

DOCUMENT RESUME

04253 - [B3324554]

Uranium Enrichment Policies and Operations: Status and Future Needs. EMD-77-64; B-159687. November 18, 1977. 45 pp. + 2 appendices (10 pp.).

Report to the Congress; by Elmer B. Staats, Comptroller General.

Issue Area: Energy: Making Nuclear Fission a Substantial Energy Source (1608).

Contact: Energy and Minerals Div.

Budget Function: Natural Resources, Environment, and Energy: Energy (305).

Organization Concerned: Department of Energy; Nuclear Regulatory Commission.

Congressional Relevance: House Committee on Science and Technology; Senate Committee on Energy and Natural Resources; Congress.

Authority: Department of Energy Organization Act (P.L. 95-91). Atomic Energy Act of 1954, as amended. S. 2035 (94th Cong.). H.R. 8401 (94th Cong.).

The three U.S. Government-owned uranium enrichment plants which prepare uranium for use as a nuclear reactor fuel provide enrichment services to all U.S. nuclear reactors, all Government research and weapons programs, and most foreign reactors. Findings/Conclusions: When additional enrichment plants beyond those currently planned will be needed depends largely on nuclear power growth, the U.S. share of the foreign enrichment service market, and the use of existing plants and enriched uranium supplies. If there is a uranium shortage and the United States obtains 35% of the foreign market, future enrichment plants will be needed by the 1990's. The only option for meeting long-term demand is to build additional plants. Recommendations: The Secretary of the Department of Energy should: document the results of monitoring the impact of removing or relaxing restrictions on utilities' use of foreign uranium for use by the Congress, industry, and the public; promptly publicize the agency's current stockpile policy and the basis for that policy; examine, with the Department of Defense, the advantages and disadvantages of using some retired weapons material in the civilian nuclear power program rather than using it solely to produce new weapons; prepare and implement a new operating strategy and make it available in report form to interested parties; determine, with the Department of State, the portion of the foreign market necessary to achieve the President's nonproliferation objectives and establish foreign enrichment goals by which to measure the Nation's progress in achieving those objectives and to facilitate planning for future enrichment plants; gradually increase the price of all uranium sold from its stockpile until it equals the market price at the time the Government's uranium is sold; and discontinue the policy of allowing credits for uranium obtained from residual

material that is being recycled and charge customers for the uranium they receive. (Author/SC)

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REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

Uranium Enrichment Policies And Operations: Status And Future Needs

The three Government-owned uranium enrichment plants are the world's primary source of enrichment services. These plants prepare uranium for use as nuclear reactor fuel.

The need for and timing of future plants depends largely on nuclear power growth, the U.S. share of the foreign enrichment services market, and the use of existing plants and enriched uranium supplies.

GAO recommends that the Department of Energy evaluate several options for extending this Nation's enrichment capacity. Other GAO recommendations are aimed at improving policies on (1) the enriched uranium stockpile, (2) uranium imports, (3) the ability to meet additional contract demand, and (4) uranium pricing.

NOVEMBER 18, 1977



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-159687

To the President of the Senate and the
Speaker of the House of Representatives

Uranium enrichment is a fundamental step in the nuclear fuel cycle. Because future enrichment capacity has been a controversial issue for several years, we reviewed the Energy Research and Development Administration's current policies and future plans.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), the Accounting and Auditing Act of 1950 (31 U.S.C. 66(c)), and the Legislative Reorganization Act of 1970, as amended (31 U.S.C. 1152).

We are sending copies of this report to the Acting Director, Office of Management and Budget; the Chairman, Nuclear Regulatory Commission; and the Secretary of Energy.

A handwritten signature in black ink, appearing to read "James B. Atchafalua".

Comptroller General
of the United States

D I G E S T

An adequate supply of enriched uranium is essential to the growth of nuclear power. In recent years, congressional and public debate has been intensive on whether and when additional capacity will be needed to produce enriched uranium and to what extent the Government should be involved in developing a uranium enrichment industry.

Uranium enrichment is a process which prepares uranium for use as a nuclear reactor fuel. It converts natural uranium into a mixture richer in the isotope uranium-235.

There are three uranium enrichment plants in the United States, all owned by the newly created Department of Energy (until October 1, 1977, the Energy Research and Development Administration owned the plants). They provide enrichment services to all U.S. nuclear reactors, all Government research and weapons programs, and most foreign reactors.

GAO identified and assessed the issues on key questions facing uranium enrichment decisionmakers:

- When will additional enrichment capacity, beyond existing and planned facilities, be needed?
- Are there options for meeting short- and long-term excess enrichment demand?
- How can additional long-term enrichment capacity be provided?
- Is ERDA obtaining adequate compensation for its uranium sales?

KEY CONCLUSIONS

There are many uncertainties about the critical factors that affect the answers to the questions above.

Given these uncertainties, G.O reached the following conclusions:

- When additional enrichment plants beyond current plans will be needed depends largely on nuclear power growth, the U.S.

share of the foreign enrichment services market, and the use of existing plants and enriched uranium supplies. (See p. 15.)

--If there is a uranium shortage and the United States obtains 35 percent of the foreign market--about what the Energy agency is forecasting--the United States will need future enrichment plants by the early 1990s. Because of the 8-year lead time required to construct enrichment plants, a decision on future plants would be needed by 1985. If the United States wants to obtain significantly more than 35 percent of the foreign market--a position many feel will help meet balance-of-payments and nonproliferation objectives--and there is a uranium shortage, a decision on future plants would need to be made soon. (See p. 15.)

--There are several possible ways that the agency could meet short-term excess enrichment demand, such as (1) using its enriched uranium stockpile and material from retired nuclear weapons, (2) increasing the amount of uranium left in the residual material, and (3) allowing a contract adjustment period. (See p. 21.)

--The United States has only one option for meeting long-term demand beyond the capabilities of existing and planned facilities--build additional plants. The two primary issues affecting decisions on future plants are (1) the extent that the Government should assist private enrichment groups and (2) the technology that will be used. (See p. 25.)

--The agency's pricing policy for uranium sold from its stockpile under long-term arrangements should be changed to be based on the market price at the time the uranium is sold. (See p. 34.)

--The Atomic Energy Act of 1954, as amended, provides that the agency must charge a reasonable amount in the sale of Government-owned uranium rather than to reduce the enrichment charge by giving its customers a credit for uranium obtained from residual material belonging to the Government. This policy is also not a good business practice. (See p. 36.)

RECOMMENDATIONS

GAO recommends that the Secretary, Department of Energy:

--Document the results of monitoring the impact of removing or relaxing restrictions on utilities' use of foreign uranium for use by the Congress, industry, and the public.

- Promptly publicize the agency's current stockpile policy and the basis for that policy to provide the Congress, industry, and Government officials a clear and current view of the stockpile's potential for meeting short-term customer needs. Any policy changes and their impact should also be publicized.
- Examine, with the Defense Department, the advantages and disadvantages of using some retired weapons material in the civilian nuclear power program rather than using it solely to produce new weapons. The results of this examination should be reported jointly by the agency and the Defense Department to the President and appropriate congressional committees for their consideration in determining the best use of this material.
- Prepare and implement a new operating strategy and make it available in report form to interested parties, including the Congress and private industry. This report should (1) estimate the number of new contracts that can realistically be undertaken with existing and planned enrichment facilities, (2) discuss the need for and timing of future facilities, and (3) describe and explain the agency's current position on the expected size and use of the enriched uranium stockpile, the feasibility of reducing or removing the restrictions on using imported uranium in domestic reactors, and the availability of enriched uranium from retired weapons. The report should be made available to the cognizant congressional committees to help them decide on the need for and timing of future enrichment facilities, and should also be available to interested parties in private industry and the general public. In addition, the agency should make the Congress and the public aware of any changes in its positions.
- Determine, with the State Department, the portion of the foreign market necessary to achieve the President's non-proliferation objectives and establish foreign enrichment goals by which to measure the Nation's progress in achieving those objectives and to facilitate planning for future enrichment plants.
- Gradually increase the price of all uranium sold from its stockpile, including the uranium obtained from recycled tails, until it equals the market price at the time the Government's uranium is sold. The price should be reevaluated periodically to keep it aligned with the market price.
- Discontinue the policy of allowing credits for uranium obtained from residual material that is being recycled and charge customers for the uranium they receive.

ENRICHMENT UNCERTAINTIES

In the analysis that led to this report's conclusions and recommendations, GAO identified critical uncertainties affecting uranium enrichment:

- Electrical demand and the nuclear power growth rate. (See p. 13.)
- The future of spent fuel reprocessing, which could reduce enrichment demand by 20 percent or more. (See p. 11.)
- The percent of the foreign enrichment services market that the United States may want or is able to obtain. (See p. 15.)
- The amount of electricity available to power existing enrichment plants. The agency estimates that electricity supplies will be sufficient to operate the plants at a 90-percent average capacity through 1984. (See p. 6.)
- Uranium shortages. Such shortages may force the agency to operate its plants in a uranium-conserving manner, which would increase the plant capacity needed to produce each unit of enriched uranium. (See p. 8.)
- The amount of enriched uranium available from the agency's stockpile and retired weapons. (See p. 21.)
- The extent that the Government should assist private groups in building future enrichment plants. (See p. 25.)
- The technology that will be used in these plants. (See p. 26.)

AGENCY COMMENTS

The Energy Research and Development Administration disagreed with GAO's recommendations to establish market goals for foreign enrichment sales, consider using enriched uranium from retired weapons for the civilian nuclear power program, and change the agency's uranium-pricing policies.

GAO, in turn, disagrees with the agency's positions and reemphasizes its belief in the desirability of establishing foreign market goals as a sound basis for good management and planning, and, with the Defense Department, examining the advantages and disadvantages of using material from retired weapons for the civilian nuclear power program. (See p. 31.) GAO also reemphasizes that the agency should change its

uranium-pricing policies to provide a more equitable return to the Government. (See p. 40.)

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ABBREVIATIONS

DOE	Department of Energy
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
OVEC	Ohio Valley Electric Company
SWU	separative work unit
TVA	Tennessee Valley Authority

CHAPTER 1

PERSPECTIVE

Nuclear reactors used to generate electricity are fueled by uranium. Before the uranium can be used as fuel for light-water reactors, it must undergo a complex process called enrichment, which converts natural uranium into a mixture richer in the isotope uranium-235.

Uranium enrichment is but one step in the total preparation of uranium for use as nuclear fuel. This complete procedure is called the nuclear fuel cycle and includes

- mining the uranium ore,
- milling the ore to produce uranium concentrate,
- converting the solid uranium to a gas,
- enriching the uranium,
- fabricating the enriched uranium into nuclear fuel,
- removing the spent fuel from the reactor and reprocessing it to recover usable uranium and reactor-produced plutonium, and
- disposing of the highly radioactive wastes.

There are no commercial spent-fuel reprocessing plants operating in the United States today. On April 7, 1977, the President announced that commercial reprocessing in the United States would be indefinitely deferred because of its proliferation implications, and that the United States will explore the possibility of international fuel cycle programs with other nations sharing our nonproliferation objectives.

The future of uranium enrichment in the United States has been a controversial issue for the past several years. The debate over whether the next plant should be Government or privately owned received considerable attention when the President proposed the Nuclear Fuel Assurance Act (S. 2035 and H.R. 8401) to the Congress in June 1975. Passage of this bill would have enabled the Administrator of the Energy Research and Development Administration (ERDA) to enter into cooperative arrangements with (subject to congressional review and approval), and provide assistance and assurance to, as many firms as he believed necessary to develop a competitive private enrichment industry.

Although there was a great deal of controversy over the need for future domestic enrichment capacity, and when and how it should be provided, the 94th Congress was unable to reach a final decision before adjourning.

To provide the Congress with more information to use in making such decisions, we reviewed the status of uranium enrichment in the United States and the projected need for additional enrichment capacity in the future. 1/ We also reviewed ERDA's policies for pricing uranium sold to customers and giving credit to customers for uranium obtained from residual material (tails).

This report recognizes that pursuant to the Department of Energy Organization Act (Public Law 95-91), ERDA's responsibilities were transferred to the Department of Energy (DOE) on October 1, 1977. Therefore, we have addressed our recommendations to the new Department.

URANIUM ENRICHMENT IN THE UNITED STATES

Natural uranium contains seven-tenths of one percent of the energy-producing uranium-235 isotope. The remainder of the natural uranium, uranium-238, cannot be used in nuclear reactors. The enrichment process separates the two uranium isotopes until the uranium-235 content is increased to the desired level--up to about 95 percent for weapons purposes. Light-water reactors require uranium enriched to about 3-percent uranium-235.

Uranium enrichment facilities in the United States consist of three ERDA-owned plants located at Oak Ridge, Tennessee; near Paducah, Kentucky; and near Portsmouth, Ohio. These plants are operated by private firms under cost-plus-fixed-fee management contracts. Union Carbide Corporation, Nuclear Division, operates the Oak Ridge and Paducah plants, and Goodyear Atomic Corporation operates the Portsmouth plant.

These ERDA uranium enrichment plants use a process called gaseous diffusion to enrich the uranium. ERDA has successfully used this process for the past 30 years.

1/Any reference to "future" enrichment facilities refers to facilities beyond the Government's three existing gaseous diffusion plants and planned centrifuge facilities.

The gaseous diffusion process depends on the small difference in weight between the uranium-235 and uranium-238 isotopes in the uranium gas or feed material. The feed is forced through a series of filters that separate it into two streams. The lighter uranium-235 isotopes pass through the filters more readily than the other isotopes and become the product stream. The heavier isotopes are collected into the second stream, which is residual material (tails).

There are three other enrichment processes currently under development by ERDA. In the centrifuge process, the uranium spins in a tube until the lighter and heavier isotopes have separated into two streams. On April 20, 1977, the President announced that instead of building a gaseous diffusion addition to its Portsmouth, Ohio, plant, the agency would build an equivalent-size centrifuge facility because

--it would require only about 4 percent as much electricity as the gaseous diffusion facility, and

--recent reductions in projected enrichment demand were sufficient to allow any temporary excess demand to be covered by the enriched uranium stockpile and to allow time to fully develop the centrifuge technology.

The laser isotope separation method uses a laser beam to separate the uranium. This process is still being tested and, according to ERDA, will not be ready for use in the near future.

The Dawson separation process uses magnetic force to separate the uranium. This process although promising, still requires substantial research and development before it will be ready for commercial use.

OPERATION OF ERDA'S PLANTS

ERDA's plants were originally operated to produce enriched uranium for nuclear weapons programs. Since the beginning of the civilian nuclear power program, the plants' primary product has shifted from weapons material to reactor material. The plants now produce enriched uranium to fulfill contracts with domestic and foreign utilities and for use in Government research and military programs.

The amount of enriched uranium that can be produced by ERDA's three existing plants is influenced primarily by two factors: (1) plant capacity and (2) plant operating mode (tails assay).

Plant capacity

The production capacity of enrichment plants is defined in terms of separative work units. Separative work units (SWU) are not a quantity of material but a measure of the effort expended to separate a given quantity of uranium feed into two streams (one having a higher percentage of uranium-235). ERDA's existing plant capacity is about 19.3 million SWU and is being expanded to about 28 million SWU by 1981. ERDA plans to build gas centrifuge facilities that will add another 8.8 million SWU, bringing ERDA's total capacity to almost 37 million SWU by the late 1980s. The amount of enriched uranium that can be obtained from these SWU depends on the plants' operating mode.

Operating mode

The operating mode (tails assay) determines the amount of uranium-235 that remains in the depleted uranium (tails) after enriching the uranium to the necessary level. The tails assay determines the amount of feed and separative work needed to produce a given quantity of enriched uranium. For example, if the tails assay is increased, less separative work is required because less uranium-235 is being concentrated in the product and more uranium-235 is left in the tails. However, additional feed is required to produce the same amount of enriched product. Conversely, if the tails assay is decreased, more separative work but less feed is required. Since electricity is required to operate the plants, any increase in separative work will also require a corresponding increase in electricity. The table below illustrates the effect of various tails assays on the feed and SWU required to enrich one kilogram of natural uranium to 3 percent uranium-235.

<u>Tails assay</u> (percent)	<u>Feed</u> <u>required</u> (kilograms)	<u>SWU</u> <u>required</u>	<u>Enriched product</u> (kilogram)
.20	5.48	4.31	1.0
.25	5.97	3.81	1.0
.30	6.57	3.42	1.0

The following chapters discuss the supply of, and demand for, enrichment services; compare the supply and demand; and discuss possible ways to meet short-term excess demand and decisions needed on future U.S. enrichment capacity. They also discuss several of ERDA's policies regarding uranium sales and prices.

CHAPTER 2

SUPPLY OF AND DEMAND FOR

ENRICHMENT SERVICES

Until recently, the three U.S. plants were the only major source of enrichment services in the free world. In the past few years, however, several foreign countries and consortiums have built, or are building, enrichment facilities. This report primarily addresses the U.S. ability to meet U.S. and foreign demand.

An adequate supply of enriched uranium is vital to the continued growth of nuclear power. Before utilities can proceed with plans for additional nuclear powerplants, they must be assured of a fuel supply (including enrichment services). If nuclear power is to provide a major portion of this Nation's energy needs, actions must eventually be taken to provide the necessary enrichment plants.

The construction of additional enrichment plants may also have implications for this Nation's balance of payments and nuclear nonproliferation objectives. By maintaining its current share of the market, the United States may be able to more effectively discourage other countries from building their own enrichment facilities and may be able to use its market position as a negotiating tool in implementing its international safeguard and nonproliferation policies.

The following sections identify and compare the expected supply of uranium enriching capacity to existing and projected demand.

SUPPLY

ERDA's overall objective in operating its enrichment plants is to maximize the production of enriched uranium to assure that

- current contract requirements are met,
- Government requirements are satisfied, and
- a stockpile of enriched uranium is established for emergency use.

In meeting these objectives, ERDA must operate its plants under certain physical constraints, including (1) plant capacity, (2) power availability, and (3) uranium availability.

Current and planned plant capacity

ERDA is currently expanding its enrichment capacity and, as noted on page 3, plans to build additional capacity. The expansion effort, however, requires large quantities of electricity that suppliers may have difficulty providing. Actual capacity, therefore, could vary--depending on the electrical power supply.

Current capacity expansion

ERDA's capacity expansion program was initiated in 1971 and is scheduled for completion in 1981. This expansion program consists of two subprograms--the Cascade Improvement Program and the Cascade Upgrading Program.

The Cascade Improvement Program will increase the efficiency of plant operations by modifying the process equipment to incorporate the most recent technological improvements. The Cascade Upgrading Program will increase the capacity of existing plants by enlarging the plants' electrical systems and cooling capability. Because of their magnitude, these programs are being accomplished in phases.

As of January 1977 ERDA had obtained about 2.1 million additional SWU annually from completed phases of the expansion program, giving it a current maximum capacity of about 19.3 million SWU. Upon the scheduled completion of these programs, ERDA expects to have obtained an additional annual increase of about 8.7 million SWU.

Additional facilities

In fiscal year 1976 ERDA was authorized to build additional enrichment facilities. ERDA planned to provide this capacity by adding to its existing gaseous diffusion plant at Portsmouth, Ohio. This was to be a contingency measure to assure that domestic enrichment capacity was available even if the private industry ventures failed. As noted earlier, however, the President announced that ERDA will build equivalent-size gas centrifuge facilities (to be completed in the late 1980s) instead of the Portsmouth gaseous diffusion addition. This additional capacity will enable ERDA to operate at a lower tails assay, thereby conserving natural uranium resources and, also, service some additional customers.

Power availability

Currently, there is not enough available electrical power to operate the gaseous diffusion plants at their maximum

capacity of 19.3 million SWU. As a result, ERDA's actual fiscal year 1977 capacity will be about 15.4 million SWU. Actual capacity will remain below maximum until 1985, when ERDA expects to have all of its planned power. Because the plants will have received less than maximum power between 1978 and 1984, ERDA's expected production will be about 19 million fewer SWU--about 10-percent lower than the maximum capabilities of the expanded plants.

Also, the availability of power in the future is contingent upon several factors that are not certain. ERDA is presently obtaining electrical power from three suppliers --Tennessee Valley Authority (TVA), Electric Energy Incorporated, and Ohio Valley Electric Company (OVEC). TVA has contracted to provide power to the Paducah and Oak Ridge plants into 1990, but some power through 1984 is under a "best-effort" contract that ties delivery to TVA's generating capacity. As the generating capacity of the TVA system reaches certain prescribed levels, additional power is contractually made available to the plants. OVEC supplies the power for ERDA's Portsmouth plant. The present OVEC contract extends through March 1979. ERDA plans to negotiate a second contract that will cover deliveries through the 1990s.

Any difficulties encountered by the utilities in achieving their planned generating capacities could adversely affect the plants' SWU production. For example, during the first half of fiscal year 1977 ERDA lost 1,365,000 SWU of its expected production (about 14-percent) when construction schedules for two TVA nuclear powerplants were delayed and TVA was unable to deliver the expected power. ERDA also has a policy to release power to its suppliers to provide electricity for residential and industrial customers in an emergency. For example, during the unusually severe winter of 1976-77 ERDA lost an additional 184,000 SWU when TVA was permitted to direct some of ERDA's power to its other customers. Although ERDA officials are reasonably certain that the plants will have at least the expected power deliveries, accidents and losses such as those mentioned above cannot be predicted or prevented. With the United States becoming increasingly dependent upon electricity, such incidents are likely to occur again in the future.

The power for the centrifuge facilities is not yet under contract but, as noted earlier, these new facilities will need only about 4 percent as much power as would the gaseous diffusion addition that would have required the construction of three new powerplants. ERDA does not anticipate any problems in purchasing the power necessary to operate the centrifuge facilities.

Uranium availability

ERDA provides only the enriching services; customers must provide the uranium feed to be enriched. The customers purchase most of this feed on the open market; however, some of it is purchased from ERDA. (See p. 34.) ERDA's plant operations are affected by the utilities' ability to obtain an adequate uranium supply. If there is a uranium shortage, the plants must operate at a lower tails assay to enable ERDA to meet its contract demand while making the most efficient use of available uranium resources. If the demand for enriched uranium grows as projected--or faster--ERDA could raise the plants' tails assay and thereby release additional SWU capacity to meet the increased demand. This would be a useless exercise, however, if the customers are unable to obtain the larger quantities of uranium feed required by operating the plants at a higher tails assay.

Domestic uranium availability is primarily dependent upon (1) the amount of uranium ore that is economically recoverable and (2) the U.S. mining and milling industries' capacity for extracting the ore and processing it into uranium concentrate. ERDA's estimates of economically recoverable domestic uranium resources show that U.S. utilities will be heavily dependent upon unproven but expected uranium deposits. If these deposits are not as productive as expected, the uranium supply could fall short of demand.

By the early 1980s ERDA expects that the milling industry will begin large-scale processing of ore with a lower uranium content. The necessary mill modifications and expansions will depend on many factors--such as capital, labor, and equipment availability--making future production levels difficult to predict. Because utilities will become increasingly dependent upon low-quality ore, the milling industry's success in this area is an important factor in determining the domestic uranium supply.

A comparison of ERDA's most recent uranium production estimates and projected domestic uranium requirements shows that supplies should be ample at least through 1990. However, supply estimates are based on assumptions about existing and expected resources and planned increases in the number of production facilities and are, therefore, subject to revision. If, for example, production facilities are not built as expected, supply could fall short of demand in the late 1980s. Such shortfalls could advance the date by which future enrichment capacity will be needed.

There are other studies, however, that predict a very tight uranium supply and still others that state that there

is an abundant supply. For example, the National Research Council in an April 1977 draft report 1/ estimates that uranium production will fall significantly short of ERDA's projected demand. On the other hand, the Nuclear Energy Policy Group projects that domestic uranium resources will be more than adequate through at least the year 2015 or 2020. 2/ These conflicting opinions have made the utilities uncertain of future fuel supplies, thus contributing to the recent decline in the nuclear power growth rate.

Because there is some uncertainty about uranium supplies, ERDA plans to operate its enrichment plants at a tails assay that will allow it to make the most efficient use of uranium fuel and still meet its contract requirements.

Commercial spent-fuel reprocessing could, according to a Nuclear Regulatory Commission (NRC) estimate, reduce the domestic uranium demand by about 22 percent through the year 2000 by capturing some of the energy in spent fuel. There are a number of unresolved safety and safeguards issues surrounding reprocessing technology, however, and in view of the President's April 7, 1977, announcement to indefinitely defer commercial reprocessing, it is unlikely that reprocessing will have any impact on the demand for uranium in the near future.

In addition to domestic uranium supplies, the United States may also draw on foreign supplies. However, under provisions of ERDA's uranium enrichment services criteria established pursuant to the Atomic Energy Act of 1954, as amended, U.S. utilities may only import up to 10 percent of the uranium required during 1977 for their ERDA enriching contracts. The allowable percentage will increase to 15 percent in 1978, 20 percent in 1979, 30 percent in 1980, 40 percent in 1981, 60 percent in 1982, and 80 percent in 1983. Starting in 1984 there will be no restrictions. The purpose of a gradual increase in the use of foreign uranium is to assure the stability of the domestic uranium industry.

1/"Problems of U.S. Uranium Resources and Supply to the Year 2010," Uranium Resource Subpanel of the Energy Fuel Resources Group, Committee on Nuclear and Alternative Energy Systems, National Research Council, April 6, 1977.

2/"Nuclear Power Issues and Choices," the Nuclear Energy Policy Study Group, sponsored by the Ford Foundation, administered by the MITRE Corporation, Ballinger Publishing Company, Cambridge, Massachusetts, 1977.

If there is a uranium shortage, imported uranium could help meet domestic uranium requirements, thereby relieving some of the strain on the domestic mining and milling industries and preserving some domestic uranium resources for later use. This option is not without its shortcomings, however. For example, allowing more uranium to be imported could adversely affect the domestic uranium industry by reducing domestic uranium sales and revenues needed to reinvest in exploration and development of new deposits.

ERDA officials, in commenting on this report, said that they have studied this policy on several occasions but could not provide any formal reports for our review. They said that removing uranium import restrictions would have little or no immediate effect on the ability of domestic customers to purchase foreign uranium because

--most foreign uranium immediately available is already committed, and

--uranium contracts are usually entered into 5 to 10 years in advance of delivery and existing import restrictions will, for the most part, be lifted by the time delivery is made under these contracts.

ERDA officials also pointed out that utilities are not precluded from importing and stockpiling foreign uranium for use when the import restrictions on using foreign uranium are relaxed in the future. Also, since several foreign countries rely more heavily on nuclear power than the United States, leading uranium-exporting nations may further limit the uranium available to the United States to assure that their own needs are met. Canada, for example, will not permit exporting uranium until the uranium requirements for its operating and planned reactors for 30 years have been assured.

We agree that, if there is little or no foreign uranium available today, changes in import restrictions would not help relieve a domestic uranium shortage. However, because foreign uranium supplies are uncertain and estimates are subject to change--as evidenced by Australia's recent announcement that it has lifted the ban on mining its vast uranium deposits and that the uranium would be available for export --we believe that DOE should continue to periodically study and should document the advantages and disadvantages of changing the restrictions to allow increased uranium imports so that, if a shortage occurs, it will be able to know whether it is an appropriate action to take.

In view of all the uncertainties about uranium availability and its importance to the nuclear industry, we are conducting a separate review of domestic and foreign uranium supply estimates in an attempt to identify reasonably acceptable estimates.

DEMAND

There are two categories of enrichment demand--existing demand and projected future demand. Unfortunately, future demand for domestic enrichment services is very uncertain, and thus may vary, depending on assumptions about electrical consumption growth rates, nuclear power growth rates, the decision on spent fuel reprocessing, uranium supply, percentage of the foreign market that can or will be obtained by U.S. enrichers, and general economic conditions.

One of the most critical--and controversial--issues affecting the demand for enrichment services has been spent-fuel reprocessing. Light water reactors can use only about 2 percent of the energy in uranium fuel before that fuel must be replaced. Also, in using this fuel, some of the uranium-238 is converted to plutonium, which is also a usable nuclear fuel. Thus, a great deal of energy remains in the spent fuel. Reprocessing spent fuel would recapture much of this energy. NRC's analysis of reprocessing shows that it could reduce this Nation's total enrichment requirements by about 14 percent through the year 2000.

NRC is evaluating the costs and benefits of wide-scale spent-fuel reprocessing and, at the conclusion of its evaluation, NRC is expected to decide whether it will license reprocessing facilities in the United States. However, on April 7, 1977, the President announced that because of associated safety and safeguards problems, commercial reprocessing in the United States would be deferred indefinitely. Although it is still feasible for NRC to reach a favorable decision on reprocessing, it is not likely that it would take a position directly opposing the President's policy statement. Therefore, in the following discussion of existing and projected demand--both domestic and foreign--enrichment requirements are given assuming no spent fuel reprocessing.

Existing demand

Most of the existing demand for U.S. enriching services is under one of three types of contracts: (1) requirements contracts, under which ERDA agrees to supply all of the enrichment services required to fuel a specific nuclear reactor, (2) fixed commitment contracts, under which ERDA agrees

to provide fixed amounts of enrichment services for a certain time period, and (3) conditional contracts, under which ERDA agrees to provide enriching services if spent-fuel reprocessing is approved. All conditional contracts are with foreign customers and, although technically dependent upon NRC's approval of spent-fuel reprocessing, former President Nixon announced on August 6, 1974, that these contracts would be fulfilled under any circumstances.

As a result of economic conditions and the prolonged licensing process due to increased concern about nuclear power environmental and safety questions, nuclear reactor orders have declined. For example, only three reactors were ordered by domestic utilities in 1976.

To align its enriching contracts more closely with its customers' needs, in June 1975 ERDA offered its customers a one-time option (known as an open season) to defer or cancel their enrichment services contracts. Many utilities used this opportunity to terminate or slip their enrichment schedules several months. About 65 percent of the delays were due to decreases in electricity demand and economic problems; the other 35 percent were due to construction or other problems. This option reduced the number of domestic reactors under ERDA contracts from 233 to 209, the number of foreign reactors under ERDA contracts from 179 to 152, and reduced total enrichment requirements by about 20 percent--which delayed the need for additional plant capacity.

The following table shows the expected SWU required to fulfill ERDA's existing contracts, assuming the plants operate at 0.25-percent tails assay as currently planned by ERDA. The table also shows Government requirements for research and weapons programs.

Separative Work Requirements Under ERDA Contracts
Based on 0.25-Percent Tails Assay

<u>Fiscal year</u>	<u>Utility contracts</u>	<u>Government requirements</u>	<u>Total</u>
------(in millions of SWU)-----			
1977	10.1	1.3	11.4
1980	18.2	1.3	19.5
1983	28.6	1.3	29.9
1985	33.7	1.8	35.5
1990	33.5	1.7	35.2

Projected demand

Many Government, private industry, and research groups have projected future expected nuclear generating capacity. Because there are so many uncertainties involved and assumptions that must be made, these projections vary greatly --depending on the combinations and values of assumptions that are made. Projections of the number of installed nuclear reactors have consistently been revised downward since the early 1970s. For example, in 1965 the former Atomic Energy Commission projected that there would be about 450 nuclear powerplants in 1985; in 1970 it projected 300 plants in 1985; and in 1977 ERDA projected that there will be only about 127 plants in 1985. Although the Government has historically encouraged the growth and development of nuclear power, recent White House policy statements indicate that the Government will be taking a more critical and cautious approach to nuclear energy that will most likely have a limiting effect on nuclear power growth. ERDA's 1977 moderate growth projections are shown in the following table.

Projected Nuclear Capacity (note a)

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>
	----- (in thousands of megawatts) -----			
Domestic	60.4	127.1	195.1	380.5
Foreign	<u>65.9</u>	<u>143.9</u>	<u>286.0</u>	<u>640.0</u>
Total	<u>126.3</u>	<u>271.0</u>	<u>481.1</u>	<u>1020.5</u>

a/A standard-size nuclear reactor produces about 1,000 megawatts of electricity annually.

The computer model that calculates ERDA's nuclear capacity projections also calculates the amount of enriching services required to support the projected capacity. ERDA's projected enriching services requirements are shown in the following table. Projected enrichment requirements are presented at a 0.20-percent tails assay because this is the assay at which most ERDA and industry officials expect future plants to operate. However, ERDA plans to operate its plants at about a 0.25-percent tails assay at least through 1990, which could increase requirements in those years by as much as 10 percent.

ERDA's Projected SWU Requirements
for Future Nuclear Capacity
Based on 0.20-Percent Tails Assay

	<u>Domestic</u>	<u>Foreign</u>	<u>Total</u>
	----- (in millions of SWU) -----		
1980	9.1	8.9	18.0
1983	14.1	13.6	27.7
1985	16.5	18.6	35.1
1987	19.9	24.5	44.4
1990	24.7	34.0	58.7
1995	34.3	50.0	84.3
2000	43.7	66.8	110.5

The following section compares the existing and planned supply of enriching services to the existing and future demand.

SUPPLY VERSUS DEMAND

ERDA'S three existing plants represent, at least for the immediate future, the free world's primary supply of enrichment services and the United States only supply. Supply will increase in the next 5 to 10 years with the addition of domestic and foreign plants now in the planning stages or under construction.

The Government's requirements for enriching services represent only about 5 percent of ERDA's annual capacity through 1990. ERDA's plans have allocated the necessary SWU for these requirements and, if the plants operate at expected levels, ERDA officials expect no problems in fulfilling these requirements.

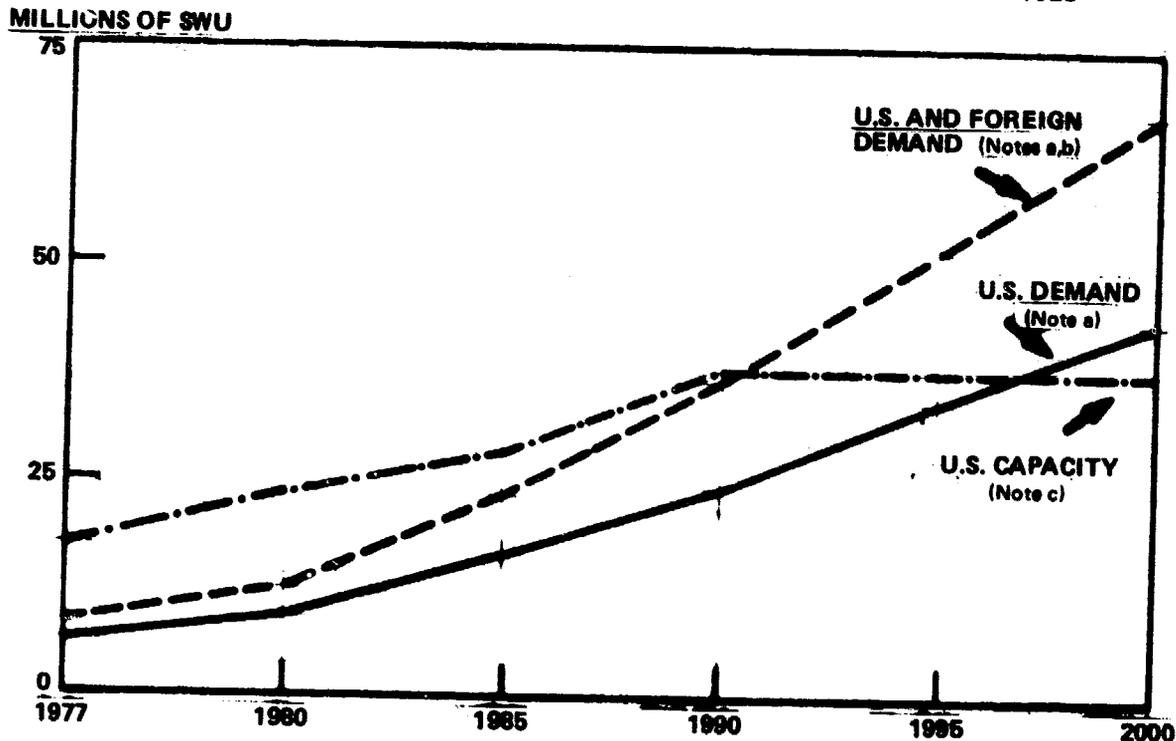
Because there is a 10-year leadtime needed to plan, license, and build new nuclear powerplants, utilities must soon begin planning for plants to be operating in the early 1990s. One factor they must consider in making a decision is whether enrichment capacity will be available. The uncertainty associated with future U.S. enrichment capacity is one factor contributing to the recent slowdown in nuclear power growth. A definite commitment to build future U.S. capacity could remove some of this uncertainty.

In addition, because many foreign countries plan to rely heavily on nuclear power and thus create a rapidly growing enrichment demand, additional U.S. capacity could be justified before the 1990s if it were used to meet foreign demand. The current U.S. policy on selling enrichment services to foreign customers is that it is in the United States best interests, both politically and economically, to remain a reliable supplier to its foreign customers. Other countries are entering the enrichment supply market, however, and ERDA officials expect the percentage of foreign demand supplied by the United States to decrease.

ERDA's current contracts represent over 90 percent of the estimated foreign market. Compared with ERDA's projected foreign requirements these contracts will represent at least 50 percent of the potential foreign market through 1988. ERDA projects, for planning purposes, that the United States should be able to maintain a reasonable share of the market in the future (30 to 40 percent). For our analysis, we used a 35-percent share of the foreign market (about the same as that used by the agency in its planning) as a base case for projecting future enrichment demand.

The following graph summarizes the relationship between ERDA's existing and planned capacity and projected demand for enrichment services.

ANNUAL PROJECTED DEMAND FOR U.S. - SUPPLIED ENRICHMENT SERVICES



a/ Domestic and foreign demand are based on ERDA's moderate-growth projections, assuming no reprocessing and a 0.20-percent tails assay.

b/ Foreign demand supplied by U.S. capacity is 35 percent of ERDA's estimate of total foreign demand.

c/ U.S. capacity includes the three existing plants and the planned centrifuge facilities.

Total demand for U.S. enrichment capacity will exceed existing supply in the early 1990s, assuming the United States has 35 percent of the foreign market. If the uranium supply is sufficient to allow operations at a 0.30-percent tails assay, additional capacity beyond what currently exists or is planned may not be needed until the mid-1990s.

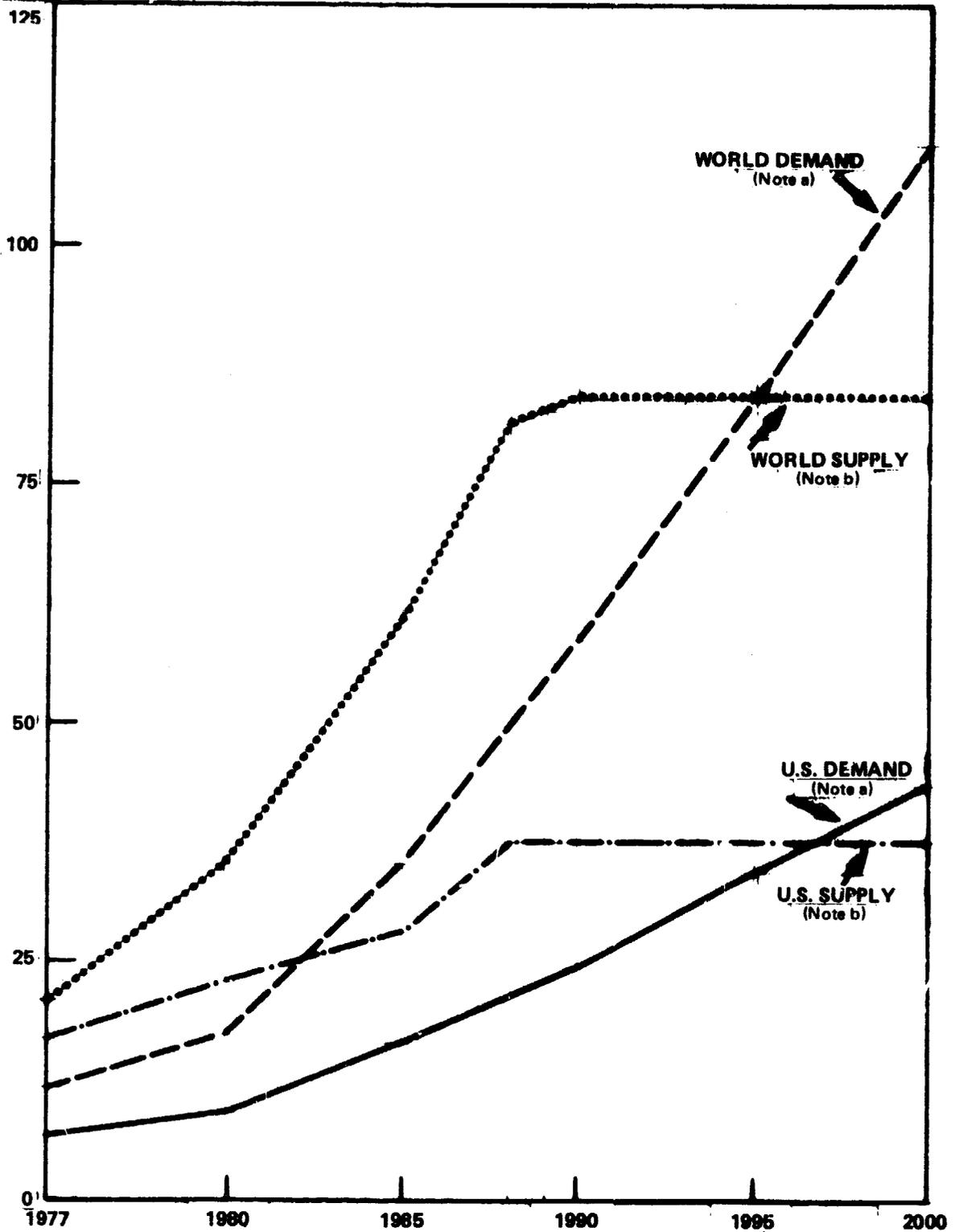
The United States has traditionally attempted to be a reliable supplier of enrichment services in an effort to limit the proliferation of nuclear technology and weapons capability and to improve the Nation's balance of payments. On April 7, 1977, the President expressed a desire to

maintain this Nation's role as a major and reliable supplier of reactor fuel. Under this policy, the United States may want to increase its future market share beyond the 30 to 40 percent used by ERDA in its forecasting, which would advance the date by which additional capacity would be needed.

A comparison of worldwide supply of and demand for enrichment services--assuming a 0.20-percent tails assay and no reprocessing--shows that additional capacity to meet world demand will be needed sometime around 1995. The following graph illustrates this point.

WORLD SUPPLY OF AND DEMAND FOR URANIUM ENRICHMENT SERVICES

MILLIONS OF SWU



a/ERDA's moderate growth projections, assuming 0.20-percent tails assay and no reprocessing.

b/Enrichment plants announced, planned, under construction, and existing.

Even with significant additions to the world supply of enriching services by foreign countries, however, national policies may hinder the natural market actions that would appropriately distribute the supply. For example, one of the European consortiums may restrict their customers to countries participating in the construction of the plant.

CONCLUSIONS

Because of the many uncertainties about the need for and timing of additional enrichment capacity, the question of when additional capacity will be needed is also highly uncertain. It is affected by the anticipated growth in electrical demand and nuclear power, the decision on spent-fuel reprocessing, the uranium supply, the ability to obtain the necessary power to operate existing plants, and the percentage of the foreign market the United States may want or is able to obtain.

By not reprocessing spent fuel, operating at a low tails assay, and favoring a policy of obtaining about 35 percent of the foreign market, future U.S. capacity will be needed in the early 1990s. Considering the long lead-times required to construct enrichment plants, the decision to build future plants could not be delayed beyond 1985. If the United States wants to obtain significantly more than 35 percent of the foreign market, a decision needs to be made soon.

Commenting on this report, ERDA officials said that the decision to build a new plant beyond the planned centrifuge facilities could not be delayed until 1985. They believe that, because of the long leadtimes for congressional decisions, contract awards, and construction, the decision should be made within 2 or 3 years. We agree that an earlier decision would be better, but estimates indicate that a 1985 decision would not prohibit the construction of a new plant by the early 1990s.

If ERDA is able to operate its plants at a 0.30-percent tails assay, the need for future plants may be delayed until the mid-1990s. Again, an increase in the share of the foreign market would advance this date. However, a 0.30-percent tails assay requires more uranium and, because uranium supplies are uncertain, operating at a 0.30-percent tails assay may not be practical.

Uranium availability is one of the major and most controversial factors affecting ERDA's enrichment activities and the entire nuclear industry. Although ERDA projects an adequate uranium supply, some experts disagree. This

uncertainty could hinder the growth of domestic nuclear power, and the desire to conserve uranium supplies has become an important factor in ERDA's operating plans. Several foreign countries (such as South Africa and Australia) have large uranium deposits and could supply enough uranium to U.S. customers to relieve some of the pressure on domestic mining and milling companies and to extend domestic uranium resources. The United States faces strong competition for these supplies from other nations, however, and foreign policies may further restrict the available quantities. We are currently reviewing the issues surrounding domestic and foreign uranium availability to attempt to identify reasonably acceptable estimates.

CHAPTER 3

POSSIBLE WAYS TO MEET

ENRICHMENT DEMAND

Although current projections of the future supply of and demand for enrichment services cover a wide range of possibilities, most show an eventual excess of demand over supply, both domestically and internationally. In the short term, ERDA has several possible alternatives for using its existing capacity to temporarily meet excess demand. The only feasible solution for meeting long-term increased demand on a permanent basis is to build additional enrichment plants.

The need for and timing of additional domestic capacity, beyond the new gas centrifuge facilities depends on assumptions about uranium availability, the growth rate of nuclear power, decisions about spent-fuel reprocessing, the percentage of the foreign market this country will want and be able to obtain, and general economic conditions. The following sections discuss possible ways to meet both short-term and long-term excess enrichment demand.

SHORT-TERM ACTIONS

There are several possible actions available to ERDA that could either increase plant production or redistribute the existing supply (1) to relieve those customers whose expected nuclear capacity has been revised downward and (2) to service those that need the enrichment services. These short-term actions include (1) selling enriched uranium from the ERDA stockpile or from retired weapons systems, (2) raising the plants' operating tails assay to allow ERDA to service additional contracts, and (3) allowing customers with unwanted enriching contracts to cancel or defer their contracts to make capacity available for new customers.

While some or all of these actions can extend the date by which additional capacity will be needed, and can provide the SWU to meet interim excess demand, they must be regarded as short-term solutions only.

Selling from the enriched uranium stockpile and retired weapons systems

One of ERDA's operating objectives is to maximize its enriched uranium stockpile and use it to (1) meet excess demand during peak years, (2) provide a working inventory at the enrichment plants, and/or (3) provide insurance against unknown or uncertain future needs and production. ERDA may

use the stockpile to meet the short-term needs of a few additional customers, but has not yet made any commitments. Although using the stockpile to meet short-term needs appears to be a simple solution, the extent to which it could be used depends on the quantities available and the type of sales contract used. In any event, there will be a limited quantity available, and ERDA must determine how it will be distributed.

ERDA officials currently estimate that an inventory equivalent to about 15 million SWU is needed for the three purposes stated above. According to these officials, however, this need is subject to change as real-world conditions change. Depending on future plant operations, the actual size of the enriched uranium stockpile in 1985 could range from 25 to 30 million SWU. Thus, unless conditions change, from 10 to 15 million SWU--or enough to fuel 16 to 25 nuclear powerplants for 5 years--could be available to meet additional customers' short-term needs.

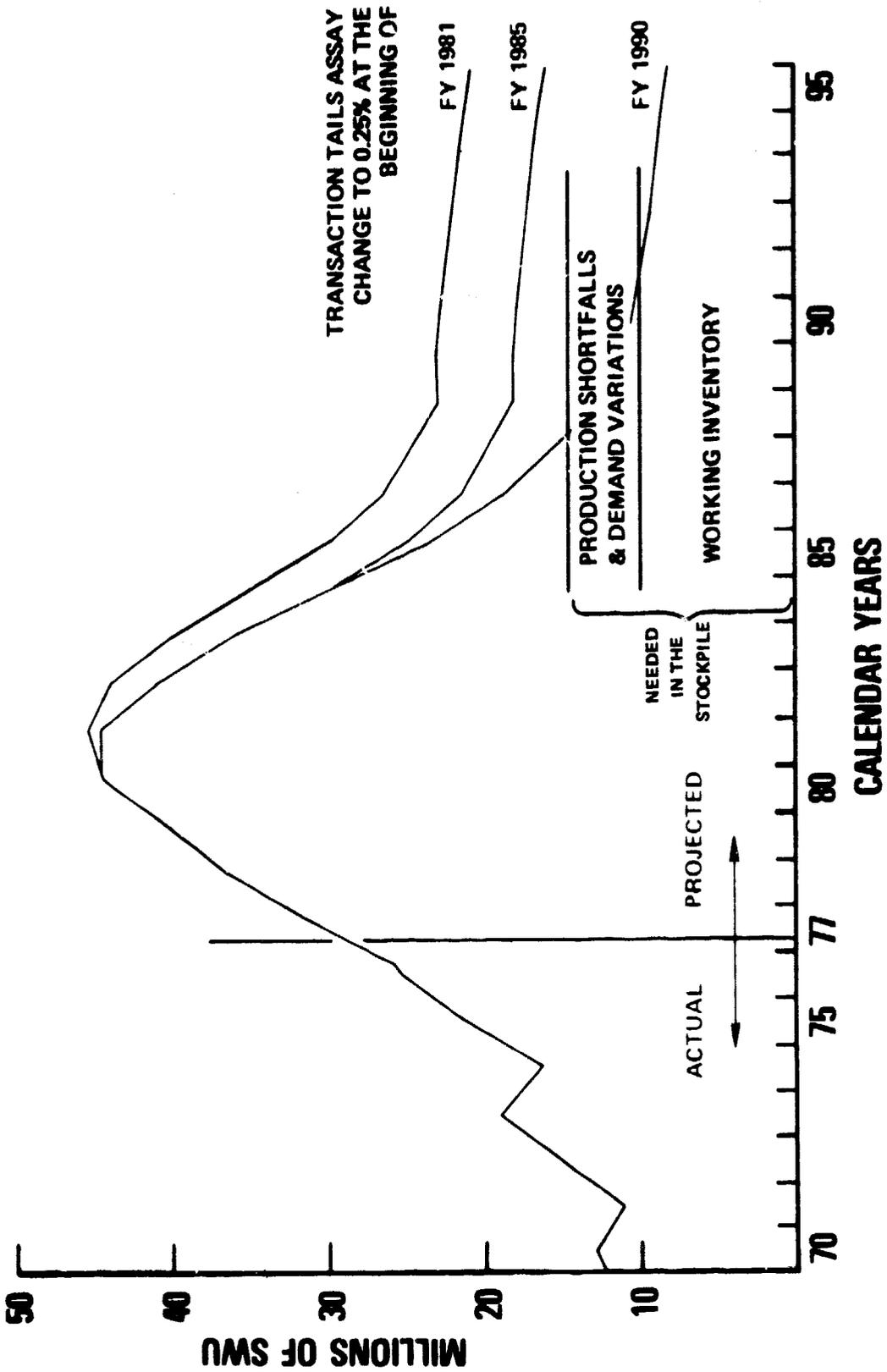
The graph on page 23 shows ERDA's anticipated stockpile levels, assuming the plants operate at about 0.25-percent tails assay and spent-fuel reprocessing is not permitted. These estimates are subject to all the factors that affect ERDA's SWU production, such as electricity and uranium availability.

ERDA has not widely publicized its policy on the enriched uranium stockpile. Because there seems to be some public and congressional misconceptions about the size of the stockpile and how it could be used, DOE should promptly publicize its stockpile policy and its basis. This policy should also be included in an overall report on ERDA's enrichment plant operating policies and plans.

Another possible source of enriched uranium is the material contained in retired weapons systems. The uranium removed from the retired weapons could be blended with the enriched uranium stockpile and used to meet commercial demand. In the fiscal year 1977 appropriations hearings, an ERDA official stated that the weapons program needed all the uranium from retired weapons. We reviewed ERDA's current plans and found that, although significant quantities of enriched uranium will be removed from retired weapons, it is all scheduled to be recycled into new weapons, according to ERDA's plans.

Although the enriched uranium required for the nuclear weapons program is produced and handled by ERDA, the quantities needed are determined by the Defense Department. Thus,

ERDA-ENRICHED URANIUM STOCKPILE



any changes in the use of enriched uranium designated for the weapons program must be made by the Defense Department.

There is a need to further consider the tradeoffs in using this potential source of enriched uranium to meet domestic energy needs. The issue is: What are the tradeoffs between using this material in new weapons production or using it to meet domestic energy needs? According to an ERDA official, such an assessment has not been made.

Increasing the operating tails assay

As discussed in chapter 1 (see p. 4.), a higher tails assay requires less SWU per unit of enriched uranium than a lower tails assay. Thus, ERDA could service more contracts with its existing and planned capacity by operating at a higher tails assay. However, a higher tails assay requires more feed per unit of enriched uranium and ERDA cannot raise the tails assay beyond uranium suppliers' ability to meet the increased demand.

Before ERDA was authorized to increase its enrichment capacity, it planned to operate its three existing plants at a 0.37-percent tails assay (assuming no spent-fuel reprocessing) to meet its existing contract requirements. After ERDA was authorized to increase its capacity, ERDA planned to use the additional capacity to supply existing contracts and operate all the facilities at a lower (0.25 percent) tails assay because of uncertain uranium supplies.

On April 20, 1977, the President announced that the order books for enrichment services contracts would be open to new customers. If the planned centrifuge facilities were used solely for new business, ERDA could service up to 90 additional reactors. However, for the reasons discussed above, only a portion of the facilities will be available for new contracts. ERDA officials currently estimate that they will be able to service about 10 additional reactors while operating at a 0.25-percent tails assay; but this estimate is subject to change, depending on such factors as ERDA's decision on another contract adjustment period and the ultimate stockpile size.

The impact of using the new centrifuge facilities to supply new customers on the plants' total operations must also be considered. For example, additional contracts would require plant capacity that would have otherwise been dedicated to increasing the enriched uranium stockpile. Thus, management's flexibility for meeting unforeseen emergencies could be hampered.

Allowing another open season

In the first quarter of fiscal year 1977, domestic utilities announced 32 reactor schedule slippages and one cancellation. Thirteen of the announced slippages were due to a decline in the need for power and financial and economic reasons. Compared to utility actions about the time of the 1975 open season--95 slippages and 23 cancellations for the above reasons in a seven-quarter period--this represents a significant slip in scheduled nuclear plants.

Also, a comparison of ERDA's contracted domestic SWU requirements with its projected domestic SWU requirements shows that the contracted requirements exceed the projected requirements by 2 to 75 percent through 1990. If ERDA's projections are accurate, domestic utilities may have over-contracted for enriching services.

As a result, on April 21, 1977, ERDA announced that it is considering contract adjustments in those instances where a customer is facing severe consequences from contractual obligations in excess of actual needs. The criteria by which to equitably evaluate each customer's request and to determine whether contract adjustments are needed are still under development.

LONG-TERM ISSUES

The United States has only one option to meet long-term demand beyond the capabilities of ERDA's three enrichment plants and the gas centrifuge facilities--build additional plants. The two primary issues affecting decisions concerning future plants are (1) the extent to which the Government should assist private enrichment groups and (2) the technology that will be used.

Government assistance

The Atomic Energy Act of 1954 (Public Law 83-703, as amended) and the Private Ownership of Special Nuclear Materials Act of 1964 (Public Law 88-489, as amended) require ERDA to encourage civilian nuclear-power industry development. Private industry has developed capabilities to provide all the materials, equipment, and services needed in generating nuclear power, except uranium enrichment. Because of the large amount of capital required to construct an enrichment plant, Government assistance may be required.

The proposed Nuclear Fuel Assurance Act was an attempt to provide for Government assistance to private uranium

enrichment groups, but differing philosophies produced only short-term decisions and no resolution of the issue for future plants. We have discussed the pros and cons of proposals for private ownership in prior reports (RED-76-36, Oct. 31, 1975, and RED-76-110, May 10, 1976) and concluded that:

- Management of the Government enrichment facilities could be accomplished more effectively by a corporation having a self-financing authority to borrow funds from the Treasury or the public. A self-financing proposal would free the corporation from the budgetary requirement of seeking congressional appropriations approval, thereby permitting more business-like operation of the plants.
- ERDA should seek and encourage private industry to continue efforts in advanced technologies through explicit programs. We recognize that Government assistance and assurances will be required. In working to this end, however, the Government should seek an equitable sharing of risk by the private enrichers and the Government.

We also concluded that the Government should provide the next increment of domestic enrichment capacity by adding on to one of the existing Government gaseous diffusion plants. This conclusion was based on the time frame in which ERDA estimated the capacity would be needed (i.e., early 1980s) and the status of other technologies at the time. In support of the President's recent proposal to build centrifuge facilities, ERDA officials said that technology development has sufficiently progressed and projected enrichment demand has sufficiently declined to permit the change in technology and still provide the capacity when needed. If ERDA's assessments of the technology and demand are correct, we would agree with its decision. We are currently reviewing the centrifuge program and the basis for this decision.

Technology

The technology used in future facilities could affect the construction schedule and the amount of initial capital and electrical power required. The gaseous diffusion process is a proven method but has several drawbacks. It

- must be constructed in very large units to be economical,
- consumes tremendous amounts of electricity, and

--requires about an 8-year leadtime.

The gas centrifuge process is expected to offer many economic and technological advantages over the diffusion process, in that it

--can be built in units that are one-third the cost of diffusion plants (this reduces the initial capital required and adds flexibility), and

--consumes about 4 percent the amount of electricity.

When the proposed Nuclear Fuel Assurance Act was being considered by the 94th Congress, ERDA received four proposals for private enrichment plants, three of which were for centrifuge plants. Thus, it appears that U.S. private industry is also confident that the centrifuge process is ready for commercial use.

Another process, called laser isotope separation, is still in the research stage. If successfully developed, the process could have considerable impact on the economics of enriching uranium. Two ERDA research laboratories have estimated that the

--capital cost would be about one-third the cost of diffusion or centrifuge plants,

--annual electricity required would range from 8 to 100 megawatts compared to almost 2,400 megawatts for a diffusion plant, and

--plants would operate economically at a lower tails assay than would either diffusion or centrifuge.

The process has not yet been determined to be commercially feasible, so its future use in large-scale plants is uncertain.

Another technology being developed by ERDA is the Dawson separation process. This process shares all the advantages of the laser process and, in addition, employs a conventional technology (i.e., magnetic force). Although this process looks very promising, substantial development work will be required before it is ready for commercial use.

CONCLUSIONS

We have discussed several ways that ERDA might assure adequate short-term supplies of enriched uranium for nuclear reactors. ERDA has already decided to use some of these

options--considering a limited open season and undertaking additional contracts--but has not yet established specific policies and criteria for implementing these options. ERDA has also studied most of these options in the past but, because of recent changes, DOE should fully review and reevaluate all these options for their potential value in meeting short-term enrichment needs.

This evaluation should include an examination, in cooperation with the Defense Department, of the advantages and disadvantages of using some material from retired weapons in the civilian nuclear power program. The results of such an examination should be reported jointly to the President and appropriate congressional committees for their consideration in determining the best use of this material.

Based on its detailed reevaluation, DOE should prepare a report on its operating strategy. This report should:

- Include an estimate of the number of new contracts that can realistically be undertaken with existing and planned enrichment facilities.
- Discuss the need for and timing of future facilities.
- Include a description of and the basis for ERDA's current position on the expected size and use of the enriched uranium stockpile, the feasibility of reducing or removing the restrictions on using imported uranium in domestic reactors, and the availability of enriched uranium from retired weapons. DOE should continue to monitor changes affecting these areas and make public any resulting changes in its positions. In addition, because recent changes to ERDA's stockpile policy have been made, DOE should promptly publicize the revised policy rather than waiting until its report is completed.
- Be made available to the responsible congressional committees and to interested parties in private industry and the general public.

If there is a uranium shortage, imported uranium could help meet domestic uranium requirements, thereby relieving some of the strain on the domestic mining and milling industries and preserving some domestic uranium resources for later use. Currently, the use of imported uranium is restricted to only a small percentage of total requirements. As discussed in chapter 2, however, this option is not without its shortcomings. DOE should continue to periodically study and document the advantages and disadvantages of changing

the restrictions to allow increased uranium imports so that, if a shortage occurs, it would be able to know whether it would be an appropriate action to take.

Short-term actions cannot be used as a long-term source of enrichment capacity. Additional enrichment plants must be built some time in the future under some form of ownership and using one of the existing technologies.

Questions about financial and managerial arrangements and the technology to be used in future enrichment plants beyond the planned centrifuge facilities should be resolved in a timely fashion. Early resolution of these questions will show foreign as well as domestic customers that the United States is committed to being a reliable supplier of enrichment services. It would not only help to attain U.S. nonproliferation goals but would also contribute to better planning of the role of nuclear power in supplying U.S. energy needs.

This country's future share of the foreign market is uncertain and is a major factor in deciding when new capacity will be needed. There are a number of policy issues involved that revolve primarily around (1) whether the United States should continue to be a major supplier of enrichment services as a means to deter other countries from developing nuclear weapons and (2) whether foreign enrichment contracts could or should be encouraged to improve the U.S. balance-of-payments position.

Several bills have been proposed in the 95th Congress to provide that the United States should maintain its role as a reliable worldwide enrichment services supplier. In addition, on April 20, 1977, the President announced that he would seek legislation that would assure the supply of enriched uranium to any country that shares our proliferation objectives and can accept certain conditions consistent with those objectives. These proposals, however, do not provide specific guidance on actions to be taken or policies to be followed. Without general goals, planning for future enrichment plants is difficult.

To improve planning for future plants DOE, together with the State Department, should determine the portion of the foreign market necessary to achieve the President's nonproliferation objectives and establish foreign enrichment goals by which to measure the Nation's progress in achieving those objectives. ERDA officials have forecasted that the United States should be able to maintain a reasonable share of the future foreign demand for enrichment services (30 to

40 percent), that would necessitate additional plant capacity in the early or mid-1990s at the latest.

If the United States wishes to obtain significantly more than 30 to 40 percent of the foreign market, a decision to build additional plants should be made soon to discourage the construction of foreign plants and, possibly, to improve the U.S. competitive position. On the other hand, a change in the U.S. foreign policy could favor international plants and/or U.S. involvement in foreign plants and significantly delay the need for additional U.S. plants.

If the Congress wishes to bring private industry into the uranium enrichment business, Government assistance may be required. In 1976, for example, ERDA negotiated with four private companies to provide various forms of Government assistance for constructing uranium enrichment plants. These negotiations were conducted in anticipation of passage of the proposed Nuclear Fuel Assurance Act authorizing such assistance. This legislation, however, did not pass the 94th Congress. Until such legislation is passed and final agreement reached, the amount or type of Government assistance that will be available is uncertain. It may well be that industry will be unwilling or unable to construct additional plants within the time frame required unless substantial Government assistance is given. In that event, the Government may need to build and operate new plants--at least for the near future.

RECOMMENDATIONS

GAO recommends that the Secretary, DOE:

- Document the results of monitoring the impact of removing or relaxing restrictions on utilities' use of foreign uranium for use by the Congress, industry, and the public.
- Promptly publicize the agency's current stockpile policy and the basis for that policy to provide the Congress, industry, and Government officials a clear and current view of the stockpile's potential for meeting short-term customer needs. Any changes to the policy and their impact should also be publicized.
- Examine, in coordination with the Defense Department, the advantages and disadvantages of using some material from retired weapons in the civilian nuclear power program rather than use the material solely to produce new weapons. The results of this examination should be reported jointly by DOE and the Defense Department to the President and appropriate

congressional committees for their consideration in determining the best use of this material.

- Prepare and implement a new operating strategy and make it available in report form to interested parties, including the Congress and private industry. This report should (1) estimate the number of new contracts that can realistically be undertaken with existing and planned enrichment facilities, (2) discuss the need for and timing of future facilities, and (3) describe and provide the basis for ERDA's current position on the expected size and use of the enriched uranium stockpile, the feasibility of reducing or removing restrictions on using imported uranium in domestic reactors, and the availability of enriched uranium from retired weapons. The report should be made available to the responsible congressional committees for their use in making decisions on the need for and timing of future enrichment facilities and to interested parties in private industry and the general public. In addition, DOE should make the Congress and the public aware of any changes in its positions.

- Determine, in cooperation with the State Department, the portion of the foreign market necessary to achieve the President's nonproliferation objectives and establish foreign enrichment goals by which to measure the Nation's progress in achieving those objectives and to facilitate planning for future enrichment plants.

AGENCY COMMENTS

Commenting on this report (see app. I), ERDA agreed with two of our recommendations concerning ERDA's current and future operating plans.

Specifically, ERDA agreed to:

- Continue to monitor the potential effect of removing or relaxing all restrictions on utilities' use of foreign uranium and to document the results of these reviews.

- Prepare, implement, and make available to interested parties a comprehensive operating plan covering the need for and timing of future enrichment facilities, enriching services market and potential sales, uranium use and availability, and stockpile positions. Work on this plan is in progress.

In addition, ERDA agreed to publicize its stockpile policy at a uranium enrichment conference to be held in Oak Ridge later this year or early next year. ERDA is considering other ways of publicizing its stockpile policy to reach a broader audience. We believe that, because ERDA has recently completed changes to its stockpile policy, it should promptly publicize its revised policy and its basis to help avoid any further misconceptions about its possible use.

Although ERDA would consider the probability of sales of enrichment services to the foreign market in formulating its updated operating strategy, it was unclear whether ERDA plans to set specific goals for foreign enrichment sales. An ERDA official subsequently said that it would not be particularly useful at this time to establish specific numerical goals for the proportion of the foreign market to be served. He said that the growth rate of the foreign nuclear fuel needs cannot be predicted very accurately beginning a decade or so in the future (the great majority of foreign fuel needs prior to that time appear to be already committed). He also said that the proportion of the available foreign market that could actually be supplied by the United States will depend not upon numerical goals but upon each foreign customer's perception of the relative attractiveness and surety of U.S. supply as compared to foreign supply alternatives. This perception will greatly depend upon the relative success of various U.S. fuel assurance initiatives now in process and upon actions of other suppliers.

Although we recognize the uncertainties facing ERDA, the future always holds uncertainties that cannot be ignored but must be dealt with as rationally and reasonably as possible in making decisions. Thus, we still believe that setting goals is desirable and represents a good management practice for future planning. In addition, remaining a reliable supplier of enrichment services is a vital part of the President's proposal for achieving this Nation's nonproliferation goals. Unless "reliable supplier" is better defined in terms of the percentage of the foreign market the United States may want or is able to obtain, it is difficult to determine whether these objectives are being met.

ERDA did not agree with our recommendation concerning the use of enriched uranium from retired weapons in the civilian nuclear power program. ERDA said that enriched uranium requirements for weapons uses are continually studied and evaluated and that the weapons composition of the stockpile is approved annually by the President. According to ERDA officials, enriched uranium requirements for weapons uses are established by the Defense Department, and ERDA's role is to satisfy those requirements, not review them.

We continue to believe that there is a need to determine how enriched uranium from retired weapons can best be used and that DOE, working with the Defense Department, should examine the advantages and disadvantages of using some of the material from retired weapons in the civilian nuclear power program. The results of that effort should be reported to the President and appropriate congressional committees for their consideration in determining the best use of this material.

Such information is needed now to properly plan for future enrichment plants. If the study shows that material from retired weapons could be available for the domestic nuclear power program, a decision on the timing and type of future enrichment plants could be affected.

CHAPTER 4

NEED FOR CHANGE IN PRICING

POLICIES FOR URANIUM SALES

ERDA receives considerable revenues from sales of uranium. In fiscal year 1976 and the transition quarter, for example, it received revenues of \$80 million. Although we did not analyze all of ERDA's pricing policies in detail, we noted two areas where immediate changes are warranted. Specifically, we found that ERDA policies allow

- sales from ERDA's normal uranium stockpile at a price substantially below the market price at the time the uranium is sold, and
- credits to enrichment customers for uranium feed obtained from recycled tails material that legally belongs to the Government.

Sections 161(m) and 63 of the Atomic Energy Act of 1954, as amended, require that ERDA charge a reasonable amount in the sale of Government-owned uranium rather than give its customers a credit for uranium obtained from recycled tails material belonging to the Government. Also, these policies, in our opinion, represent a subsidy to the nuclear industry, may adversely affect the market for uranium, and do not represent the tax-paying public's best interest.

We also found that, at the time of our review, ERDA was making emergency uranium sales and sales to small-quantity buyers at prices substantially below the current market price. ERDA, however, subsequently changed this policy and is now charging the current market price for these sales.

We plan to begin a detailed review of ERDA's pricing policies including the basis for, and the possibility of changing, the enrichment price.

SALES FROM URANIUM STOCKPILE

As of September 30, 1977, ERDA had about 17,000 metric tons in its natural uranium stockpile. ^{1/} This uranium is usually used to produce enriched uranium for ERDA's enriched

^{1/}About 4,800 metric tons of uranium are needed to fuel one 1,000 megawatt nuclear powerplant over a 30-year life.

uranium stockpile or to meet the requirements of split-tails operations. In fiscal year 1972 ERDA began split-tails operations to consume an accumulated Government uranium stockpile without disrupting the uranium market. Under split-tails operations ERDA transacts with its customers on the assumption that the plant is operating at one tails assay (the transactional tails assay) while it is actually operating the plant at another tails assay (the operating tails assay). The current transactional tails assay is 0.20 percent and the current operating tails assay is 0.25 percent. This means that as far as the enrichment customers are concerned, the plant is operating at a hypothetical mode that would leave 0.20 percent U-235 in the tails; but really the plant is using less SWU to produce a given quantity of enriched uranium by leaving a higher 0.25 percent U-235 in the tails. (See p. 4).

Since the higher (actual) operating tails assay requires more uranium feed than the lower (contractual) transactional tails assay to produce a given quantity of enriched uranium, ERDA's customers are bringing in less feed than is actually required to produce their enriched uranium. To compensate for this deficiency, ERDA supplements the customers' feed deliveries with uranium from its stockpile.

ERDA regards the supplemental feed transaction as the sale of source material under sections 63 and 161(m) of the Atomic Energy Act of 1954, as amended, which requires the selling price for source material such as uranium feed to (1) provide reasonable compensation to the Government and (2) not discourage the development of private sources. On the other hand, the sale of the actual enrichment services is governed by section 161(v) of the Act, which provides that ERDA may recover only costs for the sale of SWU. When charging its customers, ERDA adds the price of the supplemental feed, as determined under section 161(m), to the actual SWU charge and makes one billing.

ERDA computes the price of the supplemental uranium feed by averaging prices paid by ERDA's customers for deliveries in that year. Because contracts for deliveries in any particular year are generally signed several years prior to the delivery date, the price charged for the supplemental uranium is substantially less than the current uranium market price or the replacement cost if the uranium were to be replaced in the future. ERDA's price for this uranium is \$16 per pound while the current market price of uranium is about \$41 per pound.

We have not examined the entire split-tails operation and its pricing mechanism. In our view, however, ERDA's price for uranium sold should be based on the market price at the

time the Government's uranium is sold to provide a reasonable return to the Government. This would be especially important if it became necessary for ERDA to purchase replacement uranium at substantially higher prices in the future. Although ERDA does not plan to purchase uranium, long-term split-tails operations or unexpected increases in Government requirements could necessitate Government purchases. In addition, substantial ERDA uranium sales at prices well below market prices, in our opinion, do not represent good business practices.

URANIUM FEED CREDIT

As noted in chapter 2, the enrichment process results in both enriched uranium and uranium tails. Uranium tails contain fissionable uranium-235 in a percentage equal to the operating tails level of the enrichment plant.

Under ERDA's enrichment contracts, title to the uranium supplied by the customers, and that provided to the customers under the split-tails arrangement, passes to ERDA when ERDA begins the enrichment process. The contracts further provide that customers may either claim the uranium tails (at an assay determined by ERDA) and remove them from Government control or leave the material with the Government. If the customer does not elect to take the tails, the material remains Government property. Virtually all of ERDA's customers have chosen to leave the uranium tails with the Government. From processing customer- and ERDA-owned uranium during the period July 1971 to July 1975, ERDA accumulated more than 68,000 metric tons of these uranium tails.

Although this material is carried at no value on the Uranium Enrichment Services Activity Financial Statements, it still contains fissionable uranium-235 that can be extracted if the plant lowers its operating tails level below the percentage of uranium contained in the waste material. Such a situation occurred in July 1975, when ERDA lowered the operating tails assay from 0.30 percent to 0.25 percent and was thus able to recycle the 0.30-percent tails, strip the material down to 0.25-percent tails, and obtain additional uranium feed. Thus, the uranium tails represent a valuable asset to the Government.

After lowering the tails assay, however, ERDA began to compute the enrichment price to include a credit to all customers for the feed material obtained from the recycled tails. This credit is not apportioned among customers according to the amount of tails left by each customer, but rather is divided evenly among ERDA's current customers.

In computing the price of supplemental feed, ERDA charges for all the Government-supplied uranium to be sold under split-tails operations and then deducts the value of the natural uranium that will be obtained from recycled tails. Currently, the credit is valued at about \$16 per pound of uranium--the same as the price ERDA charges for supplemental feed. Therefore the recycled uranium is being provided free of charge. At \$16, the customers' cumulative credit for fiscal years 1976-78 would be about \$112 million.

We believe that the sale of uranium from recycled tails, like the uranium from ERDA's natural uranium stockpile, is governed by sections 63 and 161(m) of the Atomic Energy Act of 1954, as amended, which cover the sale of source material such as uranium from recycled tails (see p. 35). Section 161(m) requires the selling price for uranium to (1) provide reasonable compensation to the Government, and (2) not discourage the development of private sources. Section 63 provides that ERDA must charge its customers who are commercial licensees for source material.

Hence, ERDA should not deduct the value of the uranium in the recycled tails from the charge for the supplemental feed sold. Rather, ERDA should charge its customers reasonable compensation as determined under section 161(m).

In a September 26, 1977, letter (see appendix II) ERDA officials said that they realized that the amount of the present credit (\$16 a pound) would "overstate the credit," since the customers' original costs for the uranium feed from which the tails were derived was far less. To rectify this for future credits, they proposed for early adoption a change in the enrichment service charge computation to base the credit on the uranium delivery price at the time ERDA originally sold the uranium through split-tails operations. This would result in a charge to the customers equal to the difference between the price originally paid for the supplemental feed and ERDA's current price. They said that this methodology would result in cumulative credits of \$81 million for fiscal years 1976-1978.

From a management viewpoint, we still do not believe that ERDA should give any credit for this material, but rather should charge its customers full market value for all feed material obtained from recycled tails.

EMERGENCY AND SMALL- QUANTITY URANIUM SALES

In July 1976, ERDA initiated an emergency sales policy whereby customers unable to purchase uranium from commercial

sources due to extenuating circumstances could purchase uranium from ERDA's stockpile. This policy also provides that ERDA may sell quantities of uranium that are so small that undue effort would be required to purchase the uranium through commercial sources.

ERDA, in the May 1976 Federal Register, set forth the policy under which these sales would be made. That policy provides that ERDA will become a seller of last resort if the purchaser requires rapid product delivery to meet an unforeseen emergency and the seller proves to ERDA's satisfaction that the uranium cannot be purchased from a private source.

Prior to July 25, 1977, ERDA's price for uranium sold in emergency and small-quantity sales was the same as that for supplemental feed. In discussions with ERDA officials we recommended that ERDA base the price of uranium sold under these conditions on the spot-market price. ^{1/} Prior to our issuing this report, ERDA initiated a two-tier pricing policy that changed the basis for the price of uranium sold in emergency and small-quantity sales to the average of (1) the immediate past year's spot-market price and (2) the prices in contracts based on the current market price for delivery the previous year. This price is currently \$41 per pound. ERDA's new pricing policy thus satisfies our concern about the price being charged for emergency and small-quantity sales. The basis for the price of uranium sold under split-tails and other long-term arrangements, however, remains the same.

As of April 1, 1977, ERDA had made several small-quantity sales and no emergency sales since the May 1976 Federal Register notice was published. For example, on September 16, 1976, ERDA sold 6.492 kilograms of uranium enriched to 93.17 percent to General Electric Corporation for a research reactor. ERDA made this sale because the quantity was so small that it would be cumbersome both for General Electric to purchase the uranium and for ERDA to enrich it. General Electric's cost for the 1300 kilograms of feed required to produce the enriched uranium was about \$38,000 or about \$11 per pound of uranium. Had General Electric been required to purchase its uranium on the open market, it would have paid about \$41 a pound (about \$142,000).

ERDA does not anticipate many future emergency feed sales because the remainder of ERDA's normal uranium

^{1/}The spot-market price refers to the price of uranium sold for immediate delivery.

stockpile is expected to be converted to enriched uranium as soon as possible. Thereafter, emergency sales can only be made as enriched uranium from the stockpile. However, the price of the enriched uranium will include a value for the uranium feed contained in the enriched product.

In a letter to us dated June 16, 1976, Senator Mike Gravel expressed concern about ERDA's pricing policies for sales from its normal uranium stockpile. Specifically, he raised the possibility, that under its emergency sales policy, ERDA could sell large quantities of uranium to Westinghouse Electric Corporation to relieve that company of its current uranium shortfall. 1/ ERDA officials have stated that they have not received a request and do not expect one from Westinghouse because the company's predicament is a result of a business decision and not a true emergency. However, if Westinghouse applies for an emergency sale, ERDA officials have said that they will evaluate the application on the criteria discussed above.

CONCLUSIONS

In July 1977 ERDA initiated a two-tier pricing policy under which the price for uranium sold in emergency and small-quantity sales is an average of (1) the spot-market price for the immediate past year and (2) the prices in contracts based on the market price for delivery in the past year. The price of uranium sold under split-tails and other long-term arrangements continues to be based on the average of current delivery prices. We agree with this policy as it relates to emergency and small-quantity sales but, in our view, the basis for uranium sold under split-tails and other long-term arrangements should be changed to the market price. Recognizing the problems associated with a sudden large increase, however, DOE should gradually increase the price over a reasonable period of time until it equals the market price at the time the Government's uranium is sold.

ERDA's current policies do not represent good business practices or the tax-paying public's best interest. For example, the additional revenues that could be obtained from pricing the uranium at its full commercial value could be

1/Westinghouse Electric Corporation announced in early 1976 that it was canceling its uranium supply contracts because it did not have sufficient inventories to meet these obligations and the contract prices were far below current market prices. Several utilities have settled with Westinghouse, and other cases are being deliberated in the courts.

used to offset the cost of constructing the planned centrifuge facilities. Also, the Government may have to purchase uranium in the future, at substantially higher prices, to meet its own requirements.

In the case of recycled tails, ERDA's customers abandoned their rights to tails material associated with past transactions. Thus ERDA should charge the full market value for all the Government-owned uranium sold as supplemental feed. Also, an overall enrichment charge reduction is not even achieving ERDA's objective of fairly compensating its customers for uranium feed they purchased previously, because ERDA is not distributing the credit according to the amount of uranium tails left by each customer.

In our view, providing uranium to customers at a fraction of its market value or at no charge at all represents an undesirable subsidy to the nuclear industry. Because other energy technologies (such as coal and solar energy) are being developed, and their costs are compared to nuclear energy to assess their commercial feasibility, such hidden Government subsidies should be avoided. Otherwise, these comparisons may not be valid.

We believe that the Atomic Energy Act gives ERDA the legal authority to charge the full commercial price for all uranium it sells. DOE officials should revise the uranium pricing policy to reflect the authority granted in the act.

RECOMMENDATIONS

We recommend that the Secretary, DOE:

- Gradually increase the price of all uranium sold from its stockpile including the uranium obtained from recycled tails, until it equals the market price at the time the Government's uranium is sold. The price should be periodically reevaluated to keep it aligned with the market price.
- Discontinue the policy of allowing credits for uranium obtained from tails material that is being recycled and charge customers for the uranium they receive.

AGENCY COMMENTS

Commenting on this report ERDA disagreed with our recommendations to change its uranium pricing policies. (See app. I and II.)

Regarding the first recommendation, ERDA said that, because the split-tails concept was designed to dispose of surplus uranium, and because the customers were forced to purchase uranium from the Government and were not able to enter long-term commercial contracts at a lower price, it would be unfair to base the price of uranium sold under split-tails on the current market price.

We still believe that the price of uranium sold from ERDA's stockpile should be based on the current market price because:

- It is not in the U.S. taxpayers' best interests for the Government to sell its property for less than its commercial value.
- In the event it becomes necessary for the Government to replace the material in the stockpile to meet future military and research needs, there may be a difference between what ERDA is receiving for its uranium and what it might have to pay in the future. Any deficiency would have to be met by public funds.

When ERDA began split-tails operations in 1972, the basis for establishing the price was unimportant because then-current market prices and prices for uranium being delivered in that year were virtually the same. The market price has risen significantly since 1972 and the difference in these two prices is now about \$25 a pound. We believe that a policy of selling uranium significantly below current market prices is not a good management practice and should not be continued. It is unfair to the taxpaying public to sell Government material at prices substantially below its commercial value.

We recognize, however, that a sudden price increase might be unfair because the Government originally instituted split-tails operations for its own benefit. Therefore, we believe ERDA should gradually increase the price over a reasonable period of time.

ERDA also disagreed with the recommendation that it charge its customers for material obtained from recycled tails. It first justified the credit with an argument that fairness required such an adjustment. In its August 19, 1977 letter (see p. 48), ERDA concludes:

"By giving the customer a credit for this uranium, ERDA is recognizing that (1) the customer has paid for the material and (2) the customer had no practical option to

take possession of the tails material since it was ERDA's policy to provide only 0.20 % U-235 depleted uranium."

This approach fails to take into account the fact that (1) the enrichment contract governs the rights of the parties to the uranium tailings, no matter what percent U-235 in the tails is made available to the customers and (2) under the contract the uranium from the recycled tails is Government property, for which no credit may be given.

There can be no argument that the recycled tails are Government property. In its August 19, 1977, letter (see p. 48), ERDA states that title to the uranium feed passes to ERDA at the time of delivery for enrichment. The enrichment contract further provides that the customers have no rights to the tails material derived from the feed they supplied unless they elect to take the tails and even then ERDA reserves the right to specify the assay of the tails available to the customer. In fact, ERDA concedes, in its September 26, 1977, letter (see p. 50), that it has never given its customers a right to tails at more than 0.20 percent assay, thereby acknowledging that it will not, as a matter of policy, freely surrender valuable tails to enrichment customers.

Moreover, except when it computes the credit, ERDA consistently treats the uranium in the recycled tails as Government property distinct from the original feed from which the tails are derived. Even the uranium enrichment contract explicitly provides that ERDA shall give no credit for tails material. Therefore, since the tails material is uranium source material belonging to ERDA, it must be disposed of pursuant to sections 63 and 161(m) of the Atomic Energy Act of 1954, as amended. These sections require that ERDA make a reasonable charge, rather than give a credit, for the tails.

In its September 26, 1977, letter ERDA further responded to our questions concerning its authority to grant a credit for uranium from recycled tails. This letter states:

"We acknowledge that ERDA employees told the auditors that it would be unfair to charge customers a second time for the feed. However, the reason for giving the credit is that given in * * * this paper and does not rest upon the fairness or unfairness of charging a second time." (See p. 55.)

Nonetheless, the new argument, as presented in the September 26 letter, contains the same premise as the old,

i.e., that ERDA has already received reasonable compensation for the original supplemental feed and thus is not required to charge for the recycled feed. Stated simply, the new argument asserts (1) that the "credit" complies with sections 63 and 161(m) of the Atomic Energy Act, as amended, because ERDA, in receiving compensation for the original supplemental feed from which the recycled tails are derived, has already "sold" the tails material and (2) that section 161(v), prohibiting the recovery of more than cost in the sale of SWU, requires that the credit be given to avoid an overcharge because ERDA accounts for the feed from recycled tails as "resubstituted" SWU.

We have already addressed the first element of this argument in our response to ERDA's first letter. According to the agreement of the parties in the enrichment contract, the feed from recycled tails is Government property, separate from the original feed from which it is derived. Therefore, the feed obtained from the recycled tails was not, under ERDA's own contract, already sold and paid for when ERDA received compensation for the original supplemental feed. Rather, as Government-owned source material, the feed from the recycled tails can be disposed of only in accordance with sections 63 and 161(m), which require that ERDA receive reasonable compensation for source material.

Secondly, ERDA argues in its September 26 letter (see p. 54) that whenever it uses feed from recycled tails, an additional amount of money equal to the value of the feed from recycled tails

"* * * would come from the sale of enriching services (since ERDA would have been paid the full amount of reasonable compensation for the source material when first supplied as SWU equivalent supplemental feed) and its receipt would clearly be in violation of the prohibition against recovering more than the Government's costs contained in Section 161v."

This "extra" income would come from the sale of enriching services only because ERDA's accounting techniques categorize it in that way. Furthermore, ERDA's characterization of the feed from the tails stockpile as SWU to be sold under section 161(v) is inconsistent with its charging--as explained in the September 26 letter, (see pp. 52 and 53)--"reasonable compensation" under sections 63 and 161(m) for the sale of original supplemental feed from the natural uranium stockpile. We also regard ERDA's plans in the future to "charge" some price for the feed from recycled tails (see p. 53) as an admission

that the recycled feed does, in fact, fall under sections 63 and 161(m) and that charging for this feed does not violate section 161(v). Therefore, we see no reason to treat recycled tails' feed differently from the original supplemental feed. Notwithstanding ERDA's complex accounting procedures, the fact remains that the feed from recycled tails is Government property sold to enrichment customers as part of the supplemental feed.

Sections 161(m) and 63 provide that ERDA must charge a reasonable amount in the sale of Government-owned source material rather than give its customers a credit for that Government-owned source material derived from recycled tails. Furthermore, from a management viewpoint we believe that both the present and the planned credits are inequitable to the taxpayer and a bad business practice. These credits are also inconsistent with the intent of proposed legislation that would make pricing of the entire enrichment services program comparable to that of a commercial operation (a concept we support), and with ERDA's desire to operate the enrichment plants on a commercial basis.

CHAPTER 5

SCOPE OF REVIEW

Our review was directed toward evaluating several specific aspects concerning the problems with and opportunities for providing an adequate supply of uranium enrichment services. We obtained the information in this report by reviewing applicable legislation, policies, program documents, reports, correspondence, and other records and by interviewing responsible officials.

Our review was performed primarily at the ERDA headquarters in Washington, D.C., and the ERDA field office in Oak Ridge, Tennessee.



UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

AUG 10 1977

Mr. Monte Canfield, Jr., Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Canfield:

Thank you for the opportunity to review the GAO draft report entitled "Uranium Enrichment Policies and Operations: Status and Future Needs." We have reviewed the draft with members of your staff and we understand that a number of changes and clarifications which we suggested will be made. Our remaining primary concerns pertain to the GAO recommendations in the report, and we request that our views and comments be included in appropriate sections of your final report.

The first recommendation is for ERDA to continue to monitor the potential impact of removing or relaxing all restrictions on utilities' use of foreign uranium. ERDA does monitor the potential impact of removing or relaxing restrictions on the use of foreign uranium and at this time we see no advantage in altering the present restrictions. We shall continue to monitor and review this matter and document the results of our reviews.

With respect to the recommendation to publicize ERDA's stockpile policy and the bases for that policy in order to provide the Congress, industry, and Government officials with a view of the stockpile's potential for meeting short-term customer needs, ERDA has publicized the agency's stockpile policy during uranium enrichment conferences held in Oak Ridge, Tennessee. These conferences were held in February 1975 and November 1975. ERDA is planning to again publicize this policy at another conference to be held in Oak Ridge later this year or early next year. We are also considering other ways of publicizing our stockpile policies to reach a broader audience.

We disagree with the recommendation that ERDA "review and evaluate, with the Department of Defense, the advantages and disadvantages of obtaining material from the weapons stockpile for the agency's enriched uranium stockpile." The recommendation appears inappropriate, particularly in view of GAO's observation on page 32 that "We reviewed ERDA's current plans and found that although significant quantities of enriched uranium will be removed from retired weapons, it is all scheduled to be recycled into new weapons." Enriched uranium requirements for

weapons uses are continually studied and evaluated. Evaluations and planning for requirements take into account the retirement of older weapons as the stockpile is modernized or upgraded, and the weapons composition of the stockpile is approved annually by the President.

We agree with the fourth recommendation pertaining to preparing and implementing a new or updated operating strategy and making it available to interested parties, including the Congress and private industry. We have commenced work on a comprehensive plan which would include various components such as the need for and timing of future enrichment facilities, enriching services market and potential sales, uranium usage and availability, and stockpile positions. We do, of course, expect to provide pertinent similar information to the Congress in hearings tentatively scheduled for September 1977.

An updated planning strategy would, of necessity, consider the probability of sales of enriching services to the foreign market. Our basic primary interest in providing enrichment services to the foreign market is to preserve and/or enhance U.S. influence in international matters, thereby supporting this Nation's non-proliferation goals. ERDA activities in this area are closely coordinated with other Federal agencies as appropriate. We are mindful of the advantages and disadvantages of a large foreign market and of the effect perturbations in furnishing enriching services would have on our policies and goals.

We disagree with the sixth recommendation which states that the pricing policy for uranium sold from stockpile be changed to require that the price be based on the current market price. To implement this recommendation ERDA's uranium feed price for sales through "split tails" operations would be based on the current spot market value (\$41 per pound) rather than on the existing market survey (\$16 per pound). We do not agree with this recommendation and believe the report should fairly present ERDA's rationale for our existing split tails pricing policy. The split tails concept was designed to dispose of surplus uranium. The Government's uranium enrichment customers are required to purchase Government uranium as part of their enrichment transaction. Since the customer is required to purchase some uranium feed from ERDA rather than from industry the price of the uranium is set at the average market price. If ERDA had not required the customer to purchase some feed from ERDA, these customers would have procured this material on the commercial market by entering into long-term material contracts, at the then existing lower market prices. We strongly believe it would be unfair to these

customers to charge them the higher price when they could have procured the same material at a lower price. In addition, the existing price of \$16 per pound is twice the price the Government paid for the material.

We also disagree with the recommendation that ERDA discontinue the policy of allowing credits for uranium obtained from tails material which is being recycled and charge customers for the uranium they receive. Also, the draft report does not, in our opinion, adequately reflect ERDA's rationale for the uranium feed credit. The uranium enrichment contracts require the customer to deliver a stated amount of uranium feed material to ERDA. At the time of delivery, the customer passes title to the uranium to ERDA and ERDA has a liability to return an equivalent amount of normal uranium to the customer in the form of enriched and depleted uranium. [See GAO note 1, p. 48.]

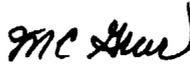
Under the "split tails" operation the customer is charged for separate work and furnishes feed material based on a predetermined (transaction) tails assay which is lower than the actual operating tails assay. Because of the difference between the "transaction" tails assay and the operating tails assay the customer has paid for more separate work units than actually utilized which was offset by his furnishing less feed than actually needed, thus necessitating ERDA furnishing the additional feed actually required. The net result is that ERDA, by virtue of receiving payment for more SWU than required, sold feed material. [See GAO note 1, p. 48.]

From the beginning of FY 1972 to the end of FY 1975, the operating tails were 0.30% U-235. Starting at the beginning of FY 1976 the operating tails were 0.25% U-235. Whereas the customer's transaction tails have remained constant at 0.20% U-235. ERDA's policy for providing tails materials to those customers who want them has been and is to give them uranium having 0.20% U-235 content. [See GAO note 1, p. 48.]

Beginning in FY 1976, ERDA began to feed the 0.30% U-235 depleted uranium and strip them to 0.25% U-235. The effect of this recycling of tails material is to increase ERDA's stockpile of enriched uranium. The additional product is not needed to meet current customer requirements. The feeding of 0.30% U-235 depleted uranium also recovers some of the uranium tied up in the previous tails material. This uranium had been provided previously by the customer or sold to the customer under the "split tails" operation. By giving the customer a credit for this uranium, ERDA is recognizing that (1) the customer has paid for the material and (2) the customer had no practical option to take possession of the tails material since it was ERDA's policy to provide only 0.20% U-235 depleted uranium. [See GAO note 1, p. 48.]

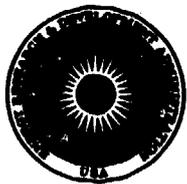
[See GAO note 2.]

Sincerely,



M. C. Greer
Controller

- GAO note:
1. ERDA's position on this matter has changed. See appendix II.
 2. Material deleted does not substantially relate to the final report.



UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

SEP 26 1977

Mr. Ralph Carlone
Associate Director
Energy and Minerals Division
U.S. General Accounting Office

Dear Mr. Carlone:

We appreciate the opportunity to review a proposed revision to your July 26, 1977, draft report entitled "Uranium Enrichment Policies and Operations: Status and Future Needs" pertaining to allowing credits for recycled tails material. We request that our views and comments be included in appropriate sections of the report.

The GAO draft report states on pages 35 through 37 that ERDA does not have the authority to, and may not properly, credit Government-owned uranium enrichment tailings to its enrichment customers who are commercial licensees. We disagree with this statement.

The revised draft contains a few statements which warrant correction or explanation. The first paragraph on page 36 should be rewritten to read:

Under ERDA's enrichment contracts, customers have the option to acquire tails material at the time enriched uranium is delivered to them. The contract provides that the maximum quantity of tails material shall be equal to the difference between the total quantity of uranium supplied by the customer as feed material and the total quantity of enriched uranium furnished to the customer reduced to the extent of processing losses as determined by ERDA. The contract also provides that the U-235 assay of the tails material delivered to the customer shall be within ERDA's sole discretion. It has been, and continues to be ERDA's practice in fulfilling requests based upon customer exercise of this option to deliver only tails material having an 0.2 percent U-235 assay.

This change is important because the paragraph as written by GAO leaves the impression that the customers had an option to acquire 0.3 percent assay tails material and by failing to exercise this option, abandoned the 0.3 percent material. In fact, they never had the right to obtain any portion of the 0.3 percent material.

Aside from the question of whether customers have abandoned tails material we will demonstrate that the utilization of the tails "credit" by ERDA under the current "split tails" mode of operation not only meets the requirements of Section 63 and 161m of the Atomic Energy Act of 1954, as amended, but is required to be calculated in the manner utilized by ERDA in order to comply with the provisions of Section 161v of said Act.

Section 161v is the section of the Act which authorizes ERDA to conduct toll enriching operations. This section mandates that ERDA charge for enriching services on a basis that will recover not more than the Government's costs over a reasonable period of time.

Under the "split tails" mode of operation ERDA chooses to operate at a certain tails assay in order to (1) meet its obligations to supply enriching services to customers; (2) to reduce stocks of normal uranium and thereby remove a "market overhang" which could inhibit the development of domestic mining and milling industries; and, (3) preproduce enriched uranium for future use.

ERDA went to the "split tails" mode of operation because the separative work unit (SWU) capacity of the enrichment plants was insufficient to meet customer needs while achieving preproduction goals. Under the original "split tails" mode of operation the customer transacted with ERDA as if the plants were being operated at 0.2 percent tails assay. The plants, however, were actually operated at 0.3 percent tails assay in order to use Government-owned feed to produce a "preproduction inventory" and reduce stocks of normal uranium.

The enriched product which could be produced at 0.2 percent tails assay from the customer supplied feed when ERDA plants were operating at 0.3 percent tails assay was not enough to provide the enriched product which ERDA had contracted to deliver. To make up the deficiency, ERDA supplied supplemental feed to the plant thereby substituting feed for SWU capacity. The feed was charged for as a component of the SWU price under the enrichment services contract with the customer.

The rationale for "selling" supplemental feed as a component of the SWU price is based on the fact that the application of sufficient enrichment effort (SWU's) to the amount of normal uranium feed supplied by the customer at the 0.2 percent transaction tails assay to produce the amount of enriched uranium desired by the customer would require (while operating at 0.3 percent tails assay) additional enrichment capacity. That is additional plant, labor, and electricity would have been required to provide the additional SWU to enrich the kilograms of normal uranium supplied by the customer to the enriched uranium in the quantity required to meet his needs. The limited plant separative work capacity precluded the application of this additional effort.

The capacity differential was filled with Government-owned supplemental feed which was equivalent to the additional enrichment effort (SWU's) which could not be applied because of insufficient plant separative work capacity. Since the supplemental feed was equivalent to the added separative work units required it was permissible for ERDA to charge for the supplemental feed as if the feed were SWU and include this charge in the SWU price.

The customer is indifferent to whether the SWU price includes a charge for feed supplied. The customer is only interested in the amount of feed that he is required to deliver to ERDA, the dollars he must pay, and the enriched product he receives. When ERDA reduced its operating tails assay to 0.25 percent, it became possible to recycle the 0.3 percent tails produced in the earlier "split tails" operation. Through the recycle a portion of the SWU is now being exerted to enrich the tails, which were derived from previously "sold" Government SWU equivalent feed. That is, ERDA is now resubstituting SWU for feed. That this resubstitution is occurring is proved by the fact that ERDA is physically feeding less normal uranium to the plant than is required to make up the feed requirement difference between the 0.25 percent tails uranium enrichment table and the 0.2 percent tails uranium enrichment table for the amount of product actually being produced.

If no adjustment were made at this time ERDA would receive (1) compensation for all of the SWU equivalent feed "sold" from the Government stockpile; (2) reimbursement of the Government cost of providing separative work units available from existing plant capacity; and, (3) an additional amount of money which would be an overcharge. To adjust its prices to correct for this potential overcharge, ERDA gives a "credit" associated with the recycled 0.3 percent tails (this credit is limited to the tails derived from the Government-supplied, SWU-equivalent, supplemental feed as such tails represent saved or reusable feed-equivalent SWU's).

GAO has stated in its draft report that ERDA has no authority to grant this "credit" because it amounts to disposition of Government property in a manner which is not an exercise of "power specifically delegated" by Congress. The following discussion will show that the utilization of this "credit" is in fact the exercise of such specifically delegated power.

Section 63 of the Atomic Energy Act of 1954 requires ERDA to "make a reasonable charge determined pursuant to Section 161m" for the source material (supplemental feed) distributed for uses of the type to which it is put by ERDA's toll enriching customers. Section 161m, in pertinent part, requires that this reasonable charge "provide reasonable compensation to the Government" for the source material. Thus, if ERDA is

charging a price which provides reasonable compensation to the Government for the source material it has complied with Section 63.

The source material "sold" to the enrichment customer when operating at 0.25 percent tails assay contains both "normal" uranium (in this case uranium hexafluoride or UF_6 having a U-235 assay of 0.711 percent) and UF_6 having a U-235 assay of 0.3 percent (0.3 percent tails). To establish the charge for this source material ERDA does the following:

1. Establishes the base charge as if all of the source material were "normal" (0.711 percent U-235) uranium. (i.e., by comparing the enrichment tables for the operating and transaction tails it computes the amount of normal uranium equivalent to the difference in feed required to produce the amount at the assay of enriched uranium required to meet customer demand for each year of the pricing period. ERDA surveys the uranium market for each year of the pricing period in order to determine the average market price of UF_6 during the pricing period. The ERDA supplied normal UF_6 is valued at these market prices).
2. It establishes a "credit" against the base charge to recognize that 0.3 percent tails assay material derived from Government-supplied supplemental feed is being substituted for some of the normal uranium feed requirements and that the tails material was generated at no cost to Government. (The credit is the market value of the normal uranium feed equivalent contained in the 0.3 percent tails material at the time the tails were generated).

The answer derived from this computation (base charge less "credit") is the charge included in the SWU price for the amount of Government-owned source material (supplemental SWU equivalent feed) "sold" to toll enrichment customers.

It should be noted that the method of application of the "credit" does in fact result in a charge being made for the amount of 0.3 percent tails applied to the customers product. This result obtains because the base charge for the supplemental feed is computed at higher market prices estimated to prevail during the pricing period while the credit is computed at the lower market prices which prevailed when the tails material from prior "split tails sales" was generated. Another way of expressing the computation that ERDA uses to establish the charge for source material is that it charges the customer the market value estimated for the future pricing period for the 0.711 percent U-235 assay material actually used in the 0.25 percent tails mode of operation and adds a charge for 0.3 percent tails computed by deducting from the current market value of the normal uranium contained in the tails material, the earlier and lower market value of a similar amount of normal uranium. Thus, the customer pays for normal uranium actually used and also pays for the tails actually used.

ERDA has determined that reasonable compensation for supplemental feed "sold" through the split tails mode of operation is the current market value of uranium with an 0.711 percent U-235 assay. Utilization of the "credit" as described above enables ERDA to recover the weighted average market value of the amount of the reduction of its natural uranium stocks resulting from the supply of supplemental feed. Therefore, ERDA has received reasonable compensation for such material and has complied with Section 63 and 161m of the Atomic Energy Act of 1954.

The authority to establish reasonable compensation of source material is committed by law to ERDA's discretion. The exercise of this discretion impels ERDA to consider the relevant facts surrounding the sale of the source material. Such consideration has led ERDA at various times to establish reasonable compensation ranging from cost to market value. (It is conceivable that given the right set of facts reasonable compensation could be below cost or above market value).

The most relevant fact associated with the sale of source material (Government-supplied SWU equivalent supplemental feed) as part of the "split tails" mode of operation is that it is accomplished as an integral part of the sale of enriching services pursuant to Section 161v of the Atomic Energy Act of 1954. As noted earlier this section denies ERDA the authority to recover more than the Government's costs over a reasonable period of time. Without the "credit" ERDA would, through its enriching services contract, receive the total of (1) reasonable compensation, as outlined above, for the source material sold; (2) the Government's costs of supplying enriching services; and, (3) an additional amount of money.

This additional money would come from the sale of enriching services (since ERDA would have been paid the full amount of reasonable compensation for the source material when first supplied as SWU equivalent supplemental feed) and its receipt would clearly be in violation of the prohibition against recovering more than the Government's costs contained in Section 161v. Application of the "credit" avoids this violation. Therefore, ERDA not only has the authority to apply the "credit" but is required to do so.

We have the following additional comments concerning the Uranium Feed Credit section of the GAO draft report:

1. Second Paragraph, p. 36. The last sentence, "Thus the uranium tails abandoned by the customer represent a valuable asset to the Government." As shown by the suggested rewrite of the first paragraph on page 36, the customer never had a right to these 0.3 percent tails and therefore could not have abandoned them. We agree that the 0.3 percent tails are a valuable Government asset.

2. Third paragraph, p. 36, fourth and fifth sentences. We acknowledge that ERDA employees told the auditors that it would be unfair to charge customers a second time for the feed. However, the reason for giving the credit is that given in the first part of this paper and does not rest upon the fairness or unfairness of charging a second time.
3. Fourth paragraph on p. 36. This paragraph is no longer accurate. In prior enrichment service charge calculations ERDA used the ERDA projected market prices for uranium feed to determine the tails recycle "credit." ERDA realized this would overstate the credit, so in an enrichment service charge change proposed for early adoption, the market price at the time ERDA "sold" the natural uranium through split tails will be used to compute the "credit." This would result in cumulative "credits" of \$81 million versus the \$112 million stated in the draft report for fiscal years 1976 to 1978.

The comments in the paper to this point should be considered in relation to the following additional paragraphs of the draft report:

1. First paragraph, p. xi, first sentence. It is ERDA's conclusion that it does have authority to give its customers "credit" for the utilization of tails material.
2. Third recommendation, p. xii, and first recommendation, p. 40. ERDA disagrees with and questions the basis for the recommendation that it discontinue the policy of allowing "credits" for the utilization of tails.
3. Second full paragraph, p. 39. We do not agree that ERDA is giving "this feed back to the customer at no cost." In addition, as discussed earlier the tails which were recycled were not "abandoned" by the customer. Furthermore, ERDA is adjusting its prices to comply with the Atomic Energy Act of 1954 rather than "compensating its customers for uranium feed they purchased previously."

Sincerely,



Fred A. Hiser

Assistant to the Controller