be achieved.

Laws and Guidelines

The Government Performance and Results Act (GPRA) was enacted in 1993 to improve public confidence in the Federal Government by holding agencies accountable through setting program goals, measuring performance against those goals, and reporting publicly on progress. NASA Procedures and Guidelines 1000.2, "NASA Strategic Management Handbook," dated February 2000, documents the Agency's policies, processes, guidelines, and responsibilities for strategic management as required by GPRA. The Handbook requires that all Agency strategic plans, the NASA Strategic Plan, Enterprise¹² Strategic Plans, and lower level strategic planning documents include specific elements to ensure consistency of Agency plans and meet GPRA requirements.

NASA Procedures and Guidelines 7120.5, "NASA Program and Project Management Processes and Requirements," dated April 3, 1998, defines the requirements for formulating, approving, implementing, and evaluating programs and projects. It is intended to support accomplishment of the NASA programs and projects, consistent with established Agency strategic planning while satisfying the requirements of multiple stakeholders and customers. The guidelines require that programs establish metrics related to the program commitments and

¹² NASA established four Strategic Enterprises to function in primary business areas for implementing NASA's mission and serving customers. The four enterprises are Human Exploration and Development of Space, Earth Science, Aerospace Technology, and Space Science. AvSP is a part of the Aerospace Technology Enterprise.

ensure metric data are collected and reported as required by GPRA, the Program Commitment Agreement¹³ and other strategic planning requirements. The guidelines further stipulate that program/project documentation should be consistent with and provide details for implementing Agency and Enterprise strategic plans.

Aviation Safety Initiative Goals

Although Aerospace Technology Enterprise officials understand that one of the Enterprise goals is to contribute to reductions in the fatal aviation accident rate, that goal is inconsistently stated in Agency documents that are available to the aviation community, Congress, and the public. NASA Strategic plans, Performance Plans and Reports, other program documents, and Agency Web sites inconsistently state the Agency's goal regarding aviation safety. The documents differ in what NASA plans to do and which accident rates are the targets of its technologies.

Various Agency documents state that NASA's role is to "enable" reductions in, "contribute" to reductions in, or "reduce" aviation accident rates. There is a significant difference in meaning between enabling a reduction in the aviation accident and fatality rates (as stated in the AvSP draft Program Commitment Agreement, dated November 10, 1999¹⁴), contributing to a reduction in aviation accident and fatality rates (as stated in the AvSP program plan, dated August 1, 1999), and reducing the fatal accident rate by 80 percent (as stated on the AvSP Internet page, dated August 14, 2000). By using the term "reduce," NASA does not make clear that it is only one of several partners that have activities under way to lower the fatal accident rate and improve aviation safety. The Agency's Web site implies that the AvSP itself will reduce the aviation fatal accidents by 80 percent. The Agency does not clarify that the reduction is a national goal or that AvSP is a contributor toward achieving the goal. While the terms "contribute" and "enable" are more appropriate in describing NASA's role in meeting a national goal, "contribute" most aptly recognizes that NASA is working in partnership with others on a common goal. Although not as direct as the term "reduce," the use of "enable" suggests that NASA can make the action possible, but does not clearly reflect the involvement of others. NASA management agrees that they are one part of a team that together is contributing toward the national goal. Appendix C provides details on the variations of the goal.

NASA has not consistently identified the accident rates that it wants to lower by the technologies being developed. Variations range from whether NASA plans to affect the fatal aircraft accident rate,¹⁵ the aircraft accident rate,¹⁶ or fatality rates,¹⁷ or a combination of all the

¹³ The agreement requires clearly defined objectives and public benefits stated in a way that can be understood by the average citizen.

¹⁴ During our audit, the term "enable" changed to "contribute" in draft versions of the Program Commitment Agreement.

¹⁵ The fatal accident rate can be calculated as the number of accidents with one or more fatalities divided by a measure of aviation activity, such as the number of aircraft miles flown, aircraft hours flown, or departures.

rates. Most of the Agency documents include reductions to the aviation accident rate. Other documents state the goal is to reduce the fatal accident rate. Reductions to the fatality rate are declared primarily within the AvSP definition documents. The National Transportation Safety Board (NTSB)¹⁸ separately calculates and individually tracks fatal aircraft accident rates, aviation accident rates, and fatality rates.

AvSP documentation should be consistent with and provide details for implementing Agency and Enterprise Strategic Plans. Goals should be expressed in a manner that allows a future assessment of whether they are being achieved. Agency documentation should consistently portray the goal because each of the rates is measurable and could be used as a measure of success. The Independent Annual Review¹⁹ of the AvSP conducted in April 2000, also noted these inconsistencies. The review briefing package states, “Without a clear distinction between the program goal and the program objectives, and specific definitions of the program’s minimum success criteria, it will be difficult to determine whether or not the AvSP is successful.”

Performance Measurement Baselines

While NASA has been inconsistent in stating the goal of the NASA Aviation Safety Initiative in various Agency documents, the baselines used to measure performance consistently refer to only the aviation fatal accident rates. Performance measures do not include a baseline for aviation accident rates (nonfatal) or fatality rates. Aviation accidents, for example, outnumber fatal aircraft accidents 170 to 24,²⁰ respectively, for commercial carriers.²¹ Although technologies developed within the AvSP are expected to have some effects on the nonfatal accident rates and fatality rates, the program office is not measuring program success by their effects on the various rates. According to program officials, the fatal accident rate is a subset of the aviation accident rate and, therefore, a reduction in the fatal accident rate would also reduce the accident rate. However, the AvSP has separately identified and equally stated in the program’s goals, plans to also contribute to reductions in aviation accident rates and fatality rates. Unless management revises the AvSP goal to reflect only the fatal accident rate, the

¹⁶ An accident is an occurrence associated with the operation of an aircraft that takes place between the time a person boards the aircraft with the intention of flight and until such time as all such persons have disembarked and (1) in which any person suffers death or serious injury or (2) in which the aircraft receives substantial damage.

¹⁷ Fatality rates include deaths and fatal injuries that result in death within 30 days of the accident.

¹⁸ The NTSB is an independent Federal agency charged by Congress with investigating every civil aviation accident in the United States and is responsible for maintaining the Government’s database on civil aviation accidents.

¹⁹ The Independent Program Assessment Office performs an Independent Annual Review of NASA programs to assess progress and milestone achievement against the program baselines and to evaluate cost, schedule and technical content of the program over its entire life cycle.

²⁰ The number of fatal accidents and nonfatal accidents is for the AvSP baseline timeframe of 1990-1996, and is based on data published by the NTSB.

²¹ Commercial carriers are those conducting operations under Federal Aviation Regulation Part 121. This applies to air carriers, such as major airlines and cargo haulers that fly large transport aircraft. For the purposes of this report, future reference to this type of aircraft will be commercial carriers.

Agency should establish baselines to also measure its performance relative to aviation accident rates and fatality rates.

Factors Affecting Program Success

The six project areas in the AvSP have identified 40 products that contribute to an overall capability expected to affect the AvSP goal. The products under development are projected to reduce the fatal accident rate by about 52 percent for commercial carriers and by about 81 percent for general aviation. However, the success of the AvSP is dependent on overcoming several risks or factors including:

- challenge of technical development;
- user implementation of the resulting technology; and
- availability of resources (staffing, time, and dollars).

Challenge of Technical Development. The AvSP project managers participated in a preliminary assessment to estimate the effect of the risks of technology under development and user implementation to AvSP's successful achievement of its goal. AvSP managers recognize that technology development for the 40 products is moderate to hard but agree it is an appropriate application of NASA resources. The project managers' assessment of technology development for the 40 products showed that for 29 (72 percent), there was a high probability that they would not be developed, as indicated below:

- 2 (5 percent) products required few technical developments and should be readily accomplished;
- 9 (23 percent) products were a moderate technical challenge and should be accomplished;
- 23 (57 percent) products were considered large technical challenges and may not be developed; and
- 6 (15 percent) products required technical breakthroughs and it is likely that they cannot be achieved.

User Implementation. Implementation of the AvSP's 40 products is a challenge. The project managers' assessment of user implementation showed that potential users of 21 (52 percent) of the 40 products have a cautious attitude about implementation.

- 19 (48 percent) product users are supportive of the new technology.
- 6 (15 percent) product users are waiting to see how the technology develops.
- 6 (15 percent) product users are initially skeptical but could be convinced of product value.
- 9 (22 percent) product users are unlikely to agree to field this capability without intensive discussion and debate.

In addition, the return on investment for 11 (27 percent) of the 40 products is negative, and NASA will need to convince the user community of the products' effectiveness to implement the product technology. Further, for 7 (17 percent) of the 40 products, the industry partners have little or no interest in developing and implementing the particular product technology. Of the 40 products, 3 have numerous or strong critics within NASA or FAA.

Availability of Resources. Adequate resources are key to program success. However, three of the six AvSP projects have staffing shortfalls. The shortfalls range from 3 to as many as 11 personnel for a particular project. If program management is unsuccessful in increasing the staff by October 2000, actions will be taken to descope planned activities, which may affect meeting AvSP goals.

As a result of the dependence on technical development, implementation, and resources, the success of the AvSP can only be projected. The actual effect of the AvSP technologies on the fatal accident rate cannot be directly measured. The success of the technologies and achievement of the goal is dependent on implementation by the aviation community. NASA defined minimum success criteria as demonstrating technology that will have at least a 50²² percent impact on the national goal, and that impact will occur only if the aviation community chooses to implement the technologies produced by the AvSP. While the factors affecting program success are recognized in the AvSP Program Plan and draft Program Commitment Agreement, they are not given adequate emphasis on how closely they are linked to the success of AvSP. NASA needs to emphasize the risks involved with the development and implementation of its aviation safety technologies and explain how these risks affect the achievement of its aviation safety goal. Without an understanding of the risks involved, the aviation community, Congress, and the public will not have a realistic concept of the difficulties in developing aviation safety products that contribute to reductions in aviation fatal accidents rates.

FAA and NASA Aviation Safety Activities

In response to the White House Commission's recommendation on aviation safety, NASA and FAA coordinated their research activities on aviation safety. In October 1998, the Administrators of FAA and NASA signed a formal agreement establishing a partnership between their agencies with the objective of articulating and achieving specific goals in aviation. One of those goals is aviation safety.

²² During our audit, the minimum reduction rate changed from 70 to 50 percent in draft versions of the Program Commitment Agreement.

NASA and the FAA are preparing the “FAA/NASA Integrated Safety Research Plan”²³ in recognition of the importance of cooperative efforts to optimize the Government research needed to attain critical aviation safety goals. The plan will serve as a guide for FAA and NASA cooperation in aviation safety research. The plan states that FAA and NASA must strive to use common methodologies to assess the success of their research efforts toward achieving the National Aviation Safety Goal, which is stated in this plan as “an 80 percent reduction in the commercial fatal accident rate by 2007, as compared to a 1994-1996 baseline.” The plan further states this common goal has been acknowledged and agreed upon by NASA and FAA. NASA’s aviation safety activities, however, are not in agreement with this draft plan because Agency documents do not consistently state what the Aviation Safety Initiative will accomplish. Further, NASA and the FAA are not using common methodologies in their efforts to affect the National Aviation Safety Goal. For example:

- NASA is using fatal accident statistics for 1990-1996 and not the FAA’s 1994-1996 baseline;
- NASA is using “number of departures” as a measure of accidents and FAA is using “flight hours;” and
- NASA includes general aviation in its performance measure, while FAA includes Part 135.²⁴

See Appendix D for details on the comparison between NASA and FAA methodologies.

Also, the draft plan does not show the individual effects of NASA and FAA aviation safety research activities on the goal. The plan should clearly state the individual contributions at these Agencies so Congress, the aviation community, and the public will know what the respective agencies are contributing toward reducing the fatal accident rate.

Conclusion

NASA's goal to reduce the fatal aviation accident rate is an important national priority. Nevertheless, some of the goals, as stated, are optimistic and could lead to unfulfilled expectations by Congress, the aviation community and the public. In addition, without appropriate baselines to measure the program’s performance, NASA may not achieve its full contribution to the overall national aviation safety goal, and that goal may not be achieved.

²³ This draft plan is dated July 2000.

²⁴ Part 135 applies to commercial air carriers commonly referred to as commuter airlines and to air taxis.

Recommendations, Management's Response, and Evaluation of Response

The Associate Administrator for Aerospace Technology should:

- 1. Clarify the Agency's contribution toward the National Aviation Safety Goal and revise plans and goals in various Agency documents to ensure a consistent representation of NASA's intended performance.**

Management's Response. Concur. The Office of Aerospace Technology clarified its Aviation Safety Program goal as “develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by year 2007 and a factor of 10 by year 2022” and will update all documentation (strategic plan, Program Commitment Agreement, Program Plan, Web page, etc.) accordingly. The complete text of management's response is in Appendix E.

Evaluation of Response. Management's actions are responsive to the recommendation. After the receipt of the comments, management indicated that it would have actions completed by December 31, 2000. The recommendation is considered resolved but will remain undispositioned and open until the agreed corrective action is completed.

- 2. Identify all baselines necessary to measure the Agency's performance in meeting the established goals.**

Management's Response. Concur. The Office of Aerospace Technology will adjust its baseline to match the FAA baseline years of 1994–1996 (see Appendix E).

Evaluation of Response. Management's actions are responsive to the recommendation. Management's actions are sufficient to close the recommendation for reporting purposes.

- 3. Revise program documentation available to stakeholders to adequately reflect the risks of development and implementation of various technologies.**

Management's Response. Concur. Management agrees that program documentation should adequately reflect the risk of development and implementation, and will communicate and stress these risks to their partners, customers and stakeholders (see Appendix E).

Evaluation of Response. Management's actions to ensure stakeholders appropriately understand the risk are responsive to the intent of the recommendation. Our draft recommendation requested that management revise goals and program documentation. Management did not believe it appropriate to revise the goals, although the phrase “when implemented” has been used in statements of the goal in AvSP's budget and FAA

Memorandum of Understanding documentation to identify the development and implementation risk. We defer to management's judgment regarding changes to the goal to reflect risk. Management recognized that program documentation should reflect the risk of development and implementation of the technologies. In their comments, management cited examples of program documentation that does reflect the risks. However, in discussions with the OIG, management acknowledged that information available to the public, such as the Aviation Safety Website, could be improved. After the receipt of the comments, management indicated that it would have actions completed by December 31, 2000. This recommendation is considered resolved but will remain undispositioned and open until the publicly available documentation is updated.

4. Coordinate with the FAA to revise the draft “FAA/NASA Integrated Safety Research Plan” to resolve differences in baselines and metrics used to guide the national efforts on aviation safety.

Management's Response. Concur. The Office of Aerospace Technology will conform to the baseline years established by the FAA, and will reflect them in the FAA/NASA Integrated Safety Research Plan (see Appendix E).

Evaluation of Response. Management's actions are responsive to the recommendation. Management's actions are sufficient to close the recommendation for reporting purposes.

Appendix A. Objectives, Scope, and Methodology

Objectives

Our overall objective was to determine whether overall program management of AvSP is effective. Specifically, our audit work included an assessment of:

- the adequacy of coordination with FAA and other partners, and
- overall success in achieving program goals and objectives including metrics used to measure program performance.

Scope and Methodology

To accomplish our objectives, we obtained an overall understanding of the National Aviation Safety Goal by reviewing the following prior studies and assessments.

- National Research Council Report, “Aviation Safety and Pilot Control,” 1997.
- RAND Institute of Civil Justice Report, “Safety in the Skies,” 1999.
- National Academy of Public Administration, “A Review of the Aviation Safety Reporting System,” 1994.
- Department of Transportation, Office of Inspector General Report, “Top Ten Management Issues,” (Issue 1-Aviation Safety), 1998.
- Federal Aviation Administration FY 2000 Annual Performance Plan.
- National Transportation Safety Board, “Annual Review of Aircraft Accident Data, Calendar Year 1996-U.S. Air Carrier Operations,” 1999.
- Aerospace Safety Advisory Panel Reports for 1998 and 1999.
- National Science and Technology Council, “National Research and Development Plan for Aviation Safety, Security, Efficiency, and Environment Compatibility,” 1999.
- Final Report to President Clinton from the White House Commission on Aviation Safety and Security, 1997.
- An Aviation Safety Research Investment Strategy: Report of the ASIST Team, 1997.
- ir Safety Foundation, “1999 Nall Report: Accident Trends and Factors for 1998.”

We focused our review on the NASA AvSP and its six projects. We reviewed the program to determine whether reasonable milestones and measures had been established by which to assess performance and ensure success. We also reviewed the performance and business management plans. Specifically, we:

- Obtained various program planning documents such as the Program Commitment Agreement (draft), Program Plan, Non-Advocate Review, FAA/NASA Integrated Safety Research Plan (draft), FAA/NASA Memoranda of Agreement/Understanding, Joint Working Group minutes, Monthly and Quarterly Program Reviews, and Independent Annual Review.
- Interviewed management personnel in both the AvSP office and Aerospace Systems Analysis branch at Langley; the NASA Headquarters Aviation Safety Goal Manager; the Office of Aerospace Technology Deputy Director, Programs Division; and a member of the Non-Advocate Review and the Independent Annual Review teams.

Management Controls Reviewed

We reviewed relevant Federal and NASA regulations on program management and aviation. Specifically, we reviewed the GPRA; NASA Procedures and Guidelines 1000.2, “NASA Strategic Management Handbook”; NASA Procedures and Guidelines 7120.5A, “NASA Program and Project Management Processes and Requirements”; NASA Web Policy: Policy for NASA Information Published over the Internet; and 49 Code of Federal Regulations Part 830, "Notification and Reporting of Aircraft Accidents or Incidents."

With respect to NASA’s Aviation Safety Initiative, we also reviewed the following documents that implement the management controls identified.

- 1998 NASA Strategic Plan with 1999 Interim Adjustments
- Aerospace Technology Strategic Plan, 1995-2000
- Langley Implementation Plan for FY 2000
- NASA FY 2001 Performance Plan
- NASA FY 1999 Performance Report
- NASA FY 1999 Accountability Report
- AvSP Non-Advocate Review and Independent Annual Review
- Budget requests for FY 2000 and FY 2001

Management controls regarding program documentation should be improved as discussed in the finding.

Prior Audit Coverage

There has been no prior audit coverage on the NASA Aviation Safety Program. However, we issued the following report relating to Aviation Safety in 1998.

Appendix A

“Report on FAA/NASA Research and Development Coordination Efforts,” Report Number P&A-98-005, October 8, 1998. This audit was a joint effort with the Department of Transportation, Office of Inspector General. The audit focused on aviation safety and air traffic management research because they are the two major joint activities supporting the National Airspace System and receive most of the funding (projected \$1.3 billion) through FY 2002. The audit identified areas where the FAA and NASA can take action to enhance the effectiveness of their coordination efforts and help ensure agency resources are used in the most cost-effective manner.

The General Accounting Office (GAO) has issued several reports on the subject of Aviation Safety; however, the GAO audits are of NASA’s aviation safety partner, the FAA. The following reports specifically address the National Aviation Safety Goal and FAA’s history regarding implementation of safety recommendations.

“Aviation Safety: Safer Skies Initiative Has Taken Initial Steps to Reduce Accident Rates by 2007,” GAO/RCED-00-111, dated June 2000. The initiative should help improve aviation safety, but has not challenged all sectors of the aviation community to push aggressively for safety improvements. There are no challenging goals established for general aviation. The Safer Skies²⁵ initiative has made progress in selecting and implementing interventions for identified safety problems, but in the past, FAA did not consistently implement the interventions successfully. Performance measures need to be developed to evaluate the effectiveness of the implemented interventions. Coordination has been extensive but needs improvement for the initiative to succeed. Additional steps need to be taken to ensure that those safety interventions most critical to reducing the nation’s fatal accident rate are given top priority and funding.

“Aviation Safety: FAA Has Not Fully Implemented Weather-Related Recommendations,” GAO/RCED-98-130, dated June 2, 1998 and “Aviation Safety: FAA Generally Agrees with but Is Slow in Implementing Safety Recommendations,” GAO/RCED-96-193, dated September 23, 1996. Both of these reports noted FAA’s limited progress in implementing safety recommendations. The FAA generally agreed with the recommendations but did not consistently follow through on implementing them.

“Aviation Safety and Security: Challenges to Implementing the Recommendations of the White House Commission on Aviation Safety and Security,” GAO/T-RCED-97-90, dated March 5, 1997. GAO testified that the White House recommendations were a good start toward ensuring greater safety for passengers, restructuring the relationships between Government and private industry, and maintaining America’s global

²⁵ Safer Skies is an FAA focused initiative addressing safety problems that have contributed to fatal accidents in the past and is designed to bring about a five-fold reduction in fatal accidents.

leadership in aviation. Yet, key questions remain about how and when the recommendations will be implemented, how much they will cost, and who will pay the cost.

Computer-Processed Data

We used computer-processed reports from NASA Headquarters, Langley, the FAA, and NTSB to understand aviation fatal accident rates. We reviewed and tested selected data but did not verify the overall validity of the reports. The lack of verification did not affect our audit results.

Audit Field Work

During January through August 2000, we conducted field work at NASA Headquarters and Langley. We performed the audit in accordance with generally accepted government auditing standards.

Appendix B. AvSP Contributions toward the National Aviation Safety Goal

Investment Area	Project	Technology	Impact	Number Of Products
Accident Prevention	System-Wide Accident Prevention (SWAP)	Human error assessment methodologies	Improve human/machine integration in design, operations, and maintenance	8
Accident Prevention	Single Aircraft Accident Prevention (SAAP)	Health and usage monitoring technologies	Continuously track, diagnose, and restore the health of on-board system, enabling self-healing designs and “refuse to crash aircraft”	3
Accident Prevention	SAAP	Not reflected in core technologies	Provide upset prevention and recovery and identify future group accident precursors	4
Accident Prevention	Weather Accident Prevention (WxAP)	Affordable technologies and systems to obtain critical weather information	Bring intelligent weather decision making based on worldwide, real-time hazard awareness to every cockpit	3
Accident Prevention	WxAP	Turbulence modeling and detection technologies	Eliminate severe turbulence as an aviation hazard	3
Accident Prevention	Synthetic Vision (SV)	Synthetic vision technologies	Make every flight the equivalent of clear-day operations	5
Accident Mitigation	Accident Mitigation (AM)	Advanced structural and material designs	Increase survivability when accidents do occur	8
Aviation System-wide Monitoring Modeling and Simulation	Aviation System Modeling and Monitoring System (ASMM)	Integrated aviation system monitoring tools	Monitor and assess all data from every flight for both known and unknown issues	6
			Total Products	40

Appendix C. Examples of Inconsistent Aviation Safety Goals

Document	Time Period	Highlighted Inconsistencies
White House Commission on	Feb. 1997	Government and industry establish a national goal to reduce the

Aviation Safety and Security		aviation fatal accident rate by a factor of 5 within 10 years and conduct safety research to support that goal.
NASA Strategic Plan*	1998-2002 2003-2009 2010-2023	Develop technologies to reduce the aviation fatal accident rate . Contribute to a reduction in the accident rate by a factor of 5. Contribute to a reduction in the aircraft accident rate by a factor of 10.
Performance Report	FY 1999	Contribute to aviation safety by reducing the aircraft accident rate .
Aerospace Technology Enterprise Strategic Goal	FY 2000	Reduce the aircraft accident rate by a factor of 5 within 10 years and by a factor of 10 within 25 years.
Accountability Report	FY 1999	Same as Aerospace Technology Enterprise Strategic Goal.
Performance Plan	FY 2001	Same as Aerospace Technology Enterprise Strategic Goal.
Budget Requests	FY 2000/01	Develop and demonstrate technologies that contribute to a reduction in aviation accident and fatality rates by a factor of 5 by the year 2007 compared to the 1994-1996 average.
AvSP Program Plan	Aug. 1999	By 2004, develop and demonstrate technologies that contribute to a reduction in aviation accident and fatality rates by a factor of 5 by year 2007 and by a factor of 10 by year 2022.
AvSP Program Commitment Agreement-Draft	Nov. 1999	Develop and demonstrate technologies that enable a reduction in aviation accident and fatality rates by a factor of 5 by year 2007.
AvSP Internet page	Aug. 2000	Reduce the fatal aircraft accident rate by 80 percent in 10 years and by 90 percent in 25 years.
“Turning Goals Into Reality” Conference	May 2000	Reduce the accident rate by a factor of 5 within 10 years and by a factor of 10 within 25 years.

* The “NASA Strategic Plan,” 1998 with 1999 interim adjustments, page 30, describes the Agency objectives for the Aviation Safety Initiative.

Appendix D. Comparison of NASA and FAA Methodologies

The White House established the overall National Aviation Safety Goal; however, the White House did not set forth specific recommendations as to categories of operation or specific baseline criteria. NASA and the FAA determined their own specific criteria. The FAA-NASA integrated plan, compared to the individual NASA and FAA stated goals and the variances in metrics to measure achievement of the National Aviation Safety Goal are noted below.

	FAA-NASA Integrated Safety Plan ¹	NASA		FAA ²	
Category of Operation	Commercial	Part 121 ³	General Aviation	Part 121	Part 135 ⁴
Measure	Fatal accident rate	Number of fatal accidents per 100,000 departures	Number of fatal accidents per 100,000 flight hours	Number of fatal accidents per 100,000 flight hours ⁵	
Scope	Not identified	Scheduled service	Not applicable	Scheduled and nonscheduled services	Scheduled service
Source	Not identified	Flight data is submitted to Bureau of Transportation Statistics. Accident data is provided by NTSB		Flight data is submitted to Bureau of Transportation Statistics. Accident data is provided by NTSB	
Baseline	Not identified	The average of Part 121 scheduled, for fatal accidents for the 7 years from 1990-1996	The baseline is the sum of all fatal accidents from 1990-1996 (2,891) divided by the sum of all the estimated hours flown over that period (171,120,000)	The average of all Parts 121 and 135 fatal accidents for the 3 years from 1994-1996	
Calculated rate	Not identified	0.044 per 100,000 departures	1.690 per 100,000 flight hours	0.037 per 100,000 flight hours	

¹This draft plan is dated July 2000.

² FAA methodologies are taken from its Fiscal Year 2000 Annual Performance Plan, pages 14-15. FAA applied the 80-percent reduction in the nation's fatal accident rate only to commercial aviation and adopted a less aggressive accident reduction goal for general aviation.

³Part 121 refers to large transport aircraft such as major airlines and cargo haulers.

⁴Part 135 applies to aircraft commonly referred to as commuter airlines and air taxis.

⁵The FAA Administrator's Fact Book dated July 2000, page 45, refers to a measure of 100,000 departures instead of the flight hours noted in the FAA Performance Plan for Fiscal Year 2000.

Appendix E. Management's Response

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001



Re: RP

TO: W Assistant Inspector General for Auditing
FROM: R/Associate Administrator for Aerospace Technology
SUBJECT: Draft Report on the Audit of NASA's Aviation Safety Program
Assignment Number A0000100

We have reviewed the subject draft report and concur with all recommendations, subject to the modification of recommendation 3 per the discussion in the enclosure. Our comments and the corrective actions we are undertaking are provided in the enclosure. If you have questions concerning our comments, please contact Mr. Terrence J. Hertz, Director, Research and Technology at 202-358-4636.

A handwritten signature in black ink, appearing to read "Samuel L. Venneri".

Samuel L. Venneri

Enclosure

Appendix E

Comments

The following comments are offered for clarification:

1. Page 1, 3rd Paragraph. As some of the technologies will likely be implemented prior to the program end, the sentence that reads "Implementation of the technologies under development will not be completed by AvSP program end in 2004..." would be better stated as follows: "Full-system-wide implementation of the technologies under development will not be completed by AvSP program end in 2004..."
2. Page 1, 3rd Paragraph. While the Enterprise's activities are to be part of the National effort to improve aviation safety, the program's success is measured by how well the program delivers on their plan and the metrics associated with the program's milestones. Therefore, the sentence that reads: "Success of the program will be based on technology that has been demonstrated through models of prototypes." would be better stated as follows: "Success of the program will be based on delivering the planned program milestones, typically with technology that has been demonstrated through models of prototypes."
3. Page 5, Challenge of Technical Development. We have some concern over the interpretation of the technical challenge as it appears to be characterized. The "risk statistics" cited are from our own self-assessment and are an appropriate distribution of risk for a focused NASA research and technology effort. If technology development is assured, or if technology development were impossible, NASA should not be doing it. In the case of the former, industry should be the developer, and in the case of the latter, more fundamental or breakthrough research would be required. Since our assessment shows that most of the technology development is moderate to very hard, it is an appropriate application of NASA resources. Having strong critics in the FAA or the airline industry and their concern of the "implementability" is the kind of challenge NASA takes on all the time. If a change is needed, it would be to take on more long range technologies.
4. Page 6, 3rd paragraph. The goal of the program is to contribute to a projected 80 percent reduction in fatal accident rate. As this is a very ambitious goal, during drafting of the Program Commitment Agreement and based on the results of the first program assessment, we concluded that reducing these accidents by half should be considered a success. We established a floor for program success (i.e., minimum success) that is a projected 50 percent reduction. Therefore the sentence that reads "In reality, NASA expects the technology it demonstrated to have at least a 50 percent impact on the national goal..." would be better stated as follows: "As minimum success, NASA expects the technology it demonstrated to have at least a 50 percent impact on the national goal..."
5. Page 7, Last paragraph in the section entitled "FAA and NASA Aviation Safety Activities." This section addresses the differences in goal statements and baselines between the FAA and NASA. The last paragraph concludes that the integrated plan should show the individual contributions at these Agencies. As the FAA is responsible for certifying and implementing the technology that NASA develops, it is impossible to calculate which Agency gets credit for which percentage of the reduction in fatal accidents. As an example, consider wind shear radar technology, NASA developed technology that has been implemented. In this example,

Change made,
Page 1

Change made,
Page 1

Clarification
made, Page 5

Change made, Page 6

No change
required

NASA developed the technology, FAA certified the technology, avionics manufacturer Collins built the device, and the airlines installed it in the aircraft. Until that last step, no reduction in fatal accidents attributed to the device would occur, yet it took a team effort whose individual contributions to the reduction in accident rate are incalculable. However, we do agree that the roles and responsibilities of each Agency should be clearly stated in the integrated plan.

6. Page 15, FAA Calculated Rate. The FAA goal uses a rate that is fatal accidents per 100,000 departures (Reference: FAA Administrator's Fact Book July 2000, p. 45), not 100,000 flight hours as indicated in the table. It should be noted that the Department of Transportation is establishing a metric associated with per 100,000 hours rate so it can harmonize with statistics from cars, trains, etc.

Footnote 5 added, Page 16

Recommendations

1. Clarify the Agency's contribution toward the National Aviation Safety Goal and revise plans and goals in various Agency documents to ensure a consistent representation of NASA's intended performance.

Concur. OAT will consistently state the Aviation Safety Program goal is "develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of five (80 percent) by year 2007 and a factor of 10 (90 percent) by year 2022." The Enterprise strategic goal (enabling technology objective) will use the same baseline but will use the term "enable" instead of "contribute." While OAT is a partner in a National effort and AvSP contributes to the reduction in fatal accident rate, the rest of OAT's activities do not entail the same level of partnership, therefore enable is the appropriate word to maintain consistency with the rest of the Enterprise strategic plan. All documentation (strategic plan, PCA, Program Plan, web page, etc.) will be updated to reflect this goal that is consistent with the White House Commission on Aviation Safety and Security.

2. Identify all baselines necessary to measure the Agency's performance in meeting the established goals.

Concur. In order to establish what actual rate reflects the 10-year goal, OAT will adjust their baseline to match the FAA baseline years of 1994-1996. (We had previously matched the FAA baseline of 1990-1996, but then the FAA modified their goal.) Using these years for the goal rate does not mean that only accidents that happened in 1994-1996 should be assessed for safety issues or impact assessments. A broad set of accident and incident data, updated each year, is needed for appropriate assessments.

3. Revise program goals and documentation available to stakeholders to adequately reflect the risks of development and implementation of various technologies.

Concur, subject to revision of this recommendation to strike the words "goals and." It is not appropriate for the goal statement to include a statement of risk. The aviation safety goal is hard and has risk, as all goals should, otherwise it would not be a very ambitious goal.

Appendix E

We concur that the documentation should adequately reflect the risk of development and implementation and we will continue to strive to ensure that our partners, customers and stakeholders have the appropriate understanding of this risk. At every opportunity we strive to communicate and stress to partners, customers and stakeholders the facts concerning the risk of implementation. The program and project plans lists these key risk and mitigation strategies. AvSP is funding risk identification/management/mitigation efforts. We point out these risks as a matter of course in program presentations. These challenges have been part of extensive discussions with NASA and FAA management. We identified them and discussed them at the NAR, the IAR, with the AvSFEAC. The AvSP acquisition strategy (cost-shared agreements) is based on accelerating implementation. Plus, we are already having success at implementation; for example, United in-service testing of AWIN, to be followed by fleet-wide implementation with Air Canada soon to follow.

4. Coordinate with the FAA to revise the draft "FAA/NASA Integrated Safety Research Plan" to resolve differences in baselines and metrics used to guide the national efforts on aviation safety.

Concur. As noted in our response to Recommendation 2, NASA will conform to the baseline years established by the FAA. This will be reflected in the FAA/NASA Integrated Safety Research Plan. Note that the FAA's goal is commercial aviation fatal accident rate whereas the White House Commission on Aviation Safety goal is aviation fatal accident rate. Consistent with the Commission, NASA's baseline will continue to include a general aviation component.

Appendix F. Report Distribution

National Aeronautics and Space Administration (NASA) Headquarters

A/Administrator
AI/Associate Deputy Administrator
B/Chief Financial Officer
B/Comptroller
BF/Director, Financial Management Division
G/General Counsel
J/Associate Administrator for Management Systems
JM/Acting Director, Management Assessment Division
L/Associate Administrator for Legislative Affairs
R/Associate Administrator for Aerospace Technology
RP/Director, Programs Division

NASA Advisory Officials

Chair, Aerospace Technology Advisory Committee

NASA Centers

Director, Langley Research Center
Chief Counsel, John F. Kennedy Space Center

Non-NASA Federal Organizations and Individuals

Assistant to the President for Science and Technology Policy
Deputy Associate Director, Energy and Science Division, Office of Management and Budget
Branch Chief, Science and Space Programs Branch, Energy and Science Division, Office of Management and Budget
Associate Director, National Security and International Affairs Division, Defense Acquisitions Issues, General Accounting Office
Professional Assistant, Senate Subcommittee on Science, Technology, and Space
Inspector General, Department of Transportation

Chairman and Ranking Minority Member – Congressional Committees and Subcommittees

Senate Committee on Appropriations
Senate Subcommittee on VA, HUD, and Independent Agencies

Appendix F

Chairman and Ranking Minority Member – Congressional Committees and Subcommittees (Cont.)

Senate Committee on Commerce, Science, and Transportation

Senate Subcommittee on Science, Technology, and Space

Senate Subcommittee on Aviation

Senate Committee on Governmental Affairs

House Committee on Appropriations

House Subcommittee on VA, HUD, and Independent Agencies

House Committee on Government Reform and Oversight

House Subcommittee on Government Management, Information, and Technology

House Subcommittee on National Security, Veterans Affairs, and International Relations

House Committee on Science

House Subcommittee on Space and Aeronautics, Committee on Science

Congressional Member

Honorable Pete Sessions, U.S. House of Representatives

NASA Assistant Inspector General for Auditing Reader Survey

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Report Title: NASA's Aviation Safety Program

Report Number: _____ **Report Date:** _____

Circle the appropriate rating for the following statements.

	Strongly Agree	Agree	Neutra l	Disagre e	Strongl y Disagre e	N/A
1. The report was clear, readable, and logically organized.	5	4	3	2	1	N/A
2. The report was concise and to the point.	5	4	3	2	1	N/A
3. We effectively communicated the audit objectives, scope, and methodology.	5	4	3	2	1	N/A
4. The report contained sufficient information to support the finding(s) in a balanced and objective manner.	5	4	3	2	1	N/A

Overall, how would you rate the report?

Excellent	Fair
Very Good	Poor
Good	

If you have any additional comments or wish to elaborate on any of the above responses, please write them here. Use additional paper if necessary. _____

How did you use the report? _____

How could we improve our report? _____

How would you identify yourself? (Select one)

Congressional Staff

NASA Employee

Private Citizen

Government: _____ Federal: _____ State: _____ Local: _____

Media

Public Interest

Other: _____

May we contact you about your comments?

Yes: _____

No: _____

Name: _____

Telephone: _____

Thank you for your cooperation in completing this survey.

Major Contributors to the Report

Karen E. VanSant, Program Director, Aerospace Technology Audits

Carol A. St. Armand, Program Manager, Aerospace Technology Audits

Sandra K. Leibold, Auditor-in-Charge

Betty G. Weber, Operations Research Manager

Nancy C. Cipolla, Report Process Manager

Patricia J. Atkinson, Program Assistant