AUDIT REPORT

Audit of NRC's Oversight of Construction
at New Nuclear Facilities

OIG-09-A-17 September 29, 2009

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
INSPECTOR GENERAL

September 29, 2009

MEMORANDUM TO: R. William Borchardt
Executive Director for Operations

FROM: Stephen D. Dingbaum **/RA/**
Assistant Inspector General for Audits

SUBJECT: AUDIT OF NRC'S OVERSIGHT OF CONSTRUCTION AT NUCLEAR FACILITIES (OIG-09-A-17)

Attached is the Office of the Inspector General's (OIG) audit report titled, *Audit of NRC's Oversight of Construction at Nuclear Facilities.* The report presents the results of the subject audit. Agency comments provided at the September 16, 2009, exit conference and a subsequent meeting September 21, 2009, have been incorporated, as appropriate, into this report.

Please provide information on actions taken or planned on the recommendation within 30 days of the date of this memorandum. Actions taken or planned are subject to OIG followup as stated in Management Directive 6.1.

We appreciate the cooperation extended to us by members of your staff during the audit. If you have any questions or comments about our report, please contact me at 415-5915 or Sherri Miotla, Team Leader, Nuclear Safety Audit Team, at 415-5914.

Attachment: As stated

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EXECUTIVE SUMMARY

BACKGROUND

In recent years, there has been renewed worldwide interest in constructing nuclear facilities. The Nuclear Regulatory Commission (NRC) is responsible for licensing and inspecting construction activities of new civilian-use nuclear reactor and fuel cycle facilities built in the United States. The nuclear industry is responsible for ensuring that the design and construction of these facilities are in accordance with applicable NRC regulations.

During the 1970s and 1980s, NRC and its predecessor, the Atomic Energy Commission, oversaw the industry's construction of the first generation of U.S. nuclear plants. Several of the construction projects experienced significant problems related to design and construction quality resulting in the cancellation of several plants in various stages of construction. Congress, at that time, questioned NRC's ability to provide effective regulatory oversight of the construction activities and directed the agency to study ways to improve quality in the construction of future plants. In response to the congressional directive, NRC issued, in May 1984, NUREG-1055, *Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants: A Report to Congress*. The report concluded that NRC's inspection practices were inadequate and offered several recommendations to improve NRC programs.

In 2006, NRC reorganized in response to the anticipated new reactor licensing and construction inspection workload. The Office of New Reactors (NRO) was created in headquarters with the primary responsibility for developing the Construction Inspection Program (CIP) and its associated program guidance. The CIP was designed to ensure that plants are built in accordance with the approved design and licensing requirements and will operate in compliance with NRC regulations. The agency continues to revise the CIP. In March 2009, NRO issued NRO-REG-112, *New Reactor Construction Experience Program*, to better inform the CIP. NRO-REG-112 provides guidance for a new construction lessons learned process that is informed by domestic and international experiences, past lessons learned, and construction inspection activities.

PURPOSE

The audit objective was to determine if and how NRC is identifying and incorporating lessons learned in its new Construction Inspection Program. Appendix A provides information on the audit scope and methodology.

RESULTS IN BRIEF

NRC's process for identifying construction lessons learned contains some, but not all, of the key elements of a successful program. While NRO-REG-112 lays out the foundation for gathering lessons learned data related to construction, it does not comprehensively contain all the key elements identified as important to the success of an organization's lessons learned program. As such, the lack of well-developed guidance could jeopardize the CIP's goal to prevent recurrences of construction-related problems and may compromise the public's confidence in NRC's ability to effectively oversee new nuclear construction projects.

RECOMMENDATION

This report makes one recommendation to help NRC improve its Construction Inspection Program. The recommendation appears in Section III.

OIG ANALYSIS OF AGENCY COMMENTS

An exit conference was held with NRC senior executives on September 16, 2009. Agency officials generally agreed with the report's finding and recommendation and decided not to provide formal comments. This final report incorporates informal comments provided by the agency, as appropriate.

ABBREVIATIONS AND ACRONYMS

CFR	Code of Federal Regulations
CIP	Construction Inspection Program
NRC	Nuclear Regulatory Commission
NRO	Office of New Reactors
OIG	Office of the Inspector General

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I. BACKGROUND

In recent years, there has been renewed worldwide interest in constructing nuclear facilities. The Nuclear Regulatory Commission (NRC) is responsible for licensing and inspecting construction activities of new civilian-use nuclear reactor and fuel cycle facilities built in the United States. The nuclear industry is responsible for ensuring that the design and construction of these facilities are in accordance with applicable NRC regulations.

Early Construction Issues

During the 1970s and 1980s, NRC and its predecessor, the Atomic Energy Commission, oversaw the industry's construction of the first generation of U.S. nuclear plants. Several of the construction projects experienced significant problems related to design and construction quality resulting in the cancellation of several plants in various stages of construction. For example, construction at the proposed Marble Hill plant in Indiana was stopped due to quality problems relating to concrete and piping installation. Additionally, construction at the proposed Zimmer plant in Ohio was halted due to quality issues caused by lack of management experience and an undersized staff. Neither plant was ever licensed to generate nuclear power.

Congress, at that time, questioned NRC's ability to provide effective regulatory oversight of the construction activities and directed the agency to study ways to improve quality in the construction of future plants. The study was to focus on the causes of the major quality-related construction problems and the untimely detection and correction of those problems.

In response to the congressional directive, NRC issued, in May 1984, NUREG-1055, *Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants: A Report to Congress*. The report concluded that NRC's inspection practices were inadequate and offered several recommendations to improve NRC programs.

NRC's Construction Inspection Program

The Construction Inspection Program (CIP) was designed to ensure that plants are built in accordance with the approved design and licensing requirements and will operate in compliance with NRC regulations. The agency continues to revise the CIP. For example, the agency incorporated some modifications suggested in its report to Congress, NUREG-1055, to improve NRC's construction oversight. Further, the CIP carries out its mandate by ensuring that licensees and applicants construct the facilities according to approved design criteria, using appropriate practices and quality materials. Also, the CIP includes the

construction inspection manual chapters and inspection procedures that support NRC's licensing process. Through the CIP, NRC staff will coordinate inspections with licensee construction schedules.

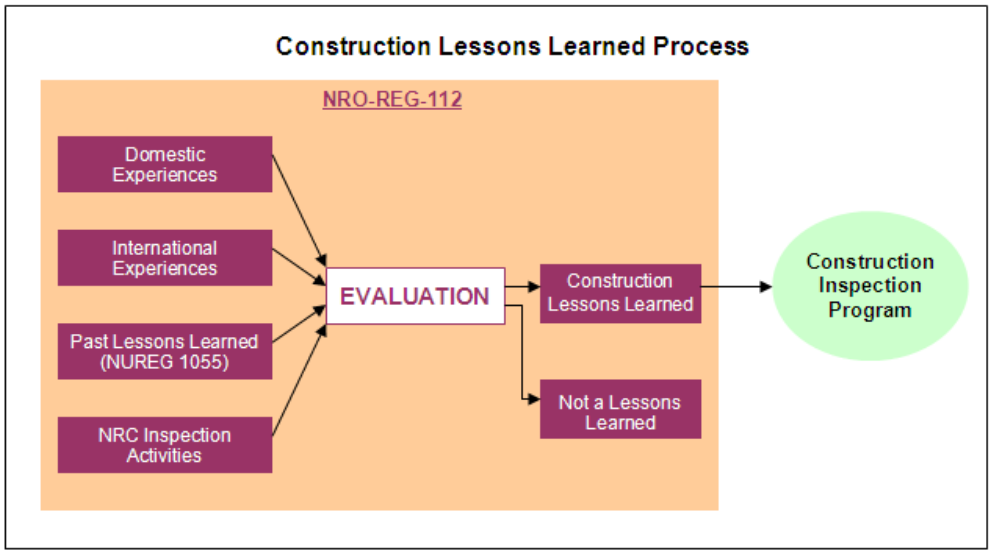
The CIP has four phases. The first phase supports a licensing decision for an early site permit, the second phase supports issuance of a combined license, and the third and fourth phases support construction activities and preparation for operations.

In 2006, NRC reorganized in response to the anticipated new reactor licensing and construction inspection workload. The Office of New Reactors (NRO) was created in headquarters with the primary responsibility for developing the CIP and its associated program guidance. To consolidate construction inspection oversight of new nuclear facilities, a Center for Construction Inspection was created in Region II, Atlanta, Georgia. Region II inspectors have the primary responsibility for implementing the CIP.

NRC's Construction Lessons Learned Process

In March 2009, NRO issued NRO-REG-112, *New Reactor Construction Experience Program*, to better inform the CIP. NRO-REG-112 provides guidance for a new construction lessons learned process that is informed by domestic and international experiences, past lessons learned, and construction inspection activities. More specifically, the NRO-REG-112 process will be used to evaluate experiences and events to determine if they rise to the level of lessons learned. These lessons learned will be used to inform and revise the CIP as necessary, as seen in Figure 1.

Figure 1. Construction Lessons Learned Process



Source: OIG analysis

Status of New Reactor Activities

For fiscal year 2009, the agency budgeted $243.5 million, including 819 full-time equivalent staff for new reactor activities to include the CIP. These staff members provide varying amounts of support to the CIP on an ongoing basis.

N1RC expects all applications for new nuclear power plants to comply with the requirements of Title 10, *Code of Federal Regulations* (10 CFR) Part 52, which implements a one-step combined construction and operating license process.[1] Upon receiving NRC approval, applicants receive a combined license that consists of a construction permit and a conditional operating license for the new reactor. As of July 2009, NRC was actively reviewing 17 combined operating license applications for new nuclear power plants, and the agency anticipates the submission of another 5 combined operating license applications by fiscal year 2011. Figure 2 indicates the projected locations of new plants across the United States. To date, NRC has approved:

- Three early site permits,[2] with a fourth under review.
- Four standard design certifications,[3] with four more under review.
- One limited work authorization.[4]

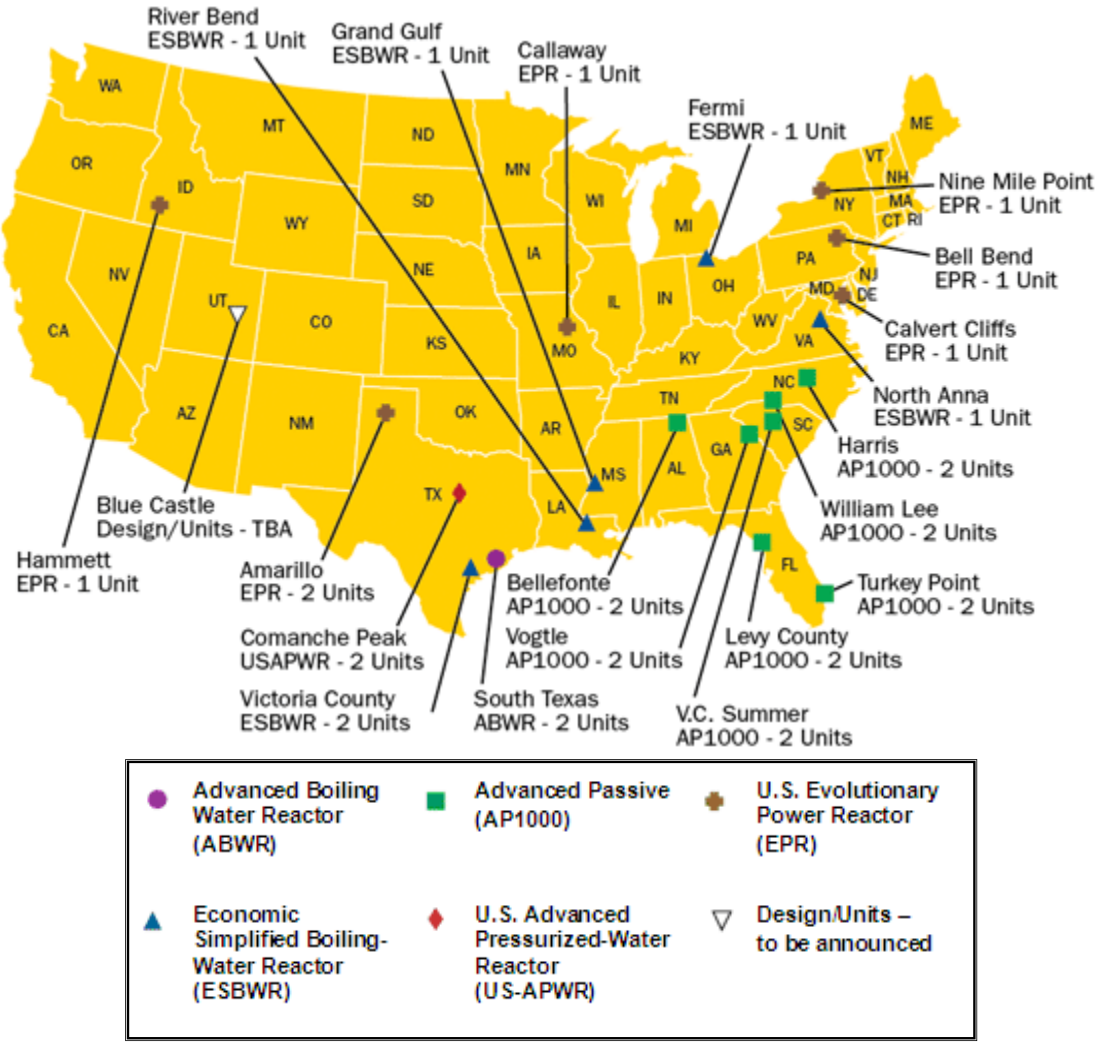
[1] 10 CFR Part 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants.* The 104 currently operating plants were licensed and built under the two-step process in 10 CFR Part 50, where applicants were required to apply for the construction permit and operating license separately.

[2] An early site permit is a Commission-approved partial construction permit issued under subpart A of Part 52, for a site or sites for one or more nuclear power facilities.

[3] Design certification is achieved through NRC's rulemaking process subsequent to staff's review and approval of a standardized nuclear power plant design, independent of a site-specific application to construct or operate a plant.

[4] A limited work authorization specifies the activities that the holder is authorized to perform, all at the applicant's own risk as the issuance of the limited work authorization has no bearing on receiving a combined license.

Figure 2. Location of Projected New Nuclear Power Plants



Source: Information depicted based on NRC public Web site as of July 9, 2009.

II. PURPOSE

The audit objective was to determine if and how NRC is identifying and incorporating lessons learned in its new Construction Inspection Program. Appendix A provides information on the audit scope and methodology.

III. FINDING

NRC's CIP Needs Enhancements to Achieve its Full Potential

NRC's process for identifying construction lessons learned contains some, but not all, of the key elements of a successful program. While NRO-REG-112 lays out the foundation for gathering lessons learned data related to construction, it does not comprehensively contain all the key elements identified as important to the success of an organization's lessons learned program. As such, the lack of well-developed guidance could jeopardize the CIP's goal to prevent recurrences of construction-related problems and may compromise the public's confidence in NRC's ability to effectively oversee new nuclear construction projects.

Key Elements for Successful Lessons Learned Programs

A comprehensive process for capturing lessons learned, which includes elements with clearly defined criteria, is vital to an organization's success. The Construction Industry Institute is a consortium of more than 100 firms from both the public and private arenas joined together to measurably improve the construction industry. Through research and development of best practices, the Construction Industry Institute published a study[5] that identifies key process elements for successful lessons learned programs.

- Leadership: Upper management needs to strongly support the process and encourage the use of lessons learned information.

- Definition: Organizations with well-established processes for capturing lessons learned have defined the term "lessons learned." The Construction Industry Institute defines lessons learned as "knowledge gained from experience, successful or otherwise, for the purpose of improving future performance."

- Collection, Analysis, and Implementation: Organizations should have a well-defined work process for submitting or collecting potential lessons learned issues and those issues should be screened and analyzed by qualified personnel. Organizations should incorporate any resulting lessons learned into work processes, procedures, or policies and then effectively communicate lessons learned information to the staff.

[5]Construction Industry Institute: Research Summary 230-1, *Effective Management Practices and Technologies for Lessons Learned Programs*, dated May 2007; Implementation Resource 230-2, *Implementation of Lessons Learned Programs,* dated July 2007; and Research Report 230-11, *An Analysis of Lessons Learned Programs in the Construction Industry,* dated November 2007.

- Resources: Organizations should provide the resources and information technology infrastructure needed to capture, analyze, and share lessons learned with staff and other stakeholders.

- Maintenance and Improvement: Organizations should have a mechanism for soliciting feedback from stakeholders on how to improve their lessons learned processes.

- Culture: An organization's culture should include a lessons learned process that is an integral part of day-to-day activities for all staff.

NRC's Construction Lessons Learned Process Lacks Key Elements

NRC's process for identifying construction lessons learned contains some, but not all, of the key elements of a successful program. NRC's leadership has publicly stated its commitment to the importance of lessons learned. The agency has also incorporated guidance for maintaining and improving its lessons learned process. However, the agency falls short in formally identifying a lessons learned definition, collection and implementation procedures, as well as appropriate resources. NRC's culture regarding its construction lessons learned process also tends to be informal.

- Leadership: The NRC Commission and other senior managers consistently emphasize the importance of understanding past and current construction lessons learned as critical to the success of new reactor construction efforts. For example, a Commission member noted that the agency needs to make sure all staff continue to "understand the mistakes of the past." Another Commission member stated that numerous historical lessons provide important insights related to quality and oversight issues during the previous period of construction. According to senior NRC managers, understanding NRC's past events is the key to avoiding future problems with new construction. And, if the agency is not proactive in capturing lessons learned, it will "not keep the memory of past events or learn from them."

- Definition: NRC does not have an official definition for lessons learned. Agency managers and staff presume that the definition is commonly understood. Yet, they all have different understandings and expectations for what lessons learned might include. Most believe that lessons learned are negative events and, therefore, they overlook the possibility of including a positive event as a lessons learned. For example, several inspectors said that they consider lessons learned to be limited to learning from past mistakes to prevent future problems,

although a senior manager stated that lessons learned are a combination of learning from past problems as well as using good management practices.

- Collection, Analysis, and Implementation: Regarding collection, NRC lacks the formal criteria to help staff identify which issues must be brought forward to management for consideration as potential construction lessons learned.

  Regarding analysis, NRC analyzes potential construction lessons learned through screening meetings that are described in NRO-REG-112.

  Regarding implementation, NRC does not have a procedure that documents how a lesson learned is implemented through the CIP.

- Resources: NRC does not identify the level of expertise required for staff involvement in the construction lessons learned evaluation process. Staff members, ranging in experience from interns to branch chiefs, participate in daily screening meetings and make decisions on whether or not to move issues forward for consideration as potential lessons learned. According to an agency manager involved in these daily screening meetings, attendance is based more on staff availability than expertise.

  OIG interviewed staff at several Federal and private entities who acknowledged that well-developed lessons learned programs are essential to their organization's success. As shown in Table 1, the lessons learned programs in these organizations reflect the key elements identified by the Construction Industry Institute related to the definition, collection and implementation of lessons learned information and available resources. For example, most of the organizations contacted have a formal definition of lessons learned and specific expectations regarding the level of experience or training for the staff involved in evaluating potential lessons learned issues.

Table 1. Examples of Federal and Private Entity Lessons Learned Program Elements

Agency/ Organization	Definition	Collection	Implementation	Resources
NRC (CIP/NRO-REG-112)	No	Access for entering issues into the process is limited.	Some lessons learned are incorporated into program guidance. However, information sharing occurs in an ad hoc fashion.	NRC screens potential lessons learned. No specified qualifications required for screeners.
FEDERAL AGENCY A	Yes	Any employee can enter any issue directly into the lessons learned process for consideration.	Staff can directly access the lessons learned database and issues are shared on a real-time basis so that offices can revise their programs.	Lead office experts screen and evaluate potential lessons learned material.
FEDERAL AGENCY B	Yes	Any employee can enter any issue directly into the lessons learned process for consideration.	Staff can directly access the lessons learned database. The agency routinely publishes individual documents with in-depth analyses of significant lessons learned.	Issues entered into the process are screened by subject matter technical experts.
PRIVATE ENTITY A	Yes	Any employee can enter any issue directly into the lessons learned process for consideration.	Staff can directly access the lessons learned database. Institutionalized lessons learned are incorporated in program guidance; other issues are retained for trending purposes.	Issues entered into the process are screened by senior managers and technical experts.
PRIVATE ENTITY B	No	Any employee can enter any issue directly into the lessons learned process for consideration.	Staff and external stakeholders can directly access the lessons learned database. Significant lessons learned are promptly communicated to the nuclear industry to allow changes to program guidance.	Issues are subject to a double-layer screening process, both performed by senior, experienced staff.

Source: OIG analysis

- Maintenance and Improvement: According to NRO-REG-112, NRC will periodically review its construction lessons learned process to assess effectiveness. The review should include an assessment of the process' efficiency and effectiveness, as well as the feedback from internal stakeholders. The review should also identify areas for improvement as appropriate.

- Culture: NRC's culture includes senior management's consistent emphasis that knowing and understanding old and new lessons learned is vital to the success of the CIP. However, NRC managers acknowledged that there is no uniform sharing of construction-related lessons learned information. Instead, the sharing occurs in an ad hoc

manner, such as conversations between colleagues, through generic communications and other agency documents, in periodic briefings, and through access to the construction experience database.

Construction Lessons Learned Guidance Is Not Fully Developed; NRC Could Miss Opportunities

NRO-REG-112 lays out the foundation for evaluating construction lessons learned; however, the guidance does not comprehensively discuss all the elements identified as important to the success of a lessons learned program. As such, the lack of a comprehensive, well-developed guidance could jeopardize the CIP's ability to successfully:

- Identify potentially significant negative and positive lessons learned.
- Use lessons learned to inform and revise inspection activities, as necessary.
- Achieve its goal to prevent recurrences of previously identified construction problems.
- Enhance public confidence in NRC's ability to effectively oversee new nuclear construction projects.

According to NRC, successful implementation of the CIP is closely tied to the level of experience and qualifications of the agency's inspectors. However, agency managers caution that the majority of NRC's construction inspection staff will have little, if any, actual experience overseeing construction activities when assigned to work in the field. Therefore, without fully developed guidance, agency inspection staff could miss opportunities to identify and analyze potentially significant negative and positive lessons learned associated with construction activities. This becomes especially important in NRC's current regulatory environment, which has seen no new domestic nuclear power plant construction in more than 20 years.

Recommendation

OIG recommends that the Executive Director for Operations:

1. Enhance CIP guidance, which includes NRO-REG-112, to include key elements identified as important to the success of an organization's lessons learned program. Specifically:

    a. Define "lessons learned" as it applies to new reactor construction.

b. Establish and document collection criteria for the types of information that CIP staff should bring forward for screening as potential lessons learned.

c. Further develop and document how a construction-related lesson learned will be implemented through the CIP.

d. Establish and document the level of expertise required for staff participation in the daily screening meetings.

IV. AGENCY COMMENTS

An exit conference was held with NRC senior executives on September 16, 2009. Agency officials generally agreed with the report's finding and recommendations and decided not to provide formal comments. This final report incorporates informal comments provided by the agency, as appropriate.

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Appendix

SCOPE AND METHODOLOGY

The objective of this audit was to determine if and how NRC is identifying and incorporating lessons learned in its new construction inspection program. To address the audit objective, OIG analyzed CIP documents, and reviewed relevant management controls and related documentation from internal and external sources, including:

- 10 CFR Part 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants.*
- NUREG-1055, *Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants: A Report to Congress,* May 1984.
- NUREG-1789, *10 CFR Part 52 Construction Inspection Program Framework Document,* April 2004.
- NRO-REG-112, *New Reactor Construction Experience Program,* March 31, 2009.
- Construction Industry Institute: Research Summary 230-1; Implementation Resource 230-2, and Research Report 230-11.

Additionally, auditors observed Operating Experience Branch screening meetings between April 3 and May 18, 2009, and conducted interviews with NRC senior management and staff from headquarters and Region II and individuals from external organizations, including Federal Government agencies and private industry entities.

OIG conducted this audit between December 2008 and June 2009 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.

Major contributors to this report are Sherri Miotla, Team Leader; Catherine Colleli, Audit Manager; Eric Rivera, Audit Manager; Timothy Wilson, Senior Analyst; and Vidya Sathyamoorthy, Student Management Analyst.