MARCH 1, 2012

AUDIT REPORT

OFFICE OF AUDITS

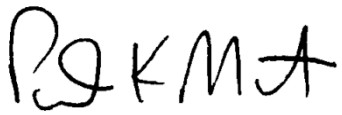
AUDIT OF NASA'S PROCESS FOR TRANSFERRING TECHNOLOGY TO THE GOVERNMENT AND PRIVATE SECTOR

OFFICE OF INSPECTOR GENERAL

National Aeronautics and
Space Administration

REPORT NO. IG-12-013 (ASSIGNMENT NO. A-11-017-00)

Final report released by:



Paul K. Martin
Inspector General

Acronyms

FY	Fiscal Year
IPO	Innovative Partnerships Office
NPR	NASA Procedural Requirements
NTR	New Technology Report
NTTS	NASA Technology Transfer System

OVERVIEW

AUDIT OF NASA'S PROCESS FOR TRANSFERRING TECHNOLOGY TO THE GOVERNMENT AND PRIVATE SECTOR

The Issue

The National Aeronautics and Space Act of 1958 directs NASA to preserve the role of the United States as a leader in spaceflight, aeronautical science, and technology. One way in which NASA seeks to meet this directive is through the development and demonstration of new technologies that foster novel approaches to NASA's current and future missions.[1]

Creating new technologies to support programs is fundamental to NASA's mission, and facilitating the transfer of these technologies to other government agencies, industry, and international entities to generate U.S. commercial activity is one of the Agency's strategic goals.[2] Technology transfer promotes commerce, encourages economic growth, stimulates innovation, and offers benefits to the public and industry.[3] For example, aerodynamics research conducted at Dryden Flight Research Center led to a method to decrease the "box-shaped" aerodynamic drag of trucks by 40 percent, thereby increasing fuel efficiency. Truck manufacturers that have incorporated these design improvements are realizing 15 to 25 percent more fuel efficiency at highway speeds. Demonstrating the commercial value of NASA's technologies can also lead to greater support from Congress and the public for Agency programs and projects. In addition, individuals who identify new technologies may gain name recognition, monetary awards, and patents.

The Stevenson-Wydler Technology Innovation Act of 1980 and Federal Technology Transfer Act of 1986 further promote the transfer of federally funded research and technology to state and local governments and the commercial sector.[4] More recently, in October 2011, the President directed Federal agencies to accelerate technology transfer

[1] NASA's definition of new technology is very broad and includes any new and useful processes, machines, manufacture, or compositions of matter, as well as computer programs, whether or not they can be copyrighted.

[2] NASA's 2011 Strategic Plan is available at http://www.nasa.gov/pdf/516579main_NASA2011 StrategicPlan.pdf (accessed February 29, 2012).

[3] For the purposes of this report, "technology transfer" refers to both transfer and commercialization and includes NASA's efforts to transfer technology to other government entities and the private sector.

[4] The Stevenson-Wydler Technology Innovation Act of 1980 requires the Federal government to ensure the full use of the results of the Nation's Federal investment in research and development. The Federal Technology Transfer Act of 1986 amended the Stevenson-Wydler Act and allowed Government-owned, Government-operated laboratories to enter into cooperative research and development agreements with universities and the private sector.

efforts and support private sector commercialization of new technologies resulting from federally funded research.[5]

NASA's Space Technology Program in the Office of the Chief Technologist is responsible for promoting and supporting the development of new technologies and administering the Agency's technology transfer and commercialization process.[6]

The following four subprograms play a role in this process:

- The Small Business Innovation Research and the Small Business Technology Transfer Programs stimulate technological innovation and increase participation by small and disadvantaged businesses in federally funded research and development programs.

- The Crosscutting Space Technology Development Program focuses on maturing flight readiness capabilities that advance future space missions such as the Edison Small Satellite Demonstration Missions designed to improve or create new small spacecraft capabilities for advanced satellite communication.

- The Exploration Technology Development Program seeks to advance development of new technologies to enable human missions beyond low Earth orbit.

- The Partnership Development and Strategic Integration Program provides funding for the transfer and commercialization of NASA-developed technologies, interagency technology coordination, and intellectual property management and seeks out partnership opportunities with other government agencies and industry.

Through these four subprograms, the Office of the Chief Technologist is responsible for managing technology investments across NASA and for developing innovative technology partnerships, technology transfer, and commercialization. The Office also serves as the point-of-contact with other government agencies, academia, and the commercial aerospace community. Each NASA Center has a Center Chief Technologist who, together with their Center-based Innovative Partnerships Office (IPO), is expected to coordinate with program and project managers, foster innovative technology partnerships with other government agencies and commercial entities, and take the lead in developing technology transfer and commercialization opportunities.

Under NASA's process, employees and contractors who develop new technologies (innovators) report, document, and identify the potential commercial applications of their

[5] Presidential Memorandum, "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses," October 28, 2011.

[6] NASA's current technology transfer policies focus on technologies in which NASA has intellectual property rights or those that have potential patentability.

work by submitting New Technology Reports (NTRs).[7] New Technology Representatives review the NTRs for completeness and enter them into the NASA Technology Transfer System (NTTS), an Agency-wide management information tool the IPO uses to oversee the NTR process. Once entered into NTTS, the IPO and Patent Counsel review the NTR to determine its technical merit. Based on these assessments, NASA may consider the new technology for patenting, publication in NASA Tech Briefs – a monthly magazine and website that feature reports of innovations developed by NASA and its industry partners – or other release to the public (e.g., software).[8,9] The IPO and Patent Counsel are involved in determining if the information in the NTR is suitable for release to the public.

Since fiscal year (FY) 2004, funding for NASA's technology transfer efforts has decreased by 68 percent, from $60 million in 2004 to $19.2 million in FY 2012. In addition, personnel resources dedicated to the technology transfer effort have similarly declined. For example, since FY 2003 the number of patent attorneys at the Centers has dropped from 29 to 19 and Headquarters IPO staff has decreased from 13 in FY 2010 to just 2 in FY 2012.

Because technology transfer is fundamental to NASA's mission and strategic goals, the Office of Inspector General initiated this audit to examine whether NASA was effectively identifying and planning for the transfer of technology developed within its programs to outside entities. The primary locations for this audit were NASA Headquarters, Ames Research Center, Dryden Flight Research Center, Goddard Space Flight Center, and Johnson Space Center. Details of the audit's scope and methodology are in Appendix A.

Results

NASA's project managers and IPO personnel at the NASA sites we reviewed could improve their effectiveness in identifying and planning for the transfer and commercialization of technologies developed as part of Agency projects. Although technology transfer and commercialization does occur, we found a general lack of awareness of NASA policy governing the process.[10] Specifically, personnel we interviewed did not realize the transfer potential of some technological assets, and project managers did not develop and IPO personnel did not assist in the development of Technology Commercialization Plans (Commercialization Plans).[11] Furthermore,

[7] NTRs may be submitted via NASA's Technology Reporting website (e-NTR) https://ntr.ndc.nasa.gov/ (accessed February 29, 2012) or using NASA Form 1679.

[8] See NASA TechFinder, Software Search, at http://technology.nasa.gov/?s=software (accessed February 29, 2012).

[9] See NASA Tech Briefs at http://www.techbriefs.com/ (accessed February 29, 2012).

[10] NASA Procedural Requirements (NPR) 7500.1, "NASA Technology Commercialization Process w/Change 1 (4/9/04)."

[11] A Technology Commercialization Plan outlines a strategy for promptly identifying and reporting new technologies and innovations, developing and implementing commercial partnerships, and evaluating and reporting on the success of those partnerships.

personnel lacked awareness of the New Technology Reporting process and were not using NTRs to identify potential technology benefits. In addition, we found that the NASA Chief Technologist, Center Chief Technologists, and Center IPOs have not effectively implemented the Agency's Technology Commercialization Policy requirements and need to conduct more outreach to NASA project managers. The decrease in resources since FY 2004 has contributed to this condition.

Consequently, NASA has missed opportunities to transfer technologies from its research and development efforts and to maximize partnerships that could provide additional resources, and industry and the public have not fully benefited from NASA-developed technologies. For example:

- Algorithms designed to enable an aircraft to fly precisely through the same airspace on multiple flights – a development that could have commercial application for improving the autopilot function of older aircraft – was not considered for technology transfer because project personnel were not aware of the various types of innovations that could be candidates for the program.[12]

- Project personnel failed to capitalize fully on a unique NASA facility used for aeronautic testing services, the Flight Loads Laboratory at Dryden, and had to turn down commercial requests, because they did not recognize the facility as a transferable technology and consequently had not developed a Commercialization Plan to manage growing customer demand.

- Project personnel did not form partnerships with industry end-users who are a potential source of funding because they did not realize that transfer and commercialization planning could lead to such partnerships. As a result, managers of a precision landing and hazard avoidance project failed to seek commercial partnerships that could have provided additional funding to help the project mature.

NASA Personnel Lack Awareness of the Agency's Technology Transfer Policy Requirements. NASA's technology transfer policy, NPR 7500.1, states that early assessment and planning is crucial for creating commercial partnerships. Accordingly, the policy requires project personnel to develop a Commercialization Plan during a project's formulation phase.[13] However, we interviewed 38 personnel (15 IPO officials, 2 Center Chief Technologists, 21 project managers) from 4 Centers, and found that none of them had ever developed or assisted with the development of a Commercialization Plan. Moreover, none of these individuals was familiar with the NASA policy governing

[12] An algorithm is a step-by-step procedure that is used in mathematics and computer science. Algorithms use a defined number of steps for calculations, data processing, and automated reasoning.

[13] NASA policy notes that program and project life cycles have two phases: formulation and implementation. NASA defines formulation as the identification of how the program or project supports the Agency's strategic needs, goals, and objectives; the assessment of feasibility, technology, concepts; risk assessment and acquisition strategies; and the preparation of plans, budgets, and schedules essential to the success of a program or project.

technology transfer and commercialization. The Chief Technologist at NASA Headquarters, who is responsible for developing and overseeing the implementation of NASA's technology commercialization policy, conceded that working knowledge of NPR 7500.1 among NASA personnel might be lacking.[14]

The NPR also directs the Center IPOs to assist project managers with developing Commercialization Plans. Developing such a plan is an important step for project managers because it:

- provides managers with a methodology for identifying potential commercial partners;
- allows managers to monitor and mature plans throughout the project's life cycle with targeted end-users in mind;
- allows NASA technological assets to reach the commercial sector at an accelerated pace;
- integrates the project's technical knowledge with the marketing expertise of the IPO;
- expands the opportunity for creating working and funding partnerships with industry for technology development and identification of end-users for the technology; and
- facilitates the formation of partnerships with commercial entities that may be able to contribute additional funding, staffing, and expertise to help sustain project development during periods of reduced Federal funding.

However, none of the 21 projects we reviewed had developed a Commercialization Plan. We believe this occurred, in part, because the program and project management policies managers use throughout a project's acquisition life cycle contain minimal references to technology transfer and commercialization. Specifically, NPR 7120.5D and NPR 7120.8 do not emphasize the importance of the Commercialization Plan and only require managers to describe their plan for technology transfer as a subpart of the program and project plan.[15] Other contributing factors are that the Agency had not allocated resources specifically for the planning, development, and implementation of Commercialization Plans and had not trained project managers concerning the technology commercialization

[14] The Chief Technologist we interviewed has since left NASA and a new Chief Technologist was appointed after our fieldwork was completed.

[15] NASA's Chief Engineer is responsible for NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007, and NPR 7120.8, "NASA Research and Technology Program and Project Management Requirements," February 5, 2008. NASA Memorandum 7120-81, "NASA Space Flight Program and Project Management Requirements," was issued on September 22, 2009, as an interim directive while NPR 7120.5D was being revised. Requirements of NPR 7120.5D discussed in this report were retained in the interim directive.

process. Furthermore, the Presidential Memorandum's addition of requirements to develop plans and establish performance goals to improve the Agency's technology transfer and commercialization process will further strain the available resources dedicated to NASA's technology transfer efforts.

Technological Assets Are Not Consistently Identified or Fully Understood. NASA policy defines a technological asset to include technologies, innovations, facilities, and expertise. However, NASA personnel we interviewed – including IPO representatives and Center Chief Technologists – were not aware of or did not have a clear understanding of the range of technologies that qualify as technological assets. Project managers focused primarily on hardware items such as lightweight fiber-optic sensors used for in-flight stress monitoring of aircraft structures, while overlooking other types of assets such as algorithms, software, and facilities. These oversights resulted in missed opportunities for a wider range of technology to be transferred and commercialized.

Innovators Lack Awareness of New Technology Reporting Process. We randomly selected 36 NTRs out of the 2,034 submitted to NTTS over the past 3 years and interviewed the innovator responsible for developing the technology described in each NTR. We found that none of the innovators had a clear understanding of the New Technology Reporting process.[16] Specifically, innovators did not understand at what point in the process they should file NTRs, what is considered reportable technology, and what to expect after an NTR is submitted. In addition, we found that none of the innovators had received training on the NTR process.

We concluded that a lack of training and understanding of the value of filing an NTR may have resulted in the underreporting of new technologies. For example, one of the innovators stated that he was discouraged from filing additional NTRs because he did not understand the process. Another innovator stated that he only filed an NTR because it was a contractual requirement. Consequently, NASA likely is not maximizing the full potential of its research and development efforts and losing the potential benefit of royalty income generated from patented technology.

New Technology Reports Are Inaccessible. As previously discussed, IPO personnel and NASA Patent Counsel review NTRs to determine whether technology should be considered for patenting, publication in NASA Tech Briefs, or other public release. If NASA decides not to pursue any of these options, the NTR remains in NTTS, which is restricted and thus largely inaccessible to other NASA personnel. We found that of the 12,644 NTRs submitted by civil service and contractor personnel from FY 2004 through FY 2011, 6,396 (50 percent) are categorized as inactive and therefore are not easily accessible. Although IPO personnel stated that inactive NTRs might eventually result in Tech Briefs articles or software releases, they could not articulate for us the difference between inactive NTRs that are eventually published or released and those that are not.

[16] Eight of the NTRs we selected had been submitted by someone other than the innovator, sometimes without the innovator's knowledge.

Although NASA officials decided not to pursue patents for or make the information in these NTRs publicly available, they may still contain information that could benefit other innovators and project managers. For example, researchers filed an NTR in February 2010 for a solar thermoelectric power system designed to provide recyclable, non-toxic, on-demand solar energy that costs less than solar panels currently in use and works during off-peak hours without the use of storage batteries. NASA did not pursue a patent on this technology because the system was not fully developed or tested. Although this technology is not mature and may not have commercial potential in its present state, the NTR may contain valuable information that could encourage further technology development. Maintaining this information in a restricted database hinders NASA's ability to build on the information in these reports.

Management Action

NASA can improve its technology transfer and commercialization efforts and better advance its strategic goals by ensuring that project managers, IPO personnel, and innovators are more aware of the Agency's requirements regarding technology transfer. We recommended that the Chief Technologist implement procedures to ensure that project managers and IPO personnel are held accountable to the requirements detailed in NPR 7500.1 to conduct a commercial assessment of technologies and prepare Commercialization Plans. In addition, the Chief Technologist should provide periodic training to NASA personnel regarding the technology transfer process, including the types of assets that qualify and the specifics of the NTR process. Further, to help ensure that program and project managers can properly implement technology transfer requirements and meet the intent of the October 2011 Presidential Memorandum, we recommend that the Chief Technologist reassess the allocation of resources for technology transfer. In addition, the Chief Technologist should coordinate with the Chief Engineer to incorporate appropriate language in NPR 7120.5 and NPR 7120.8 that emphasizes the importance of developing Commercialization Plans. Lastly, the Chief Technologist should coordinate with the General Counsel to ensure that Center IPOs and Patent Counsel review all NTRs and make them accessible to NASA project managers and innovators as appropriate.

In response to a draft of this report, the Chief Technologist concurred or partially concurred with all of our recommendations, stating that his office is committed to improving the Agency's ability to identify, capture, and transfer technology. Specifically, the Chief Technologist stated that his office has begun reviewing and revising NPR 7500.1 to ensure that the Agency's commercialization policy reflects the best practices for Federal technology transfer and will ensure that any revisions are included in other Agency acquisition planning and program management policies and processes. The Chief Technologist also stated that his office will incorporate training requirements in the updated NPR 7500.1; develop training materials and provide periodic training to project managers, IPO personnel, and innovators; conduct a "zero base" review of personnel and the funding requirements needed to implement the updated

technology transfer and commercialization requirements; and work with the Office of General Counsel to develop strategies for modifying NTTS to allow for the segregation of restricted information and provide greater access to information on reported, but unpatented technologies.

Lastly, in response to our recommendation to revise NPR 7120.5 and NPR 7120.8 to emphasize the importance of developing Commercialization Plans, the Chief Technologist proposed to work with the Chief Engineer to include appropriate language in the program and project management handbook that accompanies NPR 7120.5 to provide context and guidance for the development of Technology Commercialization Plans. We consider the Chief Technologist's proposed actions to be responsive to our recommendations; therefore, the recommendations are resolved and will be closed upon completion and verification of these actions. Management's full response to the draft report is reprinted in Appendix B.

CONTENTS

INTRODUCTION

Background _____ 1
Objectives _____ 5

RESULTS

NASA Personnel Lack Awareness of the Agency's Technology Transfer and Commercialization Requirements _____ 6

NASA Needs to Improve Its New Technology Reporting and Dissemination Process _____ 12

APPENDIX A

Scope and Methodology _____ 21
Review of Internal Controls _____ 22
Prior Coverage _____ 22

APPENDIX B

Management Comments _____ 23

APPENDIX C

Report Distribution _____ 28

INTRODUCTION

Background

NASA is the Nation's leading Government organization for spaceflight and aeronautical research projects.[17] The National Aeronautics and Space Act of 1958 charges NASA with preserving the role of the United States as a leader in spaceflight, aeronautical science, and technology and directs the Agency to provide for "the widest practicable and appropriate dissemination of information . . ." resulting from its activities.

Since 1980, Federal lawmakers have legislated and expressed continued support for the transfer of technology resulting from federally funded research and development efforts. For example, the Stevenson-Wydler Technology Innovation Act of 1980 requires that the Federal Government ensure the full use of the results of the Nation's Federal investment in research and development. The Act also requires each Federal laboratory to establish an Office of Research and Technology Applications and the laboratory director to ensure that efforts to transfer technology are included in laboratory job descriptions, employee promotion policies, and evaluation of the job performance of scientists and engineers. The Federal Technology Transfer Act of 1986 amended the Stevenson-Wydler Act and allowed Government-owned and Government-operated laboratories to enter into cooperative research and development agreements with universities and the private sector.

More recently, on October 28, 2011, the President issued a memorandum that requires all Federal agencies to develop plans that establish performance goals to improve the timeliness and increase the number of effective technology transfer and commercialization activities in partnership with non-Federal entities, including private firms, research organizations, and non-profit entities.[18] The memorandum directs that the agencies' plans cover the 5-year period from 2013 through 2017.

Technology Transfer from NASA's Research and Development Projects

Technology transfer promotes commercial activity, encourages economic growth, stimulates innovation in business and commerce, and offers environmental and social benefits to the public and industry.[19] Since 1976, more than 1,750 technology transfer

[17] Projects, as defined in this audit, include spaceflight and aeronautic research and development projects and activities, technology demonstration projects and activities, and non–research and development projects and activities in engineering and science (life science and non–life science disciplines).

[18] Presidential Memorandum, "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses," October 28, 2011.

[19] For the purpose of this report, "technology transfer" refers to technology transfer and commercialization and NASA's efforts to transfer new technology developed in its projects to other government entities and the private sector.

successes have been documented in NASA's *Spinoff Magazine*, including commercial applications in health and medicine, transportation, public safety, consumer goods, agriculture, environmental resources, computer technology, manufacturing, and energy conversion and use.[20] In just one example, aerodynamics aircraft research conducted at Dryden Flight Research Center led to a method to decrease the "box-shaped" aerodynamic drag of trucks by 40 percent, thereby increasing fuel efficiency. Truck manufacturers that have incorporated these design improvements are realizing 15 to 25 percent more fuel efficiency at highway speeds.[21] Demonstrating the commercial value of NASA's technologies can also lead to greater support from Congress and the public for Agency programs and projects. In addition, individuals who identify new technologies can benefit by gaining personal recognition, monetary awards, and patents.

Oversight Responsibility

NASA's Office of the Chief Technologist is responsible for managing, promoting, coordinating, and tracking all technology investments across the Agency. The Office serves as the point of entry and contact with other government agencies, academia, and the commercial aerospace community.

The Chief Technologist is responsible for managing the Space Technology Program, developing and executing innovative technology partnerships, technology transfer, and commercialization. The Space Technology Program comprises four subprograms that support the transfer of technology into and out of the Agency:

- The Small Business Innovation Research and the Small Business Technology Transfer Programs stimulate technological innovation and increase participation by small and disadvantaged businesses in federally funded research and development programs.

- The Crosscutting Space Technology Development Program focuses on maturing flight readiness capabilities that advance future space missions such as the Edison Small Satellite Demonstration Missions that are designed to improve or create new small spacecraft capabilities for advanced satellite communication.

- The Exploration Technology Development Program seeks to advance development of new technologies to enable human missions beyond low Earth orbit.

- The Partnership Development and Strategic Integration Program provides funding for the transfer and commercialization of NASA-developed technologies,

[20] *Spinoff Magazine* is NASA's publication that highlights the transfer of NASA technology to the private sector. Available at http://www.sti.nasa.gov/tto/index.html (accessed February 29, 2012).

[21] NASA Aerodynamic Truck Studies. Available at http://www.nasa.gov/centers/dryden/news/FactSheets/FS-100-DFRC.html (accessed February 29, 2012).

interagency technology coordination, and intellectual property management and seeks out partnership opportunities with other government agencies and industry.

NASA's Partnership Development and Strategic Integration Program provides funding for the Innovative Partnerships Office (IPO) to foster innovative technology partnerships and lead technology transfer and commercialization opportunities originating from NASA's programs and projects. The IPO is responsible for engaging NASA Mission Directorates to gain awareness of new and developing NASA technologies and for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management, and partnership opportunities with other government entities and commercial industry.

Each NASA Center also has an IPO and a Chief Technologist responsible for carrying out at the Center level the same goals and responsibilities as their Headquarters counterparts.

The IPOs are responsible for the following programmatic activities:

1. Technology infusion, which provides funding and resources to commercial companies to develop technologies of interest to NASA.

2. Technology transfer, which includes the commercialization, licensing, or other transfer of NASA-owned or -originated technology to state and local governments and the private sector.

3. Intellectual property management, which facilitates the protection of commercially valuable inventions.

4. Implementation of NASA's Prize Authority.[22]

5. Support for NASA's initiative in science, technology, engineering, and mathematics education.

6. Support for NASA's outreach activities by publishing and publicly promoting NASA technology spinoffs.

7. Support for professional development by providing opportunities for training in technology transfer.

8. Support for Agency reporting requirements and maintenance of appropriate metrics on innovative partnership program activities.

[22] The National Aeronautics and Space Act, Sec. 20144 defines Prize Authority as a program to competitively award cash prizes to stimulate innovations.

NASA's Technology Commercialization Policy

NASA's technology transfer and commercialization policy is documented in NASA Procedural Requirements (NPR) 7500.1, "NASA Technology Commercialization Process w/ Change 1 (4/9/04)." The policy requires all NASA project managers to consider possibilities for commercialization during the formulation phase of a project's life cycle and, in coordination with the IPO, develop commercialization strategies and plans.[23] It also requires the reporting of new technologies and inventions, including any invention, discovery, improvement, or innovation that was either conceived or first introduced into practice in the performance of NASA work. Specifically, program and project managers are required to collaborate with the IPO to:

- determine commercial potential and develop a Technology Commercialization Plan (Commercialization Plan);
- develop and report new technologies and innovations in the NASA Technology Transfer System (NTTS);
- develop and implement partnerships; and
- identify and report success stories.

NASA employees and contractors who develop new technologies (innovators) report, document, and identify the potential commercial applications of their work by submitting New Technology Reports (NTRs).[24] New Technology Representatives review NTRs for completeness and enter them into NTTS, the Agency-wide management information tool the IPO uses to administer the NTR process. Once entered into NTTS, the IPO and Patent Counsel review the NTR to determine its technical merit.[25] Based on these assessments, NASA may consider the new technology for patenting or publication in NASA Tech Briefs, a monthly magazine and website that features reports of innovations developed by NASA and its industry partners and contractors.[26] The IPO and Patent Counsel also determine if the information in the NTR should be made available to the public. If the IPO and Patent Counsel take no action, the process ends with the NTR remaining in NTTS categorized as inactive. According to IPO personnel, inactive NTRs may eventually result in Tech Briefs articles or software releases. However, they could

[23] NASA policy notes that program and project life cycles have two phases: formulation and implementation. NASA defines formulation as the identification of how the program or project supports the Agency's strategic needs, goals, and objectives; the assessment of feasibility, technology, concepts; risk assessment and acquisition strategies; and the preparation of plans, budgets, and schedules essential to the success of a program or project.

[24] NTRs may be submitted via NASA's Technology Reporting website (e-NTR) https://ntr.ndc.nasa.gov/ (accessed February 29, 2012) or using NASA form 1679.

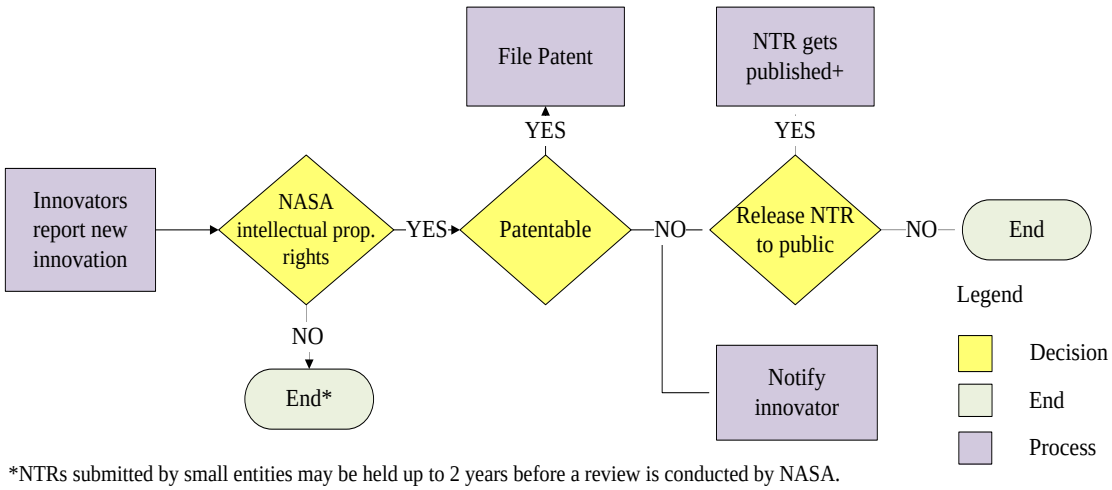
[25] Review of NTRs submitted by small entities (small business firms, colleges, universities, and non-profit organizations) can be delayed for up to 2 years because small entities can elect to retain title to an invention within 2 years of its disclosure.

[26] See NASA Tech Briefs at http://www.techbriefs.com/ (accessed February 29, 2012).

not articulate for us the difference between inactive NTRs that are eventually published or released and those that are not.

Figure 1 illustrates NASA's process for developing and reporting new technologies and innovations.

Figure 1. NASA's NTR Reporting and Tracking Process



*NTRs submitted by small entities may be held up to 2 years before a review is conducted by NASA.
+Publications may include Tech Briefs articles, conferences, or software releases as a way to explore other technology transfer options.

Resources for Technology Transfer

NASA's technology transfer budget has decreased from $60 million in fiscal year (FY) 2004 to $19.2 million in FY 2012. In addition, the number of patent attorneys at the Centers has dropped since FY 2003 from 29 to 19 and the Headquarters IPO staff has decreased from 13 in FY 2010 to just 2 in FY 2012.

Objectives

Because technology transfer is fundamental to NASA's mission and strategic goals, the Office of Inspector General initiated this audit to examine whether NASA is effectively identifying and planning for the transfer of technology developed within its programs and projects to outside entities. We also reviewed internal controls as they relate to the audit topic. The primary audit locations were the Offices of the Chief Technologists at NASA Headquarters, Ames Research Center, Dryden Flight Research Center, Goddard Space Flight Center, and Johnson Space Center. See Appendix A for details of the audit's scope and methodology, our review of internal controls, and a list of prior coverage.

NASA PERSONNEL LACK AWARENESS OF THE AGENCY'S TECHNOLOGY TRANSFER AND COMMERCIALIZATION REQUIREMENTS

NASA's project managers and IPO personnel at the NASA sites we visited could improve their effectiveness in identifying and planning for the transfer and commercialization of technologies developed as part of Agency projects. We found a general lack of awareness of NASA's policy governing technology transfer and commercialization. We also found that project managers did not develop and IPO personnel did not assist with the development of Commercialization Plans. Moreover, project managers we interviewed did not consistently recognize the transfer and commercialization potential of some types of NASA assets. A Commercialization Plan ensures a common understanding among project personnel of transfer and commercialization requirements and represents a documented plan for identifying potential partnerships. Without such plans, NASA may miss opportunities to transfer Agency-developed technologies to other government agencies and private industry.

Technology Commercialization Policy

NPR 7500.1 states that early technology commercialization assessment and planning is essential for creating commercial partnerships and identifies the types of NASA technological assets that may have commercial applications, including technologies, innovations, facilities, and expertise. The policy specifies that during a project's formulation phase, project managers – with direction and assistance from the IPO – are to develop a detailed Commercialization Plan. These plans:

- provide the project manager a methodology for identifying potential commercial partners and working with the IPO;
- allow project management to monitor and mature plans throughout the project's life cycle with targeted end-users in mind;
- permit NASA technological assets to reach the commercial sector at an accelerated pace;
- integrate project technical knowledge with the marketing expertise of the IPO;
- expand the opportunity for creating working and funding partnerships with industry for technology development and identification of end-users for the technology; and

- facilitate the formation of partnerships with commercial entities that may be able to contribute additional funding, staffing, and expertise to help sustain project development during periods of reduced Government funding.

Project Managers Are Unaware of Policy Requirements

We interviewed 38 NASA personnel (15 IPO officials, 2 Center Chief Technologists, and 21 project managers) from Ames, Dryden, Goddard, and Johnson and found that none of them had ever developed or assisted in the development of a Commercialization Plan. Furthermore, project managers we spoke with had not conducted the required commercial assessments of candidate technologies and did not have a working knowledge of NASA's policy governing technology transfer and commercialization. These individuals told us they were unaware that NASA policy required them to take these actions and that their Center's Chief Technologists and IPO staff had not offered assistance in this area. They also reported that they had been allocated no resources for planning, development, and implementation of Commercialization Plans and had not received training on the Commercialization Plan process.

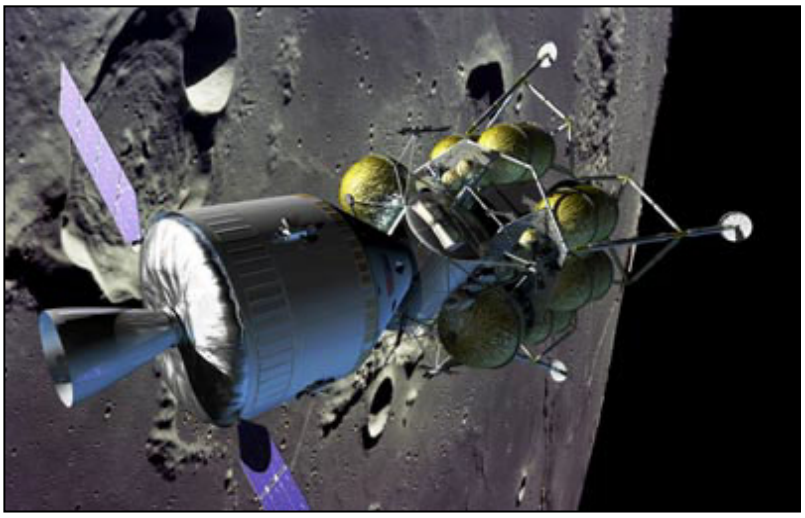
The project managers we interviewed said they were using as management guides NPR 7120.5D for spaceflight projects and NPR 7120.8 for research and technology projects.[27] NPR 7120.5D states that managers should identify options for partnering and commercialization during the project's formulation phase and requires that the project manager describe how the project will access technology requirements and identify opportunities to leverage technology development efforts. The NPR also requires managers to describe how the project's plan meets the requirements of NPR 7500.1 – NASA's technology commercialization policy. Although 7120.5D references NPR 7500.1, none of the project managers we interviewed said they had ever developed a Commercialization Plan.

Similarly, NPR 7120.8 requires that project managers develop a subplan within the overall project plan to identify opportunities for establishing partnerships with private industry, academia, or other governmental organizations. The NPR also establishes a standard funding structure to implement and manage technology transfer activities. However, unlike NPR 7120.5D, NPR 7120.8 does not identify NPR 7500.1 or require project managers to refer to the policy while developing their plans. The absence of an explicit link between NPR 7120.8 and the requirement to create a Commercialization Plan could partially explain the lack of understanding by project managers of this requirement.

[27] NASA's Chief Engineer is responsible for NPR 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007, and for NPR 7120.8, "NASA Research and Technology Program and Project Management Requirements," February 5, 2008. NASA Memorandum 7120-81, "NASA Space Flight Program and Project Management Requirements," was issued on September 22, 2009, as an interim directive while NPR 7120.5D was being revised. Requirements of NPR 7120.5D discussed in this report were retained in the interim directive.

We found several examples of projects that may have missed opportunities to take advantage of outside sources of funding because project managers were not familiar with and did not understand the potential benefits of NASA's technology commercialization process. For example, the project team for a precision landing and hazard avoidance project (see Figure 2) was not aware of NASA's technology commercialization policy and had not conducted a commercial assessment or developed a Commercialization Plan for the project. However, team members provided us with several examples from their work that could be considered new technologies with potential commercial application, such as technology to improve communication between aircraft and air traffic control that could be useful to the aviation community and technology to aid helicopter landings during dust storms, low cloud cover, fog, or other periods of low visibility that could be useful to the military. They also told us that they had sought additional NASA funding to mature these technologies but due to budget constraints had only received enough money to demonstrate that one of the developed technologies works. Project officials said they have struggled to maintain sufficient funding even for this limited work, and the project manager acknowledged that a commercial partner may have been able to address some of these funding shortfalls.

Figure 2. Artist's rendition of Precision Landing Technology for Lunar Surface Descent



Source: Autonomous Landing Hazardous Avoidance Technology Management Overview Presentation, November 9, 2010

NASA Personnel Did Not Fully Understand the Range of Items and Functions that Qualify as Technological Assets

According to NPR 7500.1, a technological asset includes technologies, innovations, facilities, and expertise. However, NASA personnel, including IPO representatives and Center Chief Technologists we interviewed, were not aware or did not have a clear understanding of the range of items and functions that qualify as technological assets. Project managers focused primarily on hardware items such as lightweight fiber-optic sensors used for in-flight stress monitoring of aircraft structures, while overlooking other types of technological assets such as algorithms, software, and facilities, thereby missing opportunities for these types of technologies to be transferred and commercialized.

For example, one project team developed algorithms and software for the Gulfstream III aircraft that allow it to fly a synthetic aperture radar pod precisely through the same airspace on multiple flights (Figure 3).[28,29]

Figure 3. Photo of a NASA Gulfstream III aircraft carrying a synthetic aperture radar pod.

Source: NASA

The software and algorithms have application in future science missions and potential commercial application in helping to modernize the autopilot function on older aircraft and in other aviation research that requires a precision flight path. However, the project team did not consider these algorithms as innovations for commercialization because team members were not aware of the various types of innovations that could be candidates for technology transfer.

In another example, project personnel from Dryden were unaware that a flight test facility used for project testing and development could be considered a technological asset. After discussing the specifics of NPR 7500.1, project personnel recognized that the Flight Loads Laboratory at Dryden (see Figure 4) is a technological asset and a candidate for commercialization.

According to project personnel, they use the Flight Loads Laboratory to fulfill Agency and commercial customer requests to develop technologies and conduct tests such as analyzing the airflow over the wing of an aircraft, which can affect lift, drag, and ultimately fuel efficiency. However, the personnel stated that they do not have an adequate process in place to manage all of the customer requests for testing. The project personnel did not realize that they could have sought assistance from the IPO for the development of a Commercialization Plan that would have helped them devise a strategy for effectively managing the growing number of requests. The lack of resources and effective commercialization planning forced project personnel to turn down several requests from commercial medical and aviation businesses and resulted in multiple missed opportunities for this project to capitalize on this unique NASA facility as a technological asset.

[28] The synthetic aperture radar is capable of penetrating soil and water up to approximately 2 inches below the surface and can detect and measure small changes in the Earth's surface.

[29] An algorithm is a step-by-step procedure that is used in mathematics and computer science. Algorithms use a defined number of steps for calculations, data processing, and automated reasoning.

Figure 4. Project testing of airflow (left photo, black section on left wing of the aircraft) at the NASA Flight Loads Laboratory at Dryden (right photo).

Source: NASA

We recognize that the transfer and commercialization of technology may occur outside of the process defined in NPR 7500.1, for example as with the Robonaut II project, which developed a robot through a commercial partnership between NASA and General Motors. Nevertheless, we believe that NASA is missing opportunities to transfer technology to outside entities because of a lack of understanding of and adherence to Agency policies regarding technology transfer and commercialization.

Recommendations, Management's Response, and Evaluation of Management's Response

To increase awareness of NASA's technology transfer requirements so that the Agency can better plan, promote, and accomplish the transfer and commercialization of technology developed within NASA projects and programs, we made the following recommendations to the Chief Technologist.

Recommendation 1. Develop and implement procedures to ensure that project managers, IPO personnel, and Center Chief Technologists are accountable to the requirements detailed in NPR 7500.1.

Management's Response. The Chief Technologist concurred, stating that his office has started the process of reviewing and revising NPR 7500.1 to ensure that the Agency's commercialization policy reflects the best practices for Federal technology transfer. Furthermore, he stated that his office will work directly with the Office of the Chief Engineer, the Office of Procurement, the Office of General Counsel, the NASA Mission Directorates, and others to ensure appropriate implementation of the updated policy. The Chief Technologist expects to complete the revision of NPR 7500.1 by December 20, 2012.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the corrective actions.

Recommendation 2. Coordinate with the Chief Engineer to:

a. provide specific language in NPR 7120.5 and NPR 7120.8 that emphasizes the importance of Commercialization Plans; and

b. direct and ensure that project managers coordinate with the IPO regarding commercial assessments and development of Commercialization Plans.

Management's Response. The Chief Technologist partially concurred with our recommendation and proposed to work with the Chief Engineer to develop a section for the program and project management handbook that accompanies NPR 7120.5 to provide context and guidance for the development of Technology Commercialization Plans. The Chief Technologist expects to complete this action by December 20, 2012.

Evaluation of Management's Response. The Chief Technologist's proposed action meets the intent of our recommendation; therefore, the recommendation is resolved and will be closed upon completion and verification of the proposed corrective action.

Recommendation 3. Provide periodic training to project managers, IPO personnel, and Center Chief Technologists commensurate with the employee's position, discipline, and level of authority regarding NASA's technology transfer and commercialization policies and requirements, including instruction on the range of items, processes, and functions that qualify as technological assets.

Management's Response. The Chief Technologist concurred, stating that his office will work with the Office of the Chief Engineer and the NASA Office of Human Resources to develop training materials for periodic training to project managers, IPO personnel, and Center Chief Technologists by February 1, 2013.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the corrective actions.

NASA NEEDS TO IMPROVE ITS NEW TECHNOLOGY REPORTING AND DISSEMINATION PROCESS

We interviewed 36 innovators and found that none had a good understanding of NASA's New Technology Reporting process.[30] Specifically, the innovators did not have a clear understanding of what qualifies as reportable new technology, at what point in the development process they should file New Technology Reports (NTRs), or what to expect after they submit an NTR. Moreover, they had not received training on the New Technology Reporting process. Taken together, these deficiencies result in less reporting of new technologies and missed opportunities for transfer and commercialization of NASA innovations.

In addition, NASA is not fully utilizing the NTRs that innovators submit. Fifty percent of all NTRs filed from FY 2004 through FY 2011 are stored in a database that is not accessible to most NASA and contract personnel. A reduction of funding and personnel has hindered the ability of Patent Counsel to timely review and disposition NTRs. As a result, there has been a marked decrease in the number of patents and NASA and contract personnel cannot easily share this information or benefit from the technology development efforts of others.

Personnel Lack Awareness of the New Technology Reporting Process

NASA's goal for new technology is to provide the widest practicable and appropriate dissemination to assure early utilization, expeditious development, and continued availability of NASA-developed technology for the benefit of the U.S. scientific, industrial, and commercial communities and the public.[31] Many commercially valuable technological advances have resulted from innovations developed as a result of NASA projects and programs, such as fiber optics for real-time monitoring of aircraft structural strain during flight and software programs for monitoring shipments of hazardous or otherwise sensitive materials.

Another benefit of promoting new technologies is that NASA and the employee may receive royalties or other payments from licensing of patented technologies. NASA distributes a percentage of royalties it receives to the innovator responsible for developing the new technology. The balance remaining is available to the Agency.

[30] While NASA innovators are predominately researchers, engineers, or designers, they can be anyone who creates a new technology as part of their NASA work.

[31] National Aeronautics and Space Act of 1958, Pub. L. 85-568, 72 Stat. 426 (1958).

NASA must be able to identify and monitor technologies and assert intellectual property rights when appropriate. Therefore, NASA policy states that each employee who makes an invention is required to submit a disclosure of such invention.[32] Similarly, contractors are required to make timely disclosures and identify all new technologies and innovations to NASA if their funding agreements contain new technology or patent rights clauses.[33] New technologies and innovations can be reported by filing either the web-based version (NASA e-NTR) or the paper version of NASA Form 1679. Contractors may also use their company's invention disclosure form.

NASA's New Technology Reporting process can be divided into three steps:

1. Innovators complete and submit an NTR (or similar form);
2. New Technology Representative reviews the NTR for completeness; and
3. New Technology Representative enters the NTR into the NASA Technology Transfer System (NTTS) database.

NTRs are important legal documents because they protect the Government's intellectual property rights associated with the technology. Accordingly, an NTR should contain sufficient technical detail to convey a clear understanding of the nature, purpose, operation, and physical, chemical, biological, or electrical characteristics of the invention or innovation. NTRs can result in new patents, software releases, or publication in a technical journal.

We randomly selected 36 NTRs submitted to NTTS since FY 2009 and interviewed the innovators who created the technologies described in them.[34] Of the 36 innovators we interviewed, none had a firm understanding of the New Technology Reporting process. Specifically, the innovators did not have a clear sense of what constituted reportable new technologies, when they should disclose new technologies, or what to expect after submitting an NTR. In addition, none had received training from NASA on the New Technology Reporting process. Table 1 summarizes the results of our interviews.

[32] NASA Policy Directive 2091.1B, "Inventions Made By Government Employees," April 21, 2008.

[33] Contractors are required to submit NTRs within 2 months of the innovator disclosing a new technology, interim reports every 12 months, and a final report prior to contract closeout that documents all new technologies or certifies that none were created.

[34] Eight of these NTRs had been submitted by someone other than the innovator, in some cases without the innovator's knowledge.

Table 1. Results of Innovator Interviews					
Center	**Number of Innovators Interviewed**	**Received No NTR Training**	**Saw No Value in Filing an NTR**	**Unclear on When to Submit an NTR**	**Received No Response after Submitting an NTR**
Ames	9	9	2	7	6
Dryden	10	10	1	9	3
Goddard	8	8	0	4	4
Johnson	9	9	3	3	2
Total	**36**	**36**	**6**	**23**	**15**

As noted in Table 1, none of the innovators received training in the NTR process, 6 did not see the value of filing an NTR, 23 were not clear when an invention should be disclosed, and 15 received no response after submitting their NTRs. Those innovators expressed concerns over a lack of feedback regarding their submissions. Some likened the NTR process to a "black hole" and stated that once a report is submitted it is "never seen again." One of the innovators said he felt discouraged from filing additional NTRs and another stated that he only filed an NTR because it was a contractual requirement. We concluded from these interviews that innovators are less likely to file NTRs if they do not understand the value of the NTR process.

Lack of training and understanding of the value of filing an NTR may result in some new technologies not being reported. Consequently, the Agency may not be maximizing the full potential of its research and development efforts related to transferring technology. Furthermore, the Agency and innovators may be losing royalty income from licensing patents from NASA-funded inventions.

New Technology Reports Are Inaccessible

Of the 12,644 NTRs submitted by civil service and contractor personnel from FY 2004 through FY 2011, 6,396 NTRs (50 percent) are categorized as inactive and currently reside in a repository in NTTS. According to IPO personnel, inactive NTRs may eventually result in Tech Briefs articles or software releases. However, they could not articulate for us the difference between inactive NTRs that were published or released and those that were not. Based on summary data for all NTRs submitted since 1959, 15,092 out of the 52,393 NTRs submitted (29 percent) did not result in patents, Tech Briefs articles, or software and technology releases in NASA TechFinder.[35] These NTRs remain in NTTS, and only IPO personnel and Patent Counsel have access to them.

[35] NASA TechFinder is a website (http://technology.nasa.gov/) that enables the public to search for information on technology and licensing opportunities of NASA technologies (accessed February 29, 2012).

However, these NTRs could still contain information beneficial to other program and project managers and innovators.

The NTR provides the IPO and Patent Counsel an opportunity to determine the appropriate owner(s) of the reported technology and determine whether it is necessary to protect it as NASA intellectual property. What qualifies as new technologies and innovations is very broad and includes any new and useful processes, machines, manufacture, or compositions of matter. It also includes computer programs, whether or not they are copyrightable. However, based on the commercial and market readiness level, some of the new technologies might not be feasible for patent application. The current practice of NTR review focuses on technologies that have NASA intellectual property rights and potential patentability.

In accordance with 15 U.S.C. § 3710d, Employee Activities, if NASA has determined that the Government has insufficient interest in obtaining patent protection or in otherwise promoting the commercialization of an invention, NASA shall provide the innovator an opportunity to obtain or retain title to the invention. If the innovator decides not to retain ownership, then NASA can make the information in the NTR available to the public, including other NASA and contractor employees. Releasing the information publicly requires both the IPO and Patent Counsel's concurrence. If NASA does not make the information in the NTR available, then it remains largely inaccessible in NTTS.

As shown in Table 2, innovators submitted 1,631 NTRs in FY 2011. During this same period, NASA filed 82 patent applications, 99 patents were issued, and 1,061 NTRs were reviewed and categorized as inactive.[36] Inactive status indicates that the technology did not result in a patent. We are concerned about the relatively high number of inactive NTRs because they may contain valuable information that could be of benefit to other NASA innovators and project managers.

[36] The disparity in yearly totals is due to NTR reviews and patent applications crossing over from year to year.

Table 2. NASA NTR and Patent Filing Summary				
Fiscal Year	NTRs		Patents	
	Submitted	Inactive	Filed	Issued
2004	1,666	602	131	109
2005	1,720	500	135	78
2006	1,739	864	127	73
2007	1,533	762	109	66
2008	1,343	1,171	117	73
2009	1,395	878	115	86
2010	1,617	558	98	87
2011	1,631	1,061	82	99

For example, an NTR was filed in February 2010 for a solar thermoelectric power system for renewable power generation. The technology described a way to generate recyclable, non-toxic, on-demand solar energy that was lower in cost than solar panels currently in use and worked during off-peak hours without the use of batteries. NASA did not pursue a patent on this technology because the system was never fully developed or tested. Although this technology was not mature and may not have commercial potential in its present state, the NTR may still contain valuable information that could encourage further technology development and advancement. At the time of our review, the NTR's status was inactive and it was not available to the public. Retaining this information in an underutilized and largely inaccessible repository hinders NASA's ability to disseminate or utilize information from these reports.

We also found that NASA's process for deciding how to disposition an NTR, which requires coordination between the Center IPOs and Patent Counsel, suffers from a lack of resources. Specifically, the number of patent attorneys has decreased from 29 to 19 over the last 9 years. This reduction hinders Counsel's ability to review and disposition the NTR for public release or filing for patent applications.

In addition, as Table 3 shows, funding for technology transfer has decreased 66 percent from $60 million in FY 2004 to $20.5 million in FY 2011. Funding further decreased to $19.2 million in FY 2012.

Table 3. NASA NTR and Patent Filing Status at the End of Each Fiscal Year and Fiscal Year Technology Transfer Funding Levels

Fiscal Year	Cumulative NTRs under Evaluation	Cumulative NTRs Awaiting/ Preparing Patent Application	Patent Application under Prosecution	Patent Filed	Technology Transfer Funding (million)
2004	585	6	20	131	$60.00
2005	654	6	28	135	$45.30
2006	725	7	41	127	$38.25
2007	844	11	81	109	$26.60
2008	1,017	14	140	117	$38.10
2009	1,493	26	322	115	$23.60
2010	1,504	30	296	98	$20.54
2011	1,878	34	372	82	$20.54

Over the same period, the number of NASA patents filed decreased by 37 percent, from 131 to 82, and the number of NTRs waiting to be evaluated increased 221 percent, from 585 to 1,878. Insufficient resources and inaccessible information in inactive NTRs jeopardizes NASA's ability to meet its technology transfer and commercialization goals and maximize the dissemination and use of technology funded and developed by NASA.

Conclusion

Although NASA has established a New Technology Reporting process to track NASA innovations and inventions, a lack of training and understanding of the value of NTRs may have resulted in new technologies not being reported. In addition, a reduction of resources has resulted in an inability to timely review NTRs, resulting in a large number remaining categorized as inactive and consequently rendering this information largely inaccessible to other NASA personnel. Therefore, the Agency may not be realizing the full potential of its research and development efforts related to transferring and commercializing technology. It is important that innovators know, protect, and exercise their rights relating to inventions, discoveries, improvements, and innovations made in the performance of their Federal work. Ensuring that innovators have a working knowledge of NASA's New Technology Reporting process increases the likelihood that newly developed innovations and inventions will be made available to the public, which could foster commercial use of these technologies.

Recommendations, Management's Response, and Evaluation of Management's Response

For NASA to maximize the potential of its research and development efforts related to transferring technology and meet the requirements of the October 2011 Presidential Memorandum, we made the following recommendations to the Chief Technologist.

Recommendation 4. Reassess the fiscal and personnel resources available for supporting the technology transfer and commercialization process and provide sufficient resources to meet requirements.

Management's Response. The Chief Technologist concurred, stating that his office will conduct a "zero base" review of the personnel and funding requirements needed to implement the updated technology transfer and commercialization requirements and will assess whether fiscal and personnel resources are aligned with and adequate to meet the updated requirements. He expects to complete this action by October 1, 2012.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the corrective actions.

Recommendation 5. Provide periodic training to project managers and innovators about the New Technology Reporting process. The training should cover the value of filing an NTR, the proper time to disclose an NTR, what happens after an NTR is submitted, and the possible outcomes of an NTR.

Management's Response. The Chief Technologist concurred, stating that his office will incorporate training on the New Technology Reporting process into the requirements of an updated NPR 7500.1 and develop training materials by July 1, 2012, with implementation planned across all Centers by October 1, 2012.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the corrective actions.

Recommendation 6. Coordinate with the General Counsel to have the Center IPOs and Patent Counsel expeditiously review all NTRs, including those that do not result in patents or NASA publication articles, so that they can be made easily accessible to NASA employees and contractors as appropriate.

Management's Response. The Chief Technologist concurred, stating that his office will work with the Office of General Counsel to determine whether, within the limitations of current budget constraints, existing legal impediments to the release of such information can be adequately addressed and modifications of NTTS to permit the segregation of restricted information can be accomplished. Collaboratively, they will also strive to improve the accessibility of reported, but unpatented technologies. The Chief

Technologist will include these considerations as part of his overall review of available fiscal and personnel resources as described under Recommendation 4 and expects the action to be completed by July 20, 2012.

Evaluation of Management's Response. Management's proposed actions are responsive; therefore, the recommendation is resolved and will be closed upon completion and verification of the corrective actions.

APPENDIX A

Scope and Methodology

We performed this audit from March 2011 through February 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We performed our fieldwork at NASA Headquarters, Ames Research Center, Dryden Flight Research Center, Goddard Space Flight Center, and Johnson Space Center. We conducted interviews with the NASA Chief Technologist, Headquarters IPO Director, the Centers' Chief Technologists, and Centers' IPO officials to obtain an understanding of the Space Technology Program. We obtained a list of spaceflight and aeronautic research and development projects, technology demonstration projects, and non–research and development projects in engineering and science. We judgmentally selected 21 of the 164 projects based on research areas and project phases. We interviewed project managers to determine if Commercialization Plans had been developed and, if so, were they monitored and updated during the life cycle of the project.

In addition, we obtained access to NTTS and performed a comparative analysis of each Center's New Technology Reporting history. We obtained a list of all NTRs from the past 3 years and randomly selected a sample of 36 NTRs from the 2,034 that had been submitted (using WinSTAT, a statistics "add-in" program in Microsoft Excel) to determine if NASA had provided sufficient oversight and resources to promote and report inventions. We also interviewed the 36 innovators responsible for developing the technologies described in those NTRs.

To accomplish our objective, we also reviewed the following:

- 15 U.S.C. 3701 et seq., Stevenson-Wydler Technology Innovation Act of 1980 (Pub. L. 96-480)
- NASA Policy Directive 2091.1B, "Inventions Made By Government Employees," April 21, 2008
- NASA Policy Directive 7500.2B, "NASA Innovative Partnerships Program," July 17, 2009
- NPR 7120.5D, "NASA Program and Project Management Processes and Requirements," March 6, 2007

- NPR 7120.8, "NASA Research and Technology Program and Project Management Requirements," February 5, 2008

- NPR 7500.1, "NASA Technology Commercialization Process w/ Change 1 (4/9/04)"

Use of Computer-Processed Data. We used data from NTTS to perform this audit. Although we did not test the general or application controls of NTTS, we did compare the information in the key data fields with our sample of NTRs and supporting documents for the data and determined that the data was valid and reliable to support our objectives and conclusions.

Review of Internal Controls

We reviewed internal controls for NASA's identification of and planning for technology transfer and commercialization processes. The control weaknesses we identified are discussed in this report. Our recommendations, if implemented, will correct the identified control weaknesses.

Prior Coverage

During the last 5 years, the Government Accountability Office (GAO) has issued one report of particular relevance to the subject of this report: "Clearer Priorities and Greater Use of Innovative Approaches Could Increase the Effectiveness of Technology Transfer at Department of Energy Laboratories" (GAO-09-548, June 2009). Unrestricted GAO reports can be accessed over the Internet at http://www.gao.gov.

MANAGEMENT COMMENTS

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

FEB 27 2012

Reply to Attn of: Office of the Chief Technologist

TO: Assistant Inspector General for Audits

FROM: Chief Technologist

SUBJECT: Response to OIG Draft, "Audit of NASA's Process for Transferring Technology to the Government and Private Sector" (Assignment No. A-11-017-00)

The Office of the Chief Technologist (OCT) appreciates the opportunity to review the draft audit report entitled "Audit of NASA's Process for Transferring Technology to the Government and Private Sector" (Assignment No. A-11-017-00). As the lead office for NASA's technology transfer policy and implementation, OCT is committed to continuous improvement in NASA's ability to effectively identify, capture, and transfer the results of the Agency's technology investments. In light of the recent realignment of functions performed by the former Innovative Partnerships Program Office within OCT, the OIG's recommendations are timely and will inform OCT's forward planning efforts as it continues its work to update its policies and processes in order to align NASA's technology transfer activities with current Agency technology priorities.

OCT notes that technology transfer and commercialization also occurs throughout the Agency by other mechanisms in addition to those covered in NPR 7500.1. For example, NASA's Aeronautics Research Mission Directorate (ARMD) shares its projects extensively and broadly with the external community through publicly available publications such as Technical Memorandums and Technical Publications. In addition, the ARMD portfolio, focused on research and development activities to address leading national challenges, makes use of Research Transition Teams (RTTs) formed between NASA and the FAA. Cited as a Federal Government "best practice" for technology transfer, these RTTs are extremely effective in transferring NASA technology to another Federal agency. For much of NASA's civil aeronautics-related research, technology transfer through the RTTs is the most appropriate transition path.

Technology transfer and commercialization activities take place across the Agency, span multiple programs and projects, and are implemented through many different mechanisms, and multiple pathways outside of OCT's purview. Such pathways include, but are not limited to partnerships, joint programs, reimbursable Space Act Agreements, presentations at conferences, and publications in technical journals and joint collaborations. In addition, at the

NASA Centers, multiple organizations are involved in technology transfer and technology commercialization: business development organizations; programs and projects; Center management; and the Innovative Partnership Offices (IPO).

Because of the breadth and span of these activities, in addition to implementing the following six recommendations made by the OIG, NASA will initiate an activity to broadly identify and assess Agency-wide technology transfer and commercialization mechanisms and ensure appropriate integration of such activities across the Agency in support of NASA's mission and goals.

In the draft report, the Office of the Inspector General outlines several findings and communicates six recommendations. NASA's response to the recommendations, including planned corrective actions, follows:

Recommendation 1: Develop and implement procedures to ensure that project managers, IPO personnel, and Center Chief Technologists are accountable to the requirements detailed in NPR 7500.1.

Management's Response: OCT concurs that it is imperative for NASA personnel at all levels to be aware of their responsibilities for supporting and implementing Agency policy supporting transfer and commercialization of NASA technologies. OCT notes that funding for NASA's technology transfer and commercialization efforts has been reduced significantly since the initial development of the requirements contained in NPR 7500.1.

NASA's new focus on technology development to support both NASA needs and the economic development of the U.S. aerospace industry has led to increased opportunities for robust technology transfer and commercialization. However, these opportunities must be balanced with the reality of increasingly constrained resources available to support commercialization activities. As a result, OCT has already started the process of reviewing NPR 7500.1 and intends to update the policy to ensure that the Agency's commercialization policy reflects best practices for Federal technology transfer and makes the most efficient use of available fiscal and personnel resources.

An updated NPR 7500.1 and associated processes are anticipated to be available for Agency NODIS review in December 2012. Once these are finalized, OCT will work directly with NASA offices including, but not limited to, the Office of the Chief Engineer (OCE), the Office of Procurement, the Office of General Counsel, and the NASA Mission Directorates to ensure appropriate implementation of the updated policy. Implementation is likely to include updates to related policies and processes (e.g., acquisition planning and program management) and the development of training for NASA program managers and innovators at all levels.

Management Corrective Action Implementation Date: OCT will complete the revision of NPR 7500.1 by December 20, 2012. OCT will work with the relevant NASA offices to ensure that all related policies reflect NPR 7500.1, as revised, and include appropriate language pertaining to commercialization as Agency policies are updated.

Recommendation 2: Coordinate with the Chief Engineer to:

a. Provide specific language in NPR 7120.5 and NPR 7120.8 that emphasizes the importance of Commercialization Plans; and

b. Direct and ensure that project managers coordinate with IPO regarding commercial assessments and development of Commercialization Plans.

Management's Response: Partially concur. NASA fully concurs with the intent of this recommendation to enhance the program and project manager's understanding of the requirement and provide assistance so that suitable actions are taken to facilitate commercialization of technology in concert with Agency strategy and direction. Appropriate flow down to applicable agency policy and requirements will be evaluated as part of the aforementioned assessment of NASA's technology commercialization strategy and the associated update to NPR 7500.1. In an effort to meet the immediate need for better understanding by the program management community, OCE will work with OCT to develop a section for the program and project management handbook accompanying NPR 7120.5 to provide context and guidance for the development of the Technology Commercialization Plan. OCT has already taken action to bridge the coordination between IPO and the project management community. The Deputy Chief Technologist has a seat on the Program Management Council, which affords OCT both an awareness of technologies being developed and an opportunity to ensure connections are made regarding technology transfer opportunities. Additionally, roles and responsibility will be revised, clear lines of authority will be established and coordination between responsible organizations will be improved as a result of NASA's assessment of the technology commercialization process.

Management Corrective Action Implementation Date: OCT will work with OCE to include appropriate language in the program and project management handbook by December 20, 2012.

Recommendation 3: Provide periodic training to project managers, IPO personnel, and Center Chief Technologists commensurate with the employee's position, discipline, and level of authority regarding NASA's technology transfer and commercialization policies and requirements, including instruction on the range of items, processes, and functions that qualify as technological assets.

Management's Response: OCT concurs that training of project managers, technology transfer personnel and Center Chief Technologists is essential to the overall success of NASA's efforts to transfer technology. Ongoing training opportunities will be integral components of the updated policies and processes to be incorporated in NPR 7500.1, as described under Recommendation 1.

Management Corrective Action Implementation Date: OCT will work with OCE and the NASA Office of Human Resources to develop training materials for periodic training to project managers, IPO personnel, and Center Chief Technologists. This action will be complete by February 1, 2013.

Recommendation 4: Reassess the fiscal and personnel resources available for supporting the technology transfer and commercialization process and provide sufficient resources to meet requirements.

Management's Response: OCT agrees that fiscal and personnel resources for supporting technology transfer and commercialization processes Agency-wide must be sufficient to meet technology transfer and commercialization requirements. As part of its review and update of NPR 7500.1, OCT will conduct a "zero base" review of the personnel and funding requirements needed to implement the updated technology transfer and commercialization requirements, and will assess whether fiscal and personnel resources are aligned with and adequate to meet the updated requirements. OCT will present its findings and recommendations to the NASA Administrator prior to initiating the Agency NODIS review of NPR 7500.1. A conceptual model reflecting an initial review of required resources may be completed in time to inform the Agency's FY2014 budget planning process.

Management Corrective Action Implementation Date: OCT will initiate the "zero base review" in March 2012, in order to inform the FY 2014 budget development process. Estimated completion date is October 1, 2012.

Recommendation 5: Provide periodic training to project managers and innovators about the New Technology Reporting (NTR) process. The training should cover the value of filing an NTR, the proper time to disclose an NTR, what happens after an NTR is submitted, and the possible outcomes of an NTR.

Management's Response: NASA concurs and will incorporate training on the NTR process into the requirements of an updated NPR 7500.1 as discussed above.

Management Corrective Action Implementation Date: OCT will develop standardized training materials by July 1, 2012, with implementation planned across all Centers by October 1, 2012.

Recommendation 6: Coordinate with the General Counsel to have the Center IPOs and Patent Counsel expeditiously review all NTRs, including those that do not result in patents or NASA publication articles, so that they can be made easily accessible to NASA employees and contractors as appropriate.

Management's Response: OCT concurs that access to information on reported, but unpatented, technologies would provide benefits to NASA program and projects by permitting them to leverage reported, but unpatented, technologies. OCT will work with the Office of General Counsel to determine whether existing legal impediments to the release of

such information can be adequately addressed to support the recommendation within current budget constraints.

NTRs may be designated "Sensitive But Unclassified" (SBU) information under NID 1600-55 and are subject to Privacy Act protection because they contain Personally Identifiable Information (PII). NTRs also include a narrative of the technology reported and therefore are not stored within a standard taxonomy that would facilitate a search to identify technology developments useful to NASA programs or projects.

Development of NTTS system modifications that would permit the segregation of restricted information such as SBU information and PII is contingent upon available fiscal and personnel resources, as is the development of a system-wide taxonomy that would permit the indexing of reported technology in an accessible manner. OCT will include these considerations as part of its overall review of available fiscal and personnel resources described under Recommendation 4.

Management Corrective Action Implementation Date: OCT will complete this action by July 20, 2012.

Thank you for the opportunity to review and comment on the subject draft audit report. If you have further questions or require additional information on NASA's response, please contact Diana P. Hoyt at 202-358-1893.

Mason A. Peck, Ph.D.

REPORT DISTRIBUTION

National Aeronautics and Space Administration

Administrator
Deputy Administrator
General Counsel
Chief Engineer
Chief Technologist
Manager, Innovation and Strategic Partnerships
NASA Advisory Council's Audit, Finance, and Analysis Committee
Director, Ames Research Center
Director, Dryden Flight Research Center
Director, Goddard Space Flight Center
Director, Johnson Space Center

Non-NASA Organizations and Individuals

Office of Management and Budget
    Deputy Associate Director, Energy and Science Division
        Branch Chief, Science and Space Programs Branch
Government Accountability Office
    Director, NASA Financial Management, Office of Financial Management and Assurance
    Director, NASA Issues, Office of Acquisition and Sourcing Management

Congressional Committees and Subcommittees, Chairman and Ranking Member

Senate Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies
Senate Committee on Commerce, Science, and Transportation
    Subcommittee on Science and Space
Senate Committee on Homeland Security and Governmental Affairs
House Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies
House Committee on Oversight and Government Reform
    Subcommittee on Government Organization, Efficiency, and Financial Management
House Committee on Science, Space, and Technology
    Subcommittee on Investigations and Oversight
    Subcommittee on Space and Aeronautics

Major Contributors to the Report:

Raymond Tolomeo, Director, Science and Aeronautics Research Directorate
Ronald M. Yarbrough, Project Manager
Jiang Yun Lu, Team Lead
Simon Chan, Management Analyst
Noreen Khan-Mayberry, Ph.D., Technical Evaluator

MARCH 1, 2012

REPORT No. IG-12-013

OFFICE OF AUDITS

OFFICE OF INSPECTOR GENERAL

ADDITIONAL COPIES

Visit http://oig.nasa.gov/audits/reports/FY12/ to obtain additional copies of this report, or contact the Assistant Inspector General for Audits at 202-358-1232.

COMMENTS ON THIS REPORT

In order to help us improve the quality of our products, if you wish to comment on the quality or usefulness of this report, please send your comments to Mr. Laurence Hawkins, Audit Operations and Quality Assurance Director, at Laurence.B.Hawkins@nasa.gov or call 202-358-1543.

SUGGESTIONS FOR FUTURE AUDITS

To suggest ideas for or to request future audits, contact the Assistant Inspector General for Audits. Ideas and requests can also be mailed to:

Assistant Inspector General for Audits
NASA Headquarters
Washington, DC 20546-0001

NASA HOTLINE

To report fraud, waste, abuse, or mismanagement, contact the NASA OIG Hotline at 800-424-9183 or 800-535-8134 (TDD). You may also write to the NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, DC 20026, or use http://oig.nasa.gov/hotline.html#form. The identity of each writer and caller can be kept confidential, upon request, to the extent permitted by law.