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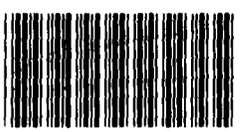
RELEASED

November 15, 1983

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives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Dear Mr. Chairman:

Subject: DOE's Allocation of Costs for Uranium Enrichment Services (GAO/RCED-84-64)

Your letter of July 25, 1983, expressed concern about a number of issues related to the Department of Energy's (DOE's) uranium enrichment services program. You requested that we respond to three questions regarding DOE's allocation of enrichment costs by November 15, 1983. The questions were:

--How does DOE allocate the costs of providing uranium enrichment services among its customers?

--Does DOE's method of allocating costs equitably reflect the costs of providing the services to each customer class?

--If it is costlier to provide high enriched uranium to the government's defense programs, what would be the effect on civilian customers if governmental customers were charged the full costs of service?[1]

You also requested that we plan to separately report on questions dealing with the components of the enrichment services price, the secondary enrichment market, and the proposed new enrichment services contract.

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[1]Low enriched uranium is primarily used to fuel commercial nuclear power reactors, including some operated by quasi-government entities such as the Tennessee Valley Authority. Most high enriched uranium is used either for research or by the federal government for defense purposes.

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We performed our audit work primarily at DOE's Office of Uranium Enrichment in Germantown, Maryland, and at DOE's Oak Ridge Operations Office in Tennessee. We also interviewed officials from Goodyear Atomic Corporation, the DOE contractor responsible for operating the Portsmouth, Ohio, gaseous diffusion enrichment plant, and analyzed accounting records, reports, and other pertinent documents they furnished. We did not validate DOE's pricing of enrichment services nor did we validate the computation of customer prices. The results of our work are summarized below. A more complete description of our audit results, as well as our objective, scope, and methodology, are contained in an enclosure to this letter.

## OVERVIEW OF DOE'S URANIUM ENRICHMENT PROGRAM

Uranium enrichment is a process used to increase the concentration of the fissionable uranium-235 isotope found in natural uranium to the levels required for the uranium to be used for nuclear power reactor fuel, in research, or for defense applications. In the United States, DOE enriches uranium in three plants located at Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. These plants use a costly, energy intensive enrichment process known as gaseous diffusion. Although the existing plants were built to satisfy U.S. military requirements, over 90 percent of the uranium presently enriched is for use as fuel in domestic and foreign nuclear power reactors.

Uranium used to fuel commercial nuclear power reactors requires less enrichment than that generally required for defense or research purposes. It is a low enriched uranium containing less than 5 percent of the fissionable uranium-235 isotope. When uranium is enriched for defense and research purposes it becomes a high enriched uranium containing up to 98 percent of the fissionable uranium-235 isotope. Although low enriched uranium is produced at all three plants, DOE produces high enriched uranium solely in its Portsmouth, Ohio, enrichment plant.

Section 161(v) of the Atomic Energy Act of 1954, as amended, (42 U.S.C. 2201(v)), requires DOE to set prices that will enable it to recover all of the government's enrichment costs over a reasonable period of time. These costs include imputed interest, electric power, other direct and indirect operating costs, depreciation, and all other programmatic costs.[2] To meet this

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[2]Government customers do not pay depreciation and imputed interest costs; however, DOE imputes revenues covering these costs and reduces the government investment account by the same amount. Imputed interest is an established interest cost (representing the cost of U.S. Treasury borrowings) assigned to a particular in-house government investment alternative, even though actual interest expenditures may not be incurred by the individual agency undertaking the activity.

requirement, each year DOE projects the costs of providing enrichment services to its customers over the ensuing 10-year period[3] and develops an enrichment services price that will enable it to fully recover such costs. Although in any given year the enrichment program may operate at a profit or loss, DOE expects to recover all enrichment costs over the 10-year period.

## SUMMARY OF INFORMATION OBTAINED

The specific questions you asked and our responses to those questions are summarized below.

--How does DOE allocate the costs of providing uranium enrichment services among its customers?
DOE allocates its enrichment services costs and prices its enrichment services based on separative work units.[4] Customers of both high and low enriched uranium are charged the same average price for each separative work unit required to produce their specific products. DOE calculates the price per separative work unit by projecting the total number of separative work units to be sold during a 10-year period and dividing it into the total projected enrichment costs for the same period of time.

--Does DOE's method of allocating costs equitably reflect the costs of providing the services to each customer class?
The costs of providing high and low enrichment services are not fairly allocated among DOE's customers. Although DOE allocates and recovers enrichment services costs through a single average price per separative work unit, we found that high enriched uranium costs more per separative work unit than low enriched uranium. Using Goodyear Atomic Corporation's allocation of enrichment production costs and other DOE cost data, we separately allocated DOE's enrichment costs among high and low enriched uranium services. On the basis of our analysis, we estimated that DOE's method of allocation resulted in about $34 million of high enriched uranium costs being assigned to low enriched uranium in fiscal year 1983.

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[3]According to DOE, it uses a rolling 10-year pricing period to spread the fixed costs over a large number of sales and to minimize fluctuations in prices.

[4]A separative work unit is a world-wide standard physics measure for uranium enrichment.

--If it is costlier to provide high enriched uranium to the government's defense programs, what would be the effect on civilian customers if governmental customers were charged the full costs of service?
Because it costs more to provide high enriched uranium than low enriched uranium, we asked DOE to estimate the effect of such a cost difference on price. DOE estimated that if it were to have separate prices, low enriched uranium would be priced between $137.35 and $137.79 per separative work unit, and high enriched uranium between $195.52 and $231.76[5] per separative work unit. DOE currently charges its customers of both high and low enriched uranium $138.65 per separative work unit.[6] Therefore, the price of low enriched uranium would be reduced by about $1 per separative work unit. Although the unit price difference may be as small as $1 for low enriched customers, such a reduction can amount to a substantial sum for a utility with several reactors. An average of 120,000 separative work units are usually required annually to enrich enough uranium to fuel a typical large nuclear power reactor. For example, the Tennessee Valley Authority has five operating reactors and purchased about 634,000 separative work units in fiscal year 1983. Thus, a $1-price reduction would have reduced its enrichment costs by about $634,000.

## RECOMMENDATIONS TO THE SECRETARY OF ENERGY

To more fairly price uranium enrichment services, we recommend that the Secretary of Energy:

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[5]The high enriched uranium price is an incremental price for further enriching low enriched uranium to high enriched uranium. Therefore, a high enriched uranium customer would be charged between $137.35 and $137.79 for each separative work unit required to obtain low enriched uranium and between about $195.52 and $231.76 per separative work unit to convert the low enriched uranium to high enriched uranium.

[6]The price shown is for DOE's commercial enrichment contracts which require customers to commit to enriched uranium deliveries at least 6 years in advance. Such contracts make up about 50 percent of DOE's active enrichment contracts. The balance of the contracts are requirements-type contracts which require customers to commit to deliveries only 6 months in advance. Because of the shorter notice period, DOE charges the requirements-contract customers a higher price, currently $11.20 more per separative work unit.

--account separately for the costs of providing high and low enrichment services and

--using such cost information, establish separate enrichment prices for customers of high and low enriched uranium.

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As requested by your office, we did not obtain official agency comments on this report. We did, however, discuss the information presented with DOE program officials who agreed with the facts presented in this report. However, they cautioned that the estimated prices they provided need further refinement before separate prices are established. They also said they had not decided whether the cost differences are large enough to warrant establishing separate prices for high and low enriched uranium. As indicated by our recommendation to account separately for costs, we agree that further refinement of the data is needed. Although the unit price difference may be as small as $1 per separative work unit for low enriched uranium customers, such a reduction can amount to a substantial sum for a utility with several reactors. Therefore, we continue to believe fairer treatment of uranium enrichment customers is needed.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 3 days from the date it is issued. At that time, we will send copies to the Director, Office of Management and Budget; the Secretary of Energy; and interested committees and Members of Congress. Copies will also be made available to others upon request.

Sincerely yours,

Milton J. Socolar

Acting Comptroller General
of the United States

ENCLOSURE I

# THE DEPARTMENT OF ENERGY'S ALLOCATION OF COSTS FOR URANIUM ENRICHMENT SERVICES

## OVERVIEW OF DOE'S URANIUM ENRICHMENT PROGRAM AND ITS ALLOCATION OF ENRICHMENT COSTS AMONG CUSTOMERS

Uranium enrichment is a process used to increase the concentration of the fissionable uranium-235 isotope found in natural uranium to the levels required for the uranium to be used for nuclear power reactor fuel, in research, or for defense applications. The level to which natural uranium must be enriched for use as nuclear power reactor fuel is much less than that generally required for uranium used for research or defense purposes. Uranium enriched primarily for use in civilian nuclear power reactors, known as low enriched uranium, normally has less than a 5-percent concentration of the fissionable uranium-235 isotope. On the other hand, uranium enriched primarily for research or defense purposes, known as high enriched uranium, contains up to 98 percent of the fissionable uranium-235 isotope.

In the United States, the federal government--through the Department of Energy (DOE)--is the sole enricher of uranium. DOE's existing uranium enrichment capability consists of three plants located at Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. These plants use a costly, energy intensive enrichment process known as gaseous diffusion and were built in the 1940's and 1950's to satisfy U.S. military requirements for enriched uranium. Since 1969, DOE and its predecessor agencies--the Atomic Energy Commission and the Energy Research and Development Administration[1]--have operated the plants to primarily enrich customer-owned uranium for use as a fuel in domestic and foreign nuclear power reactors. Except for that portion of DOE's Portsmouth, Ohio, enrichment plant devoted to high enriched uranium, all of DOE's enrichment plants are now devoted to the production of low enriched uranium, which comprises over 90 percent of the total enriched product.

Before DOE can enrich a customer's uranium, the uranium must be converted, through a series of processes, to a gas known as uranium hexaflouride. The uranium hexaflouride is then pumped through a long series of filters that enrich it by diffusing the gas into two streams, one of which has a higher concentration of

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[1]The Atomic Energy Commission was abolished on January 19, 1975, and its uranium enrichment activities were transferred to the Energy Research and Development Administration. On October 1, 1977, the Energy Research and Development Administration was abolished and its enrichment activities were transferred to DOE.

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the fissionable uranium-235 isotope than the other. Basically, the more filters the gas is pumped through the more enriched it becomes. To produce high enriched uranium, DOE processes the uranium hexaflouride through a larger number of filters and therefore uses more of its enrichment equipment and facilities.

Section 161(v) of the Atomic Energy Act of 1954, as amended, (42 U.S.C. 2201(v)), requires DOE to set prices that will enable it to recover all of the government's enrichment costs over a reasonable period of time. To satisfy this requirement, each year DOE projects the costs of providing enrichment services to its customers over the ensuing 10-year period and uses this information to develop a price that is calculated to fully recover such costs. Any differences between actual costs incurred and revenues earned from providing enrichment services are accounted for through annual adjustments to the 10-year projected costs and price. For fiscal year 1982, for example, DOE recorded over $1.8 billion in costs and nearly $2.1 billion in revenues from the sale of its enrichment services. Therefore, in fiscal year 1983 adjustments were necessary to offset fiscal year 1982's $244 million profit against future costs.

## OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of our work was to answer three specific questions raised by the chairman, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, in a letter dated July 25, 1983. The questions relate to DOE's allocation of costs of providing enrichment services for its different types of customers and are as follows:

--How does DOE allocate the costs of providing uranium enrichment services among its customers?

--Does DOE's method of allocating costs equitably reflect the costs of providing the services to each customer class?

--If it is costlier to provide high enriched uranium to the government's defense programs, what would be the effect on civilian customers if governmental customers were charged the full costs of service?

Although other questions were raised in his letter, the chairman requested that we provide our answers to these three questions under separate cover by November 15, 1983.

To answer the specific questions, we interviewed program officials at DOE's Office of Uranium Enrichment in Germantown, Maryland, and at DOE's Oak Ridge Operations Office in Oak Ridge, Tennessee. We also interviewed officials from Goodyear Atomic Corporation--the DOE contractor responsible for operating DOE's Portsmouth, Ohio, enrichment plant--which produces the high enriched uranium. We reviewed DOE financial, production,

enriched product delivery, and cost reports, as well as a DOE Inspector General report.[2] Additionally, we reviewed the Goodyear Atomic Corporation's Portsmouth plant's monthly costs of production reports, cost accounting description documents, and enrichment production cost allocation reports.

We used information obtained from interviews, records, and documents to determine DOE's method of allocating uranium enrichment service costs to its various customers. To evaluate the appropriateness of DOE's allocation of enrichment costs, we identified the costs specifically associated with high and low enriched uranium and allocated them to each type of product. For production costs, we used cost data provided by DOE and the Goodyear Atomic Corporation. We examined the validity of the data provided by the Goodyear Atomic Corporation by reviewing the accounting procedures they used to set up cost centers and collect and allocate cost data. Although DOE had assigned nonproduction operating expenses[3] among all separative work units on an average cost basis, we allocated them using the same ratio that exists between high and low enriched uranium production costs. DOE officials told us that this method should result in a reasonable allocation of nonproduction operating expenses.

To assist us in determining the effect of separately allocating enrichment costs to high and low enriched uranium on the current enrichment services price, DOE estimated separate prices for high and low enriched uranium. We did not verify the appropriateness of the enrichment costs forecast used in the model, but we noted that DOE's price computations were based on a model it normally uses for periodically determining the price of enrichment services. We tested the reasonableness of estimated prices provided to us by DOE by reviewing the assumptions DOE made when allocating the projected costs included in its computations.

As requested by the subcommittee chairman's office, to meet the November 15, 1983, deadline for responding to the chairman's questions, we did not obtain official agency comments on this report. Our audit was primarily conducted during August and September 1983. Except for obtaining agency comments and as noted above, we performed our work in accordance with generally accepted government auditing standards.

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[2]Inspector General's Report on the Uranium Enrichment Services Activities (UESA) Financial Statements for Fiscal Year Ended September 30, 1982, ER-0-83-5, dated February 15, 1983.

[3]Nonproduction operating expenses include indirect labor, interest on advanced payments, imputed interest on government investment, DOE administration, and other indirect costs.

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## DOE ALLOCATES ENRICHMENT COSTS BY SEPARATIVE WORK UNITS

A separative work unit is a physics measure for determining the amount of physical effort required to increase the concentration of the fissionable uranium-235 isotope in uranium to a particular level. The number of separative work units required to reach a given level of enrichment depends on the concentration of uranium-235 in the (1) feed or natural uranium[4] before it is enriched, (2) final enriched uranium product, and (3) waste product. DOE publishes and uses a standard table of enriching services,[5] based on an algebraic physics formula, to account for these three variables when determining the number of separative work units required to enrich uranium to a given level.

DOE allocates uranium enrichment services costs among its customers through separative work units. It calculates an average separative work unit price for recovering the costs of providing enrichment services. The price is calculated by projecting the total number of separative work units to be sold during the next 10-year period and dividing it into the total projected enrichment costs for the same period of time. DOE then multiplies the specific number of separative work units required to enrich uranium to a customer's desired level by the price per unit to arrive at a total price for a particular customer's product. For example, an average of 120,000 separative work units per year are required to enrich uranium to fuel a typical 1,000-megawatt nuclear power reactor. At the current price of $138.65 per separative work unit, a utility would spend about $16.6 million per year for enriched uranium to fuel each of its 1,000-megawatt nuclear reactors.

To further illustrate, if one customer wants uranium enriched to 3.3 percent and the other to 98 percent, and the concentration of uranium-235 in the feed and waste product are the same, it will take about 5 and 250 separative work units, respectively, to produce 1 kilogram of uranium enriched to each of these levels. At DOE's current price, a kilogram of the low enriched uranium would cost about $693 and the high enriched uranium about $34,663.

By measuring the number of separative work units required to produce each specific product and charging its customers a single average price per separative work unit, DOE, in effect, assumes that there is a direct correlation between the physical effort and

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[4]Natural uranium contains about 0.7 percent of the fissionable uranium-235 isotope.

[5]Uranium Hexaflouride Table of Enriching Services, Charges, Specifications, and Packaging, DOE.

the enrichment costs associated with that effort. As discussed in the following section, this is not the case.

## DOE'S AVERAGE PRICE PER SEPARATIVE WORK UNIT DOES NOT REFLECT HIGH AND LOW ENRICHMENT COST DIFFERENCES

Using the Goodyear Atomic Corporation study discussed below, we determined that the cost of high enriched uranium is greater per separative work unit than that of low enriched uranium. Since DOE does not allocate costs between high and low enriched product and recovers enrichment costs through the use of a single average price per separative work unit, the greater cost of producing high enriched uranium is in effect being passed on to customers of the less costly, low enriched uranium.

### Contractor study on production cost allocation

In January 1982, Goodyear Atomic Corporation began a study to determine how producing high enriched uranium at Portsmouth, Ohio, was influencing its costs per separative work unit. It undertook the study because the Portsmouth enrichment plant produces both high and low enriched uranium and its cost per separative work unit was higher than expected relative to the other two plants which only produce low enriched uranium. Accordingly, the Goodyear Atomic Corporation began keeping track of Portsmouth's costs associated with producing high and low enriched uranium. It separated production costs[6] for high and low enriched uranium by the physical layout of the Portsmouth enrichment plant. Because low enriched uranium is further enriched to high enriched uranium in only one of the three process buildings at the Portsmouth plant, the production costs for high enriched uranium were determined by segregating that building's costs and adding related support costs.[7] The results of the Goodyear Atomic Corporation study show that the production costs per separative work unit of

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[6]Direct production costs include costs such as power, depreciation of plant equipment, and direct labor. In fiscal year 1983, production costs accounted for about 55 percent of DOE's total enrichment costs.

[7]Support costs are production costs which are not included in the building's production costs. These include costs such as those for the security force and related plant administration.

high enriched uranium was nearly twice as much as that for low enriched uranium during fiscal year 1983.[8]

Our review showed that Goodyear Atomic Corporation accounts for high and low enriched uranium costs at the Portsmouth plant through the use of cost centers. These cost centers clearly attribute enrichment production costs to high and low enriched uranium. For example, while one of the Portsmouth plant's three process buildings is devoted primarily to the production of high enriched uranium, Goodyear has one cost center in that building devoted wholly to the low enriched uranium production activity, and another split evenly between each. The remaining cost centers are for high enriched uranium production activities. By accumulating costs in this way, Goodyear Atomic Corporation was able to determine the costs specifically associated with the production of each. Accordingly, for purposes of our review, we accepted the allocation of production costs at its Portsmouth plant as being reasonable.

GAO allocation of enrichment expenses

To arrive at a total production cost for low enriched uranium, we added Goodyear Atomic Corporation's allocation of low enriched production costs for the Portsmouth plant to the production costs for the other two enrichment plants. By combining this information with Goodyear Atomic Corporation's high enriched uranium cost data, we were able to determine the allocation of total production costs between high and low enriched uranium for fiscal year 1983. This totaled about $1 billion.

In addition to production costs, in its uranium enrichment program DOE incurs nonproduction operating expenses which it must recover. For fiscal year 1983, DOE estimated these expenses to be about $835 million. Because DOE had allocated these expenses between high and low enriched uranium on an average cost per separative work unit basis, we reallocated them in accordance with the same ratio that exists between high and low enrichment production costs. DOE told us our reallocation of nonproduction operating expenses in this manner was reasonable.

Adding our allocations of production costs and nonproduction expenses gave us a total enrichment cost allocation to high and low enriched uranium for fiscal year 1983. We compared our allocation of DOE's fiscal year 1983 enrichment costs with an allocation of costs based on DOE's average cost per separative work unit, as shown on the following page.

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[8]The separative work unit costs for high enriched uranium are classified. Therefore, related cost information and certain cost allocation data is not shown.

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| | GAO comparison of fiscal year 1983 enrichment costs | |
|---|---|---|
| | High enriched | Low enriched |
| | (millions) | |
| Allocation based on average separative work unit costs | $41 | $1,798 |
| Allocation based on an assignment of costs to high and low enrichment services | 75 | 1,764 |
| Over or (under) per GAO | ($34) | $ 34 |

Thus, in fiscal year 1983, our allocation of enrichment costs indicates that low enrichment customers will bear about $34 million more of the costs than is required to provide low enriched uranium. This, in effect, results in low enriched uranium customers subsidizing high enriched uranium costs.

## ESTIMATED EFFECT OF ENRICHMENT COST ALLOCATION ON CUSTOMER PRICE

To determine the effect of separately allocating enrichment costs between high and low enriched products on separative work unit price, we pointed out the cost differences between the two and requested DOE to estimate separate prices for high and low enrichment services. Based on its examination of the costs of producing enriched uranium at its Portsmouth plant, DOE allocated the cost projections used in its calculation of the current price of $138.65 per separative work unit between high and low enriched product. DOE's estimate showed that the current price would increase to between $195.52 and $231.76 per separative work unit for high enriched uranium, and decrease to between $137.35 and $137.79 per separative work unit for low enriched uranium. Because the high enriched uranium price is an incremental price for further enriching low enriched uranium to high enriched uranium, a high enriched uranium customer would be charged the lesser price for each separative work unit required to obtain low enriched uranium and the greater price per separative work unit to convert the low enriched uranium to high enriched uranium. While DOE program officials believe these prices reasonably approximate what the separative work unit prices would be if all costs were actually allocated to high or low enriched product, they pointed out that the price estimates need to be further refined before separate prices are established. These officials also told us that they have not decided whether the cost differences are large enough to warrant establishing separate prices.

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We believe that the cost differences are resulting in DOE's commercial customers being unfairly charged for enrichment services. For example, if the price per separative work unit for low enriched uranium was reduced by about $1, the annual enrichment cost for fueling a typical large reactor would decrease by about $120,000. Given that the useful life of a nuclear power reactor is about 30 years, a $1 per separative work unit reduction could result in a savings of about $3.6 million over the life of the reactor. The potential savings could be greater for large utilities with several nuclear reactors. For example, the Tennessee Valley Authority has five operating nuclear reactors and purchased about 634,000 separative work units in fiscal year 1983. Thus, a $1 price reduction would have reduced its enrichment costs by about $634,000 for that year alone.

## CONCLUSIONS AND RECOMMENDATIONS

DOE's use of a single average price per separative work unit does not fairly allocate the costs of providing enrichment services among customers of high and low enriched uranium. As a result, a portion of the costs which DOE incurs in providing high enriched uranium are being shifted to low enriched uranium, which is primarily used by utilities operating nuclear power reactors. In fiscal year 1983, for example, we estimate that about $34 million of DOE's cost of providing high enriched uranium were assigned to low enriched uranium costs.

So that DOE's customers of low enriched uranium do not bear part of the cost of producing high enriched uranium, we recommend that the Secretary of Energy account separately for the costs of providing high and low enrichment services and, using such cost information, establish separate enrichment prices for customers of high and low enriched uranium.