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NUCLEAR MATERIAL

DOE's Depleted Uranium Tails Could Be a Source of Revenue for the Government

Statement of Gene Aloise, Director
Natural Resources and Environment

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Highlights

Highlights of GAO-11-752T, a testimony before the Subcommittee on Energy and Power, Committee on Energy and Commerce, House of Representatives

June 13, 2011

NUCLEAR MATERIAL

DOE's Depleted Uranium Tails Could Be a Source of Revenue for the Government

Why GAO Did This Study

Since the 1940s, the Department of Energy (DOE) has been processing natural uranium into enriched uranium, which has a higher concentration of the isotope uranium-235 that can be used in nuclear weapons or reactors. This has resulted in over 700,000 metric tons of leftover depleted uranium, also known as "tails," that have varying residual concentrations of uranium-235. The tails are stored at DOE's uranium enrichment plants in Portsmouth, Ohio and Paducah, Kentucky. Although the tails have historically been considered a waste product, increases in uranium prices may give DOE options to use some of the tails in ways that could provide revenue to the government.

GAO's testimony is based on its March 2008 report (GAO-08-606R). GAO updated the analysis in its 2008 report to reflect current uranium prices and actions taken by DOE. The testimony focuses on (1) DOE's options for its tails and (2) the potential value of DOE's tails and factors that affect the value.

In its 2008 report, GAO suggested that Congress consider clarifying DOE's statutory authority to manage its tails. No action on this recommendation has been taken to date. Also, GAO recommended that DOE complete a comprehensive uranium management assessment. DOE issued a uranium management plan in December 2008 that addressed GAO's recommendation.

View GAO-11-752T or key components.
For more information, contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

What GAO Found

DOE's potential options for its tails include selling the tails "as is," re-enriching the tails, or storing them indefinitely. DOE's current legal authority to sell its depleted uranium inventory "as is" is doubtful, but DOE generally has authority to carry out the other options.

- *DOE's authority to sell the tails in their current unprocessed form is doubtful.* Because of specific statutory language in 1996 legislation governing DOE's disposition of its uranium, DOE's authority to sell the tails in unprocessed form is doubtful, and under the rules of statutory construction, DOE likely lacks such authority. However, if Congress were to provide the department with the needed authority, firms such as nuclear power utilities and enrichment companies may be interested in purchasing these tails and re-enriching them as a source of nuclear fuel.
- *DOE could contract to re-enrich the tails.* Although DOE would have to pay for re-enrichment, it might obtain more value from selling the re-enriched uranium instead of the tails if its re-enrichment costs were less than the discount it would have to offer to sell the tails as is.
- *DOE could store the tails indefinitely.* This option conforms to an existing DOE plan to convert tails into a more stable form for long term storage, but storing the tails indefinitely could prevent DOE from obtaining the potentially large revenue resulting from sales at current high uranium prices.

DOE issued a comprehensive uranium management plan in December 2008 that stated that the department would consider selling depleted uranium or re-enriching it to realize best value for the government and that it would begin selling or re-enriching depleted uranium in 2009. However, to date, DOE has not sold or re-enriched any of its depleted uranium and, according to DOE officials, has no current plans to do so.

The potential value of DOE's depleted uranium tails is currently substantial, but changing market conditions could greatly affect the tails' value over time. Based on May 2011 uranium prices and enrichment costs and assuming sufficient re-enrichment capacity is available, GAO estimates the value of DOE's tails at $4.2 billion—about $3.4 billion less than GAO's March 2008 estimate. However, this estimate is very sensitive to changing uranium prices, which have dropped since GAO's March 2008 report was issued. GAO's estimate is also very sensitive to the availability of enrichment capacity. In particular, DOE would have to find a company with excess enrichment capacity beyond its current operations, which may be difficult if large amounts of enrichment processing were required.

Chairman Whitfield, Ranking Member Rush, and Members of the Subcommittee:

Thank you for the opportunity to discuss our work on the Department of Energy's (DOE) inventory of depleted uranium as you consider options for using this inventory in ways that could benefit the U.S. government. As you know, since the 1940s the government has been processing natural uranium into enriched uranium. This increases the concentration of the isotope uranium-235, which is necessary to make the material useful in nuclear weapons or reactors. The generation of enriched uranium over many decades has resulted in approximately 700,000 metric tons of leftover depleted uranium, also known as "tails," that have varying residual concentrations of uranium-235 remaining. DOE stores these tails at its uranium enrichment plants in Portsmouth, Ohio, and Paducah, Kentucky. DOE is assessing its options on how to best manage this large accumulation of tails. Although the tails have historically been considered a waste product and an environmental liability, increases in uranium prices may give DOE options to use that portion of the tails with the highest residual concentrations of uranium-235 in ways that could be a source of revenue to the government.

My testimony today is based on our March 31, 2008, report to the House Committee on Energy and Commerce, the Senate Committee on Energy and Natural Resources, and the Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce.[1] We also testified on this subject before the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce on April 3, 2008.[2] In our March 2008 report, we recommended that the Secretary of Energy develop a comprehensive uranium management assessment that should contain detailed information on the types and quantities of depleted, natural, and enriched uranium the department manages and an assessment of DOE's options for this material. Consistent with our recommendation, DOE issued a comprehensive uranium management plan in December 2008. This plan stated, among other things,

[1]GAO, *Nuclear Material: DOE Has Several Potential Options for Dealing with Depleted Uranium Tails, Each of Which Could Benefit the Government*, GAO-08-606R (Washington, D.C.: Mar. 31, 2008).

[2]GAO, *Nuclear Material: Several Potential Options for Dealing with DOE's Depleted Uranium Tails Could Benefit the Government*, GAO-08-613T (Washington, D.C.: Apr. 3, 2008).

that DOE would consider selling depleted uranium or re-enriching it to realize best value for the government and that it would begin selling or re-enriching depleted uranium in 2009. However, to date, DOE has not sold or re-enriched any of its depleted uranium, and, according to DOE officials, has no current plans to do so.

My testimony today discusses (1) DOE's potential options for beneficially reusing or indefinitely storing its tails and (2) the potential value of DOE's tails and factors that affect the value.

In preparing this testimony, we updated information from our prior report. Specifically, we obtained the most recent data on the quantities and uranium-235 concentrations of tails in DOE's inventory and uranium price data to update our model of the potential value of DOE's tails. We developed this model for our March 2008 report. The model uses standard formulas to determine the amounts of enriched uranium and tails produced from given quantities of uranium and enrichment services. The model also uses uranium price data that we obtained from nuclear industry trade publications. These data are commonly used in the nuclear industry as standard measures of the market price for uranium. We interviewed knowledgeable DOE officials to determine the extent to which these data are used by the department and the industry and determined that the data were sufficiently reliable for the purposes of our report. Our prior work on DOE's depleted uranium, as well as the work conducted for this statement, was performed 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.

Background

Since the 1940s, one mission of DOE and its predecessor agencies has been processing uranium as a source of nuclear material for defense and commercial purposes. A key step in this process is the enrichment of natural uranium, which increases its concentration of uranium-235, the isotope of uranium that undergoes fission to release enormous amounts of energy. Before it can be enriched, natural uranium must be chemically converted into uranium hexafluoride. The enrichment process results in two principal products: (1) enriched uranium hexafluoride, which can be further processed for specific uses, such as nuclear weapons or fuel for nuclear power plants; and (2) leftover "tails" of uranium hexafluoride.

These tails are also known as depleted uranium because the material is depleted in uranium-235 compared with natural uranium.[3]

Since 1993, uranium enrichment activities at DOE-owned uranium enrichment plants have been performed by the U.S. Enrichment Corporation (USEC), formerly a wholly owned government corporation that was privatized in 1998. However, DOE still maintains over 700,000 metric tons of depleted uranium tails in about 63,000 metal cylinders in storage yards at its Paducah, Kentucky, and Portsmouth, Ohio, enrichment plants (see figure 1). It must safely maintain these cylinders because the tails are dangerous to human health and the environment. Uranium hexafluoride is radioactive and forms extremely corrosive and potentially lethal compounds if it contacts water. In addition, DOE also maintains large inventories of natural and enriched uranium that are also surplus to the department's needs.

Figure 1: Uranium Cylinder Storage Yard at DOE's Paducah Uranium Enrichment Plant

Source: DOE.

[3]Uranium is categorized by concentration of uranium-235, expressed as a percentage "assay." Natural uranium has an assay of about 0.7 percent uranium-235. For use in a nuclear reactor or weapon, natural uranium must be enriched to increase its assay to a level required for its ultimate use. For example, low enriched uranium (LEU), which is used in commercial nuclear power reactors, typically has an assay of between 3 and 5 percent uranium-235. Highly enriched uranium (HEU), which is used in nuclear weapons, has an assay of greater than 20 percent uranium-235 and can have an assay of greater than 90 percent. The depleted uranium tails have varying assays below the 0.7 percent assay of natural uranium. DOE's tails range from less than 0.15 to about 0.66 percent uranium-235.

Tails have historically been considered a waste product because considerable enrichment processing is required to further extract the remaining useful quantities of uranium-235. In the past, low uranium prices meant that these enrichment services would cost more than the relatively small amount of uranium-235 extracted would be worth. However, an increase in uranium prices—from approximately $21 per kilogram of uranium in the form of uranium hexafluoride in November 2000 to about $160 per kilogram in May 2011—has potentially made it profitable to re-enrich some tails to further extract uranium-235. Even with the current higher uranium prices, however, only DOE's tails with higher concentrations of uranium-235 (at least 0.3 percent) could be profitably re-enriched, according to industry officials.

DOE Potentially Has Options for the Tails but Has Not Implemented Its December 2008 Plan for Selling or Re-Enriching Them

DOE's potential options for its tails include selling the tails "as is," re-enriching them, or storing them indefinitely. However, DOE's legal authority to sell the tails in their current form is doubtful. We found that DOE generally has authority to carry out the re-enrichment and storage options. As we said earlier, DOE issued a comprehensive uranium management plan in December 2008 in response to a recommendation in our March 2008 report. In this plan, DOE stated that it would begin selling or re-enriching depleted uranium in 2009. However, to date, DOE has not done so and, according to DOE officials, has no current plans to sell or re-enrich this material.

DOE's Legal Authority to Sell the Tails in Their Current Form Is Doubtful

While selling the tails in their current unprocessed form is a potential option, we believe that DOE's authority to conduct such sales is doubtful because of specific statutory language in legislation governing DOE's disposition of its uranium. In 1996, Congress enacted section 3112 of the USEC Privatization Act,[4] which limits DOE's general authority, under the Atomic Energy Act[5] or otherwise, to sell or transfer uranium. In particular, section 3112 explicitly bars DOE from selling or transferring "any uranium"—including but not specifically limited to certain forms of natural and enriched uranium—"except as consistent with this section." Section 3112 then specifies conditions for DOE's sale or transfer of natural and enriched uranium of various types, including conditions in section

[4]USEC Privatization Act, Pub. L. No. 104-134, § 3112, 110 Stat. 1321-344, 42 U.S.C. § 2297h-10.

[5]Atomic Energy Act of 1954, as amended, 42 U.S.C. §§ 2011 et seq.

3112(d) for sale of natural and low-enriched uranium from DOE's inventory. To ensure the domestic uranium market is not flooded with large amounts of government material, in section 3112(d), Congress required DOE to determine that any such inventory sales will not have a material adverse impact on the domestic uranium industry. Congress also required in section 3112(d) that DOE determine it will receive adequate payment—at least "fair market value"—if it sells this uranium and that DOE obtain a determination from the President that such materials are not necessary for national security.

However, neither section 3112(d) nor any other provision of section 3112 explicitly provides conditions for DOE to transfer or sell depleted uranium. Because section 3112(a) states that DOE may not "transfer or sell any uranium…except as consistent with this section," and because no other part of section 3112 sets out the conditions for DOE to transfer or sell depleted uranium, we believe that under rules of statutory construction, DOE likely lacks authority to sell the tails. While courts have not addressed this question before and thus the outcome is not free from doubt, this interpretation applies the plain language of the statute. It also respects the policy considerations and choices Congress made in 1996 when presented with the disposition of DOE's valuable uranium in a crowded and price-sensitive market. This reading of DOE's authority is consistent with how courts address changes in circumstances after a law is passed: Statutes written in comprehensive terms apply to unanticipated circumstances if the new circumstances reasonably fall within the scope of the plain language. Thus, under the current terms of section 3112, DOE's sale of its tails would be covered by the statute's general prohibition on sale of uranium, even if tails were not part of the universe Congress explicitly had in mind when it enacted the statute in 1996.[6]

Should Congress grant DOE the needed legal authority by amending the USEC Privatization Act or through other legislation, firms such as nuclear power utilities and enrichment companies would be interested in purchasing at least that portion of the tails with higher concentrations of extractable uranium-235 as a valuable source for nuclear fuel. For example, our March 2008 report stated that officials from 8 of 10 U.S. nuclear utilities indicated tentative interest in such a purchase. Individual utilities were often interested in limited quantities of DOE's tails because they were concerned about depending upon a single source to fulfill all of

[6]GAO's detailed legal analysis can be found in appendix I of GAO-08-606R.

their uranium requirements. Multiple utilities acting together as a consortium could mitigate these concerns and purchase larger quantities of tails. The report also noted that some enrichment firms also told us of some interest in purchasing portions of the inventory, but their anticipated excess enrichment capacity to process the tails into a marketable form affected both the quantity of tails they would purchase and the timing of any purchase.

Our March 2008 report noted that potential buyers suggested various commercial arrangements, including purchasing the tails through a competitive sale, such as an auction, or through negotiations with DOE. However, industry officials told us that buyers would discount, perhaps steeply, their offered prices to make buying tails attractive compared with purchasing natural uranium on the open market. That is, DOE might get a discounted price for the tails to compensate buyers for additional risks, such as rising enrichment costs or buyers' inability to obtain sufficient enrichment services. In addition, potential buyers noted that any purchase would depend on confirming certain information, such as that the tails were free of contaminants that could cause nuclear fuel production problems and that the cylinders containing the tails—some of which are 50 years old and may not meet transportation standards—could be safely shipped.

DOE Could Re-enrich Its Tails

Although DOE's legal authority to sell the tails in their current form is doubtful, DOE has the general legal option of re-enriching the tails and then selling the resulting natural or enriched uranium. DOE would have to contract for enrichment services commercially because the department no longer operates enrichment facilities itself. Furthermore, DOE would have to find a company with excess enrichment capacity beyond its current operations, which may be particularly difficult if large amounts of enrichment processing were required. Within the United States today, for example, there are only two operating enrichment facilities: DOE's USEC-run Paducah, Kentucky, plant and the URENCO USA facility located near Eunice, New Mexico. In the case of the Paducah plant, almost all of its enrichment capacity is already being used through 2012, when the plant may stop operating. In the case of URENCO USA, the facility is still under construction and it is not yet operating at full capacity. Other companies are also constructing or planning to construct new enrichment facilities in the United States that potentially could be used to re-enrich DOE's tails.

Although DOE would have to pay for re-enrichment, it might obtain more value from selling the re-enriched uranium instead of the tails if its re-

enrichment costs were less than the discount it would have to offer to sell the tails as is. Representatives of enrichment firms with whom we spoke at the time of our 2008 report told us they would be interested in re-enriching the tails for a fee. The quantity of tails they would re-enrich annually would depend on the available excess enrichment capacity at their facilities.

Additionally, as noted above, prior to selling any natural or enriched uranium that results from re-enriching tails, DOE would be required under section 3112(d) of the USEC Privatization Act to determine that sale of the material would not have a material adverse impact on the domestic uranium industry and that the price paid to DOE would provide at least fair market value. Section 3112(d) also would require DOE to obtain the President's determination that the material is not needed for national security.

DOE Could Store the Tails

DOE also has the general legal option to store the tails indefinitely. In the late 1990s, when relatively low uranium prices meant that tails were viewed as waste, DOE developed a plan for the safe, long-term storage of the material. DOE has constructed new facilities at its Paducah plant and its closed Portsmouth uranium enrichment plant to chemically convert its tails into a more stable and safer uranium compound that is suitable for long-term storage. The facilities are currently undergoing system checks and once they begin operating in 2011, DOE estimates it will take approximately 25 years to convert its existing tails inventory.

As our March 2008 report noted, storing the tails indefinitely could prevent DOE from taking advantage of the large increase in uranium prices to obtain potentially large amounts of revenue from material that was once viewed as waste. DOE would also continue to incur costs associated with storing and maintaining the cylinders containing the tails. These costs amount to about $4 million annually. Sale (if authorized) or re-enrichment of some of DOE's tails could also reduce the amount of tails that would need to be converted and, thereby, save DOE some conversion costs.

Moreover, once the tails were converted into a more stable form of uranium oxide, DOE's costs to re-enrich the tails would be higher if it later decided to pursue this approach. This is because of the cost of converting the uranium oxide back to uranium hexafluoride, a step that would be required for re-enrichment. However, according to DOE officials, after the conversion plants begin to operate, the plants would first convert DOE's lower concentration tails because they most likely would not be

economically worthwhile to re-enrich. This would give DOE additional time to sell or re-enrich the more valuable higher-concentration tails.

DOE Has Not Implemented Its December 2008 Plan to Sell or Re-enrich Some of Its Tails

Our March 2008 report noted that DOE had been developing a plan since 2005 to sell excess uranium from across its inventories of depleted, natural, and enriched uranium to generate revenues for the U.S. Treasury. In March 2008, DOE issued a policy statement that established a general framework for how DOE plans to manage its inventories. However, we noted that the March 2008 policy statement was not a comprehensive assessment of the sales, re-enrichment, or storage options for DOE's tails. The policy statement lacked specific information on the types and quantities of uranium that the department has in its inventory. Furthermore, the policy statement did not discuss whether it would be more advantageous to sell the higher-concentration tails as is (if authorized) or to re-enrich them. It also did not contain details on when any sales or re-enrichment may occur or DOE's legal authority to carry out those options under section 3112 of the USEC Privatization Act. It also lacked information on the uranium market conditions that would influence any DOE decision to potentially sell or re-enrich tails. Further, it did not analyze the impact of such a decision on the domestic uranium industry, and it did not provide guidance on how a decision should be altered in the event that market conditions change. Although the policy statement stated that DOE would identify categories of tails that have the greatest potential market value and that the department would conduct cost-benefit analyses to determine what circumstances would justify re-enriching and/or selling potentially valuable tails, it did not have specific milestones for doing so. Instead, the policy statement stated that this effort will occur "in the near future."

Our March 2008 report therefore recommended that DOE should complete the development of a comprehensive uranium management assessment as soon as possible. We stated that the assessment should contain detailed information on the types and quantities of depleted, natural, and enriched uranium the department currently manages and a comprehensive assessment of DOE's options for this material, including the department's authority to implement these options. Furthermore, we stated that the assessment should analyze the impact of each of these options on the domestic uranium industry and provide details on how implementation of any of these options should be adjusted in the event that market conditions change.

In December 2008, DOE issued an "Excess Uranium Inventory Management Plan." Among other things, the plan states that DOE would begin selling or re-enriching depleted uranium in 2009. However, the department has not, to date, sold or re-enriched any of its depleted uranium. According to DOE officials, the department currently has no plans to sell or re-enrich this material.

DOE's Depleted Uranium Inventory Is Potentially Worth Billions of Dollars, but Many Factors Could Greatly Change Its Value

At current uranium prices, we estimate DOE's tails to have a net value of $4.2 billion; however, we would like to emphasize that this estimate is very sensitive to changing uranium prices, which recently have been extremely volatile, as well as to the availability of enrichment capacity. This estimate assumes the May 2011 published uranium price of $160 per kilogram of natural uranium in the form of uranium hexafluoride and $153 per separative work unit—the standard measure of uranium enrichment services. Our model also assumes the capacity to re-enrich the higher-concentration tails and subtracts the costs of the needed enrichment services. It also takes into account the cost savings DOE would realize from reductions in the amount of tails that needed conversion to a more stable form for storage, as well as the costs to convert any residual tails.

As noted above, this estimate is very sensitive to price variations for uranium as well as to the availability of enrichment services. Uranium prices are very volatile, and a sharp rise or fall in prices could greatly affect the value of the tails. For example, our March 2008 report estimated the tails had a net value of $7.6 billion. This estimate was based on the February 2008 published uranium price of $200 per kilogram of natural uranium and $145 per separative work unit. Prices for uranium have since fallen from $200 per kilogram of natural uranium to $160 per kilogram. There is no consensus among industry players whether uranium prices will fall or rise in the future or on the magnitude of any future price changes. Furthermore, the introduction of additional uranium onto the market by the sale of large quantities of DOE depleted, natural, or enriched uranium—assuming DOE obtains authority to sell depleted uranium—could also lead to lower uranium prices. Therefore, according to DOE's uranium management plan, DOE is limited to selling no more than 10 percent of the domestic demand for uranium annually. This is intended to help achieve DOE's goal of minimizing the negative effects of DOE's sales on domestic uranium producers. However, this limit lengthens the time necessary to market DOE's uranium, increasing the time the department is exposed to uranium price volatility. These factors all result in great uncertainty of the valuation of DOE's tails.

In addition, the enrichment capacity available for re-enriching tails may be limited, and the costs of these enrichment services are uncertain. For example, at the time of our March 2008 report, USEC only had a small amount of excess enrichment capacity at its Paducah plant. If it used the spare capacity, USEC would only be able to re-enrich about 14 percent of DOE's most economically attractive tails between now and the possible closing of the plant in 2012. Although USEC officials told us at the time of our March 2008 report that the company was willing to explore options to extend the Paducah plant's operations beyond 2012 and dedicate Paducah's capacity solely to re-enriching DOE's tails after this point, negotiations between the company and DOE would be needed to determine the enrichment costs that would be paid by DOE. The Paducah plant uses a technology developed in the 1940s that results in relatively high production costs. Even if the Paducah plant were to be dedicated entirely to re-enriching DOE tails after 2012, over a decade would be required to complete the work because of limitations on the annual volume of tails that can be physically processed by the plant. This lengthy period of time would expose DOE to risks of uranium price fluctuations and increasing maintenance costs.

USEC and other companies are constructing or planning to construct enrichment plants in the United States that utilize newer, lower-cost technology. However, these facilities are not expected to be completed until some time over the next decade. It is unclear exactly when these facilities would be fully operating, the extent to which they will have excess enrichment capacity to re-enrich DOE's tails, and what enrichment costs DOE could expect to pay. For example, the size of the fee DOE may have to pay an enrichment company to re-enrich its tails would be subject to negotiation between DOE and the company.

In summary, as was the case when we reported in March 2008, the U.S. government has an opportunity to gain some benefit from material that was once considered a liability. Under current law, however, one potential avenue for dealing with DOE's depleted uranium tails—sale of the material in its current form—is likely closed to the department. Obtaining legal authority from Congress to sell depleted uranium under USEC Privatization Act section 3112 or other legislation would provide the department with an additional option in determining the best course of action to obtain the maximum financial benefit from its tails. Our March 2008 report therefore suggested that Congress consider clarifying DOE's statutory authority to manage depleted uranium, under the USEC Privatization Act or other legislation, including explicit direction about whether and how DOE may sell or transfer the tails. Depending on the

terms of such legislation, a sale of DOE's tails could reap significant benefits for the government because of the potentially large amount of revenue that could be obtained. In any event, enacting explicit provisions regarding DOE's disposition of depleted uranium would provide stakeholders with welcome legal clarity and help avoid litigation that could interrupt DOE's efforts to obtain maximum value for the tails.

DOE's issuance of a comprehensive uranium management plan in December 2008 provided welcome clarity on the department's plans for marketing its uranium. Unfortunately, DOE has failed to follow-through with the actions laid out in its plan. By not following its plan to sell or re-enrich some its tails beginning in 2009, DOE has increased uncertainty in the uranium market about its ultimate plans for its depleted uranium tails. In addition, DOE continues to be unable to quickly react to changing market conditions to achieve the greatest possible value from its uranium inventories.

Chairman Whitfield, Ranking Member Rush, and Members of the Subcommittee, this completes my prepared statement. I would be happy to respond to any questions you or other Members of the Subcommittee may have at this time.

GAO Contact and Staff Acknowledgments

If you have any questions or need additional information, please contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Major contributors to this statement were Ryan T. Coles (Assistant Director), Antoinette Capaccio, Karen Keegan, and Susan Sawtelle.

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