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NUCLEAR WEAPONS

Improvements Needed to DOE's Nuclear Weapons Stockpile Surveillance Program

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The Honorable Strom Thurmond
Chairman
The Honorable Sam Nunn
Ranking Minority Member
Committee on Armed Services
United States Senate

The Department of Energy (DOE) is responsible for managing the nation's nuclear weapons stockpile, including surveillance of weapons currently in the stockpile to identify reliability and safety problems. DOE conducts three types of stockpile surveillance tests—flight tests, nonnuclear systems laboratory tests, and nuclear and nonnuclear component tests—on nine types of nuclear weapons. Your offices asked us to provide information on the status of the stockpile surveillance program. If the program is not on schedule, you asked us to determine why it is not and provide you with information on the steps being taken to get the program back on schedule.

Results in Brief

DOE is behind schedule in conducting many of the stockpile surveillance tests. These include flight tests of three types of weapons, nonnuclear systems laboratory tests of one type of weapon, and laboratory tests of most key components. In some instances, DOE is several years behind schedule. Only through testing can DOE identify problems or defects that would warrant changing the reliability level it assigns to a particular weapon. Being behind schedule in the testing program provides DOE with less information on the weapons, thereby providing less confidence in the reliability levels assigned.

The stockpile surveillance program is behind schedule for a variety of reasons. At one facility, testing was suspended because the facility lacked an approved safety study required to disassemble and inspect one type of weapon. Testing was suspended at another facility because of concerns about safety procedures. Testing delays also occurred during the transfer of testing functions to new facilities.

DOE does not have written plans indicating in detail how it will get the testing program on schedule. For some of the tests, DOE officials told us that it will be years before the tests are back on schedule. Furthermore, several factors, including the possible expiration of required safety studies, future limitations on the number of flight tests, and the lack of

contingency plans in the event a test facility is temporarily shut down, could prevent DOE from being able to conduct tests and return to its schedule.

Background

The purpose of DOE's stockpile surveillance program is to ensure, primarily through three types of tests, that the safety and reliability of nuclear weapons are maintained. Flight tests involve the actual dropping or launching of a weapon, which has had the nuclear components removed. Nonnuclear systems laboratory tests involve testing a weapon's nonnuclear systems to detect defects due to handling, aging, manufacturing, or design. The nuclear and nonnuclear components laboratory tests involve destructive analysis to identify defects or failures in individual weapon components.

Weapons are randomly selected for flight and nonnuclear systems laboratory tests from the stockpile each year. Weapons chosen for the nuclear and nonnuclear components laboratory tests are judgmentally selected from the weapons that have been selected for the other two tests. For testing purposes, DOE considers the active stockpile to consist of nine weapon types—three bombs and six missile warheads, each with unique capabilities. From 1958 to 1996, DOE's stockpile surveillance program has tested about 14,000 weapons, with about 2,400 findings documented. Over 50 percent of these findings were considered "significant." A significant finding is the identification of a defect or failure in a weapon system. A defect is an observable anomaly, while a failure is a flaw or malfunction in the weapon that would prevent the weapon from operating as intended.[1]

When a significant finding is disclosed, DOE may perform additional tests to confirm the finding, determine the cause of the problem, assess its impact on the stockpile, and recommend a corrective plan. Of the 2,400 findings, 370 were "actionable." DOE defines an actionable finding as a finding that lowers the weapon's reliability or for which some action is taken. About 1 in 3 actionable findings (118 findings) have resulted in retrofits and major design changes. The remainder required either process changes or no physical changes. When a weapon's reliability is lowered because of a finding, the result is reported to the Department of Defense (DOD).

[1]About 1.3 percent of the tests have identified failures.

DOE and the national nuclear laboratories[2] have determined that they generally need to test about 40 to 44 weapons of each type in the stockpile over a 4-year period.[3] According to DOE officials, over that 4-year time frame, the tests should consist of 8 to 12 flight tests per weapon type (an average of 2 or 3 tests per year) and 28 to 36 laboratory tests of nonnuclear systems (an average of 7 to 9 per year). Finally, from the weapons scheduled for testing each year, DOE designates components from certain weapons for laboratory tests. DOE considers five components to be key—the pit, the secondary, the detonator sets, the gas transfer system, and the high explosives.[4] On average, for each weapon type, DOE believes that one pit, one secondary, two to five detonator sets, one or two gas transfer systems, and one high-explosive system should be tested each year.

According to DOE officials, when a significant number of tests are cancelled or delayed, the Department lacks information on the reliability of the weapon. While lack of testing will not affect the reliability level assigned to a weapon (only a test finding can alter the reliability level), the lack of test information reduces DOE's confidence in the assessed reliability of the weapon.

Stockpile Surveillance Tests Are Behind Schedule

DOE is currently behind schedule in conducting some flight tests, nonnuclear systems laboratory tests, and nuclear and nonnuclear components laboratory tests. For some tests, DOE is several years behind schedule. These schedule slippages are the result of a variety of factors, including an unapproved safety study, suspension of testing at some facilities, and the transfer of testing functions to new facilities.

Flight Tests

Flight tests involve the actual dropping or launching of a weapon from which the nuclear components have been removed. DOE uses specially designed equipment—referred to as telemetry packages—to test the integration and functioning of the weapon's electrical and mechanical subsystems. Until November 1992, DOE planned to conduct a minimum of 3

[2]The Sandia National Laboratories, Los Alamos National Laboratories, and Lawrence Livermore National Laboratories.

[3]The number of weapons needed to be tested can vary somewhat according to the history of the weapon type and the number of weapons of that type in the stockpile at that time.

[4]The pit is a metal casing that contains plutonium. The pit is where the fission explosion originates. A nuclear weapon secondary is an assembly in the weapon where a fusion explosion originates. The detonator sets off the high explosive, and the gas transfer system includes a tritium reservoir and associated hardware.

flight tests per year—or 12 flight tests over a 4-year period—for bombs, InterContinental Ballistic Missiles, and Submarine-Launched Ballistic Missiles. According to DOE officials, in November 1992, DOE reduced its plan for testing Air Force InterContinental Ballistic Missiles from three tests per year to two—or eight tests over a 4-year period. DOE officials informed us that they made the reduction based on an evaluation of applicable existing test data and in preparation for the Air Force's implementation of the START I and START II treaties.[5] Under these treaties, the Air Force will have to reduce the number of warheads carried on missiles. The plan for testing bombs and Submarine-Launched Ballistic Missiles was not altered and remains at 3 per year, or 12 over a 4-year period.

DOE officials told us that they believe the reduction in flight tests from three to two per year for InterContinental Ballistic Missiles represents an acceptable increase in the risk of having undetected problems in weapons. The officials explained that by flight testing three weapons per year, there is a 90-percent chance of discovering a "flight-unique" defect if the defect occurs in 18 percent of the weapons. By testing only two weapons per year, the risk increases. With two tests per year, the defect would have to occur in 22 percent of the weapons to have a 90-percent chance of discovering it. DOE officials believe that conducting fewer than two tests per year (or eight tests over a 4-year period) is a concern and a significantly increased risk to the program.

Three weapon types—the W62, W78, and W88 warheads—have had, on average, fewer than two tests conducted per year over the past 4 years. Table 1 shows the three weapon types, DOE's plan for testing, and the number of tests conducted over the past 4 years (fiscal years 1992 through 1995).

Table 1: Flight Tests Conducted During Fiscal Years 1992 Through 1995 for Selected Weapon Types

Type of weapon	4-year plan (no. of tests scheduled)	Actual tests completed (4 years)
W62	8	6
W78	8	7
W88	12	3

[5]The START (Strategic Arms Reduction Treaty) I and START II treaties are arms control agreements between the United States and what was formerly the Soviet Union that mandate reductions in strategic offensive nuclear weapons.

The W62, a warhead used by the Air Force on the Minuteman III missile, has been flight-tested six times (of the eight planned) over the past 4 years. Two planned tests were not conducted because DOE's Pantex facility had trouble preparing warheads for flight testing and could not deliver the test warheads to the Air Force in time for the test flights. The W78 warhead, also used on the Minuteman III, has had seven flight tests (of the eight planned) over the past 4 years. DOE and the national laboratory officials told us that a flight test with telemetry equipment was not conducted because the Department decided to use the available warhead test slot on the test missile for a nontelemetry DOE test of the W78.[6]

The W88 is a warhead used by the Navy on the Trident II missile. Only 3 W88 stockpile flight tests (of the 12 planned) were conducted during the 4-year period from fiscal year 1992 through 1995. Flight testing of W88 warheads taken from the stockpile was halted for more than 1 year because an important safety study required for disassembly and inspection of the warhead at DOE's Pantex plant lacked approval. A Nuclear Explosive Safety Study is required for each weapon type before DOE's Pantex Plant can disassemble and inspect a weapon selected for testing. Without disassembly and inspection capability, surveillance tests, including flight tests of sample warheads from the stockpile (the nuclear components must be removed and replaced by the telemetry equipment), cannot be conducted. DOE and national laboratory officials are not concerned about the reliability of the W88 warhead because they have collected considerable data over the past few years by testing W88 warheads that had never been placed in the stockpile. Because the W88 warhead is a relatively new weapon, DOE officials believe that the information from these "new material" tests provides good reliability data.

Nonnuclear Systems Laboratory Tests

Of the nine weapon types, only the W88 warhead is considered by DOE to be of concern in relation to nonnuclear systems laboratory tests. These tests involve testing the nonnuclear systems—such as the radar systems and fuzes—in the weapon to detect defects due to handling, aging, manufacturing, or design. DOE officials said the Department should have conducted about 28 laboratory tests, but over the past 4 years, only 15 (or 54 percent) tests were performed. According to DOE and national laboratory officials, the tests were not conducted because of the absence of an approved safety study at Pantex. DOE officials said that in this case,

[6]DOE has periodically conducted these nontelemetry tests on the W78 and W87 over the past 3 years because they provide for flight dynamics that are more typical of a real warhead than the telemetry warheads. The nontelemetry tests do not, however, provide discrete information on the operation of the weapon's components.

the lack of testing reduces their confidence in the weapon's reported reliability. DOE officials told us that they could not quantify the decrease in confidence.

Laboratory Tests of Nuclear and Nonnuclear Components

From the weapons selected for testing each year, one weapon of each type is selected to have individual nuclear and nonnuclear components destructively tested. Although many other components are tested (such as cables and electrical components), according to DOE officials, the five key components tested are the pit, the secondary, the detonator assembly, gas transfer system, and high explosive. Testing of four of these key components has been behind schedule in recent years. Only the high explosives tests have been conducted on schedule.[7]

The pit is a part of the nuclear package that, until 1989, was manufactured and tested at DOE's Rocky Flats facility in Colorado. According to DOE officials, the Department ideally tests one pit per year per weapon type. In December 1989, the Rocky Flats facility ceased production operations. At first, DOE believed that Rocky Flats would reopen; however, in 1992 DOE decided to move pit tests to the Los Alamos National Laboratory. This lapse created a backlog of up to 4 to 5 years, but testing is currently nearly back on schedule.

The secondary is tested at DOE's Y12 facility in Oak Ridge, Tennessee. Ideally, one secondary should be tested per weapon type per year. Few have been tested since September 1994, when Y12 was placed in a "stand-down" mode because of problems related to safety procedures that had been noted by the Defense Nuclear Facilities Safety Board.[8] Most of these problems did not involve unsafe conditions, but were related to not following approved procedures. According to DOE officials, a 1-year backlog of secondaries to be tested currently exists.

DOE's Mound facility in Ohio tested detonator sets through 1994. At that time, responsibility for testing detonator sets was moved to DOE's Los Alamos and Lawrence Livermore Laboratories. Ideally, DOE tests two to five detonator sets per year per weapon type. Los Alamos began testing in June 1996, and Lawrence Livermore is scheduled to begin testing later this year. In the meantime, a 1-1/2-year backlog of detonator sets to be tested exists.

[7]According to DOE officials, all other component tests are on schedule.

[8]The Defense Nuclear Facilities Safety Board was created in 1988 to investigate situations at DOE's defense nuclear facilities that could adversely affect public health and safety.

DOE's Mound facility also tested gas transfer systems through 1994. Ideally, one or two gas transfer systems are tested per weapon type per year. Responsibility for testing gas transfer systems was moved to DOE's Savannah River facility in South Carolina. Savannah River began testing some gas transfer systems earlier this year, but a 1-1/2-year backlog currently exists.

According to DOE officials, the lack of nuclear component testing decreases DOE's confidence in the reliability assessments of the weapons in the nuclear stockpile. DOE officials said that they could not estimate the degree to which confidence in the reliability assessments of the weapons had decreased because of the backlogs in nuclear components laboratory tests. However, the officials said that the confidence had not diminished to a point of concern. The officials explained that pits, secondaries, detonator assemblies, and gas transfer systems are long-lived items, and generally, testing could be suspended for 3 years without confidence diminishing to a point of concern.

DOE's Ability to Conduct Some Future Tests Is Uncertain

DOE has taken actions to increase the number of stockpile surveillance tests but has not prepared detailed plans for returning the stockpile surveillance program to its schedule. Without such plans, it is difficult for us to assess the likelihood that stockpile surveillance tests will return to the schedule. Furthermore, we believe that issues and factors such as the availability of test missile launches, expiration of approved safety studies, or cessation of operations at test facilities could have an adverse effect on DOE's future ability to remain on schedule.

Flight Tests and Nonnuclear Systems Laboratory Tests

For most weapon types, DOE has taken actions that may return flight tests and nonnuclear systems laboratory tests to the schedule in the short term. However, in the longer term, implementation of the START I and START II treaties, the availability of telemetry packages used in flight testing, and the expiration of safety studies could cause these testing programs to fall behind schedule.

Based on the Air Force's agreement to provide for sufficient flight tests on test missiles, DOE estimates that W78 warhead flight tests will be back on schedule by the end of fiscal year 1996. The W62 warhead is behind schedule for flight testing because DOE could not deliver the test warheads to the Air Force in time for the tests. DOE officials told us that this should not recur, but, as discussed later, DOE may not be able to maintain the W62

warhead flight test schedule in the long term because of limited inventories of testing equipment.

The safety study that caused delays in the W88 warhead testing has been approved, and both flight testing and nonnuclear laboratory systems tests have been resumed. To get flight tests back on schedule, DOE plans to conduct six flight tests in fiscal year 1996 (as of July 1996, DOE had conducted three telemetry and one nontelemetry test during fiscal year 1996), four in 1997, three in fiscal year 1998, and three in fiscal year 1999. To get nonnuclear laboratory systems tests on schedule, DOE plans to consolidate 3 years of testing into 2 years. DOE estimates that flight tests will be back on schedule sometime during fiscal year 1999 and nonnuclear systems laboratory tests will be back on schedule in fiscal year 1998.

In the longer term, tests of the W78 warhead—as well as the W62 and W87 warheads—could be a problem.[9] DOE officials told us that when the START I and START II treaties are fully implemented, the Air Force may be limited in its ability to conduct flight tests. Air Force officials confirmed that providing for future InterContinental Ballistic Missile flight tests may be difficult because of limitations imposed by the START treaties. These treaties require a transition from Multiple Independent Reentry Vehicles to Single Reentry Vehicles. Until recently, multiple flight tests were routinely conducted on one missile firing. After the treaties are fully implemented, only one test warhead per missile will be allowed. A reduction in the number of warhead tests per flight reduces the overall number of tests that can be conducted because the number of missiles available for testing purposes is limited.

Future flight tests of the W62 warhead could also be limited by a lack of telemetry packages. Initially, DOE had enough telemetry packages to test this warhead during its projected life. However, retirement of this warhead has been delayed, and DOE is running out of telemetry packages. Also, the company that produced the package has gone out of business. DOE is studying the possibility of using parts from W68 warhead telemetry packages (the W68 has been retired, but telemetry parts remain that may be recertified for use in the W62) to increase the number of telemetry packages available. If this is done, DOE could test W62 warheads for 4 years at the rate of two per year. DOE officials told us that a decision will be required in 1998 to determine if this warhead will remain in the stockpile

[9]The W87 is the warhead used on the Air Force's Peacekeeper missile. Testing of this weapon is currently not behind schedule.

long enough to make the redesign and purchase of new telemetry packages worthwhile.

Finally, while the W88 warhead safety study has been approved, the expiration of other approved safety studies at Pantex could affect DOE's future ability to conduct stockpile surveillance tests in the future. To conduct any of the three major types of stockpile surveillance tests, Pantex must be able to inspect the weapon, disassemble the weapon, reassemble the weapon, and replace the nuclear package with telemetry for the flight test. Without a valid safety study for each weapon type, Pantex cannot conduct any of these operations. The safety studies are valid for 5 years, and an extension can be granted for an additional 5 years. The safety study for the W78 warhead expired in April 1995 but has since been revalidated. Safety studies for the W87 and B83 warheads will expire within the next year. DOE does not anticipate a problem as revalidation of the studies is scheduled to occur before the old studies expire.

Laboratory Tests of Key Components

Although DOE has no formal written plans specifically for returning laboratory tests of key components to the schedule, DOE officials told us that activities have been undertaken and progress is being made toward eliminating the backlog of tests. Table 2 shows the type of component, the number of tests normally conducted for each component, and the approximate number of components in the backlog as of July 1996.

Table 2: Backlog of Laboratory Tests for Key Components

Type of component	Planned tests per year	Backlog of tests
Pit	9	2
Secondary	9	7
Detonator sets	18 to 45	114
Gas transfer systems	9 to 18	22

Pit testing began at Los Alamos in fiscal year 1993. By conducting 19 tests per year, DOE officials said that the 4-to 5-year backlog that once existed will be eliminated by the end of this fiscal year. DOE officials also told us that about 10 pit tests were "written off." This means that DOE determined that it was not necessary to conduct the tests because sufficient past data existed or because testing one or two pits out of a backlog of three or four for a specific weapon would, in its opinion, provide sufficient data.

Regarding the secondary tests, Y12 is still in a stand-down mode. Tests of seven secondaries are currently being conducted under "special

operations." Special operations are defined as discrete activities or operations that can be performed before resuming normal activities within a nuclear facility. Completion of these seven tests is scheduled before the end of fiscal year 1996. DOE also is in the process of testing three secondaries at Los Alamos. (Los Alamos has the capability to test secondaries in very limited numbers.) However, about a 1-1/2-year backlog still exists. DOE plans to conduct a readiness assessment for restarting normal operations by October 1, 1996. Currently, DOE is considering conducting 15 tests of secondaries (at least one of each type of weapon in the active stockpile) during fiscal year 1997. This would put secondary testing back on schedule.

Detonator set testing began at Los Alamos in June 1996 and will begin at the Lawrence Livermore Laboratory later this year. DOE plans to eliminate the backlog by the end of fiscal year 1997. This should not involve overtime or reallocation of resources. DOE officials explained that once the laboratories are set up to test the detonator sets, doing additional tests will require very little extra time.

Gas transfer system testing began at Savannah River in 1996. Savannah River will conduct a phased approach to eliminate the backlog of tests one weapon type at a time. As a result, some weapon types will be back on schedule within a year while others will fall further behind. DOE officials believe that the Department will eliminate all backlogs sometime during fiscal year 2000.

DOE does not have formal written plans describing how it will return component laboratory tests to the schedule. DOE officials at the Albuquerque Operations Office informed us that in the case of gas transfer systems and detonators, the Activity Transfer Plan prepared when testing responsibility was transferred from the Mound facility establishes the testing capability at the new locations. Beyond the plan, however, planning for reducing the backlogs and returning to the testing schedule is done informally. Officials representing all organizations involved in the testing meet periodically to resolve problems affecting the testing program. In this manner, DOE officials said that they reach agreement on what to do and how to do it. However, without formal documents detailing testing plans, costs, and schedules, it is difficult—if not impossible—to review the plans and assess their adequacy, determine the cost-effectiveness of the plans, or measure progress the test facilities are making.

DOE Does Not Have Contingency Plans for Stockpile Testing

In the past, DOE had more facilities and more alternatives for shifting functions and operations. However, in DOE's current nuclear complex, if a particular facility cannot perform testing for an extended period, there is little redundant capability for stockpile surveillance testing. Without redundancy, planning for continued testing operations in the event of problems at one or more of the existing facilities takes on added importance. However, DOE does not have formal contingency plans for continuation of stockpile surveillance tests in the event that one or more of the testing facilities experienced serious operational problems and could not perform testing for an extended period of time.

In the past, several facilities have been unable to conduct testing for extended periods of time. Most recently, as discussed previously, Y12 was unable to conduct surveillance tests because of procedural safety problems. When the stand-down occurred, DOE did not have a plan that established how or where surveillance tests should or could be resumed. As a result, secondary testing was halted until special operations began earlier this year at Y12, and DOE decided to test several secondaries at Los Alamos. In the meantime, a backlog of secondaries accumulated. Perhaps the most drastic example occurred when operations at Rocky Flats ceased in 1989. No contingency plan for testing existed, and in the time it took to make a decision on where testing should be conducted and complete the transfer arrangements, a 4- to 5-year backlog of pits waiting to be tested accumulated.

DOE has a draft report that discusses alternate locations for conducting weapons-related activities. For example, DOE's draft Stockpile Management Preferred Alternatives Report shows that for detonator-related functions, Los Alamos would be the alternative. DOE officials indicated, however, that this does not mean that these locations have surveillance testing capability available, although the facility or operations at the facility could possibly be modified to perform the function.

In the event of a disruption of operations at a facility that would preclude testing, DOE officials said that they would use the Stockpile Management Preferred Alternatives Report to devise a specific plan. Depending on the nature of the problem at the original facility, the length and nature of the outage, and the specific weapon(s) involved, DOE would determine the best course of action. That course of action could be (1) to wait for the problem to be fixed at the site and resume normal operations at the original facility, (2) conduct operations at the original facility under

special operations, or (3) alter an existing facility to assume surveillance operations. DOE officials said that they believe that developing a specific plan after the problems occur is the best course of action because of the wide range of problems that could occur and the variables related to outage length and potential remedies.

Conclusions

Confidence that the nation's nuclear weapons are reliable is taking on added importance because these weapons are aging, and no new weapons are being produced to replace the existing weapons. As a result, the stockpile surveillance program's role in assessing weapons' reliability and ensuring confidence in the reliability takes on increased importance. DOE's confidence in the reliability levels assigned to some nuclear weapons has been diminished because some needed tests have not been carried out. To ensure nuclear weapons' reliability, it is important that DOE's stockpile surveillance be maintained on schedule. However, without formal written plans detailing how DOE will increase the number of surveillance tests in order to return the program to its schedule, it is difficult to determine if DOE's estimates on getting the surveillance testing back on schedule are reasonable and cost-effective. Furthermore, without contingency plans, DOE's ability to respond to possible future major disruptions in its testing operations is uncertain.

Recommendations

We recommend that the Secretary of Energy direct that the Assistant Secretary for Defense Programs develop

- detailed, written plans to restore stockpile surveillance tests to the schedule and
- contingency plans for testing facilities to provide for continued testing operations in the event that a testing facility is shut down for an extended period of time.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for its review and comment. We met with officials from DOE's Office of Nuclear Weapons Management and its Albuquerque Operations Office, Weapons Quality Division, including the Director of the Office of Nuclear Weapons Management, who agreed that the report was accurate and agreed with our conclusions and recommendations.

During our discussions, the DOE officials stressed that they are making every effort to get the stockpile surveillance program on schedule and, over the past year, have made much progress toward that goal. In addition, DOE officials stressed that reliability of the nuclear weapons in the stockpile have not been adversely affected by a lack of testing.

Scope and Methodology

Our objectives in this review were to (1) provide information on the status of DOE's stockpile surveillance program; (2) if the program is not on schedule, determine why it is not; and (3) provide information on the steps being taken to return the program to the schedule.

To determine if DOE's stockpile surveillance program is on schedule, we obtained statistics from DOE and DOD and compared those statistics with DOE's test schedules. For weapon types or components that were behind schedule, we discussed with DOE and laboratory officials the reasons why they were behind schedule and the efforts being made to return to the schedule. We also discussed with DOE and DOD officials the prospects for problems in keeping future tests on schedule. We reviewed the safety study expiration and approval schedule for each weapon type and discussed with DOE officials the contingencies in the event a testing facility could not operate. We verified DOE's statistical analysis of confidence levels and defect discovery probabilities. We conducted our review between April and July 1996 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 10 days after the date of this report. At that time, we will send copies of the report to the Secretary of Energy; the Secretary of Defense; and the Director, Office of Management and Budget. We will also make copies available to others on request.

If you or your staff have any questions about this report, please call me at (202) 512-3841. Major contributors to this report include Bernice Steinhardt, Associate Director; William F. Fenzel, Assistant Director; Kenneth E. Lightner Jr., Evaluator; William M. Seay, Evaluator; and John D. Gentry, Evaluator.

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