

REPORT TO THE CONGRESS



BY THE COMPTROLLER GENERAL
OF THE UNITED STATES



LM098252

Certain Actions That Can Be Taken To Help Improve This Nation's Uranium Picture

Energy Research and Development Administration

Nuclear reactors--using uranium as a fuel--will be used to meet a major part of this country's future energy needs. Because uranium may soon be in short supply, this Nation must develop and use this valuable resource to its maximum potential.

GAO notes that certain actions can be taken to help improve this Nation's uranium picture. These improvements include the

- need for a reliable system to verify the amount of uranium exports and the extent and effect of foreign investment on this country's uranium supply,
- possibility of recovering lower quality ore deposits, and
- need for more research and development on new and better uranium mining and milling technologies.

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

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

As the primary fuel for nuclear reactors, uranium will become an increasingly important energy source. Because of a possible uranium shortage, we reviewed certain actions that can be taken to help improve this Nation's uranium picture.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Administrator, Energy Research and Development Administration; the Chairman, Nuclear Regulatory Commission; and the Administrator, Federal Energy Administration.

A handwritten signature in black ink, reading "James B. Atchafalua".

Comptroller General
of the United States

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ABBREVIATIONS

AEC	Atomic Energy Commission
ERDA	Energy Research and Development Administration
FEA	Federal Energy Administration
GAO	General Accounting Office
NMIS	Nuclear Materials Information System
NRC	Nuclear Regulatory Commission
NURE	national uranium resource evaluation program

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

CERTAIN ACTIONS THAT CAN BE
TAKEN TO ACHIEVE AN ADEQUATE
URANIUM SUPPLY
Energy Research and Development
Administration

D I G E S T

Because of the growing shortage of petroleum, nuclear power is being counted on to play an increasingly important role in meeting this Nation's future energy needs. It presently accounts for about 8 percent of the total U.S. electrical generating capacity. The Energy Research and Development Administration estimates that reactors will provide about 46 percent of the total capacity by the year 2000.

Because current light water reactors use only 1 to 2 percent of the energy available in uranium fuel, new and better reactors are being developed, such as the liquid metal fast breeder reactor, to more efficiently use uranium fuel thereby extending domestic uranium reserves.

Uncertainty exists as to both the demand for and supply of economically recoverable uranium which is used to fuel nuclear reactors. The agency estimates that the Nation's uranium resource base might be sufficient to meet the cumulative demand until the year 2000.

Others, such as the Electric Power Research Institute, say that demand will not exceed supply until the year 2040 or later. This uncertainty exists primarily because of

- different assumptions about the electric consumption growth rate,
- the proportion of electricity which will be generated by nuclear fission in the future, and
- the availability of economically recoverable uranium.

The question may not be how many resources and reserves exist, but how much uranium can be produced. Estimated reserves can only be made available to meet demand if uranium mining and milling production capacity is expanded. If production capacity is not increased beyond what is currently planned, the demand for uranium to fuel nuclear reactors may not be met.

Unless an adequate supply of fuel is available for both current light water reactors operating and planned and for new reactors under development, the agency's plans for nuclear power development may not be realized. This problem takes on even greater significance when the 8- to 10-year leadtime necessary to develop and bring a uranium deposit into production is considered.

GAO evaluated

- the effectiveness of the agency's monitoring over, and the reliability of information on, uranium exports of domestic uranium and possible control of uranium by foreign investors in the uranium industry and
- ongoing efforts to increase uranium supply through (1) recovering low-quality uranium ore and (2) researching and developing better exploration, mining, and milling techniques.

GAO's review showed that:

- The agency uses a voluntary reporting system to obtain data on uranium exports. As long as much of the reporting of data by industry is voluntary and unverified, the Congress and the public can be expected to raise questions as to the credibility of the data, even though it may be entirely valid.
- The agency has a management information system which can be used to test the accuracy of the voluntary system. It agreed that improvements were needed to improve reporting of data into its management information system and is making the necessary improvements. (See p. 10.)

--Because this management information system is also used to monitor the movement of plutonium and other special nuclear material and in view of the problems GAO found regarding the completeness of data on the shipments of uranium, the agency should make a limited review of the source documents for the movement of plutonium and other special nuclear materials to verify that its information is reliable. (See p. 14.)

--Although possible uranium shortages are generally considered in making overall export policies, domestic uranium supply is not considered as a specific factor by any Federal agency during the export licensing review process. The agency does not currently view this situation as a problem because of the reported low level of exports. (See p. 13.)

--The agency does not have reliable information on foreign investment in the domestic uranium industry and possible foreign control of future uranium discoveries that may result from such investment. (See p. 16.)

--Because it is not profitable to recover, some low-quality uranium ore deposits--located near or adjacent to high quality deposits--were not being recovered at the time of GAO's review. According to the agency, however, this problem has been alleviated by recent increases in the price of uranium. (See p. 22.)

--Although the agency is involved in a program to extend its uranium resource estimates and to research and develop new and improved uranium exploration procedures, equipment, and technology, not enough is being done by industry or the agency to research and develop new, lower cost technology for uranium mining and milling. (See p. 26.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

GAO discussed this report with Energy Research and Development Administration, Nuclear

Regulatory Commission, and Federal Energy Administration officials. For the most part, these officials generally agreed with the recommendations based on the findings in this report and their comments have been included, where appropriate.

MATTERS FOR CONSIDERATION BY THE CONGRESS

In view of the importance of uranium in meeting this Nation's plans for nuclear energy, the Congress should require the agency to report on the results of its efforts to improve the reporting of data into its management information system.

This report should reconcile differences between domestic uranium exports as currently reported through the agency's management information system with such exports reported through its voluntary reporting system.

The Congress should also closely monitor the agency's efforts in determining the amount and effect of foreign investments to the domestic uranium industry.

CHAPTER 1

INTRODUCTION

Because of the growing shortage of domestic gas and petroleum, nuclear power is being counted on to play an increasingly important role in meeting this Nation's energy needs in the future. The Energy Research and Development Administration (ERDA) ^{1/} estimates that, although nuclear reactors presently account for about 8 percent of the total U.S. electrical generating capacity, they will be used to provide about 46 percent of the total capacity by the year 2000. Because current light water reactors use only 1 to 2 percent of the energy available in uranium fuel, money is being spent to develop new and better nuclear reactors, such as the liquid metal fast breeder reactor, to more efficiently use uranium fuel thereby extending domestic uranium reserves.

Both the demand and supply of economically recoverable uranium is uncertain. ERDA estimates that the Nation's uranium resources might be sufficient to meet demand until the year 2000. Others, such as the Electric Power Research Institute, say that demand will not exceed supply until the year 2040 or later. This uncertainty exists primarily because of different assumptions about the electric consumption growth rate, the share of electricity generated by nuclear fission, and the amount of economically recoverable uranium.

Unfortunately, estimates of uranium resources vary, and in attempting to compare the supply of uranium to demand, the general conclusion is that both are so sensitive to the assumptions which are chosen that almost any desired result can be achieved. The following discussion on ERDA's demand and supply estimates illustrate this point. Nevertheless, if the plans for nuclear power are to be achieved, this Nation must develop and use this valuable and limited resource to its maximum potential.

It is therefore important that (1) ERDA have reliable data to implement sound export policies, (2) industry make all reasonable attempts to recover as much uranium ore as

^{1/}The Energy Reorganization Act of 1974 (Public Law 93-438) abolished the Atomic Energy Commission (AEC) and established the Energy Research and Development Administration and the Nuclear Regulatory Commission (NRC). 67

is practicable before closing a mine, and (3) ERDA and the uranium industry research and develop new and better ways to mine and mill uranium.

URANIUM DEMAND

The demand for uranium concentrate varies depending on assumptions about the availability of electrical power and uranium for operating the uranium enrichment plants, the reprocessing and reuse of spent fuel, 1/ and the recycling of plutonium--a useable byproduct of the fission process. The following table shows the range of cumulative uranium demand as projected by ERDA in February 1975 for 1980, 1985, and 1990 for four electrical growth projections. The projections are based on both pessimistic and optimistic assumptions about these variables.

<u>Range of Cumulative Uranium Demand</u>			
<u>Electric growth</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>
	---(tons)---		
High (note a)	119,300 to 146,200	334,800 to 431,500	696,100 to 933,600
Moderate to high (note b)	100,100 to 123,500	271,700 to 356,000	566,600 to 762,400
Moderate to low (note c)	85,200 to 105,800	234,200 to 308,800	491,800 to 662,800
Low (note d)	77,000 to 95,900	203,600 to 269,800	414,900 to 562,500

a/Assumes an electrical growth rate of 7 percent a year through the mid-1980s declining to 6.4 percent through 1990.

b/Assumes an electrical growth rate of 6.25 percent a year through 1985 declining to 5.85 percent through 1990.

c/Assumes an electrical growth rate of 6 percent a year through 1985 declining to 5.4 percent through 1990.

d/Assumes an electrical growth rate of 5.8 percent through 1985 declining to 4.75 percent through 1990.

1/Nuclear fuel that has been used to the extent that it can no longer effectively sustain a chain reaction in the reactor.

URANIUM SUPPLY

ERDA's estimates of domestic uranium resources are made in two categories of reliability--uranium reserves and potential uranium resources.

--Uranium reserves are defined as ore contained in known deposits and delineated by drilling data.

--Potential uranium resources are estimates of undiscovered uranium based on reasonable geologic extrapolations or judgments.

Continuing extensive geological and geophysical investigation and drilling will be required to discover and to convert the potential resources into reserves.

To meet ERDA's criteria for recovery and be termed as a reserve, an ore deposit must have a sufficient quantity of uranium to support recovery of all of its forward costs to recover the ore.

Forward costs are defined as all future expenditures required to develop, mine, transport, and process the ore to recover the uranium. Forward costs do not include such costs as return on investment and costs already incurred in property acquisition and exploration. Therefore, the selling price of uranium (currently about \$35 to \$40 a pound for 1980 delivery) will be higher than forward costs depending on demand and supply.

The following are ERDA estimates of domestic uranium reserves and potential resources.

Uranium Reserves and Potential Resources January 1, 1976

<u>Forward cost</u> <u>a pound (note a)</u>	<u>Reserves</u>	<u>Potential</u> <u>resources</u>	<u>Total</u>
	----- (tons) -----		
\$10	270,000	1,005,000	1,275,000
15	430,000	1,620,000	2,050,000
30	<u>640,000</u>	<u>2,920,000</u>	<u>3,560,000</u>
Additional byproduct (note b)	<u>140,000</u>		<u>140,000</u>
Total including byproduct	<u>780,000</u>		<u>3,700,000</u>

a/Each cost category includes the tons of uranium from the preceding cost category.

b/Byproduct of phosphate and copper production through 2000.

As the table shows, ERDA estimates that domestic uranium resources total 3.7 million tons of \$30 a pound or less uranium of which 780,000 tons are known reserves. The availability or extent of the remaining 2.9 million tons of potential resources is uncertain because these potential resources are not delineated by drilling data.

The following table demonstrates the wide range of results that can be obtained by using different assumptions about uranium supply and demand. Under ERDA's most optimistic assumption, uranium reserves will be adequate to meet demand beyond 1990; however, under ERDA's pessimistic assumptions, the 780,000 tons of reserves would not be adequate to meet the demand much beyond 1990.

Uranium Reserve and Demand

<u>Electric growth</u>	<u>Range of cumulative excess of uranium reserves over demand</u>		
	<u>1980</u>	<u>1985</u>	<u>1990</u>
High	660,700	445,200	83,900
	to 633,800	to 348,500	to -153,600
Moderate to high	679,900	508,300	213,400
	to 656,500	to 424,000	to 17,600
Moderate to low	694,800	545,800	288,200
	to 674,200	to 471,200	to 117,200
Low	703,000	576,400	365,100
	to 684,100	to 510,200	to 217,500

In addition to uranium reserves of 780,000 tons, ERDA uses 1.06 million tons of potential resources which have the greatest reliability of existence as a planning base for developing nuclear power. According to ERDA, these reserves and resources totaling 1.84 million tons could be sufficient to meet demand until the year 2000.

The question may not be how many reserves and resources exist, but how much uranium can be produced. Estimated reserves can only be made available to meet demand if uranium mining and milling capacity is expanded. According to Federal Energy Administration (FEA) officials, if industry does not increase its production capacity beyond what is currently planned, ERDA's projected demand for uranium to fuel nuclear reactors may not be met. In reaching this conclusion, these

officials assumed that a 3-year difference existed between the need for uranium production capacity and the actual use of the uranium in a reactor. Based on this difference, these officials noted that, beginning as early as 1979 the total uranium produced would not be sufficient to meet 1982 nuclear reactor requirements. 1/

Expanding uranium production to meet rising demand will be a formidable task if reliance on nuclear fission for electricity generation continues. The ability to increase the capability will be made more difficult by (1) an 8-year lead-time needed from the beginning of exploration to initial production, (2) the necessity for an 8- to 10-year reserve to justify initiating a mining and milling operation, (3) potential equipment and material shortages, and (4) competition for capital and trained personnel.

Economics can also affect uranium reserves. Inflationary pressures cause costs to increase thereby causing reserves included in lower cost categories to be reevaluated and placed in higher cost categories. For example, in 1974 ERDA estimated that there were 277,000 tons of uranium reserves in the \$8 forward cost category. In the 1975 estimate this was reduced to 200,000 tons, and in the 1976 estimate the \$8 forward cost category was included in the \$10 forward cost category, primarily because of a reevaluation reflecting inflationary pressures. Similar but smaller reductions also occurred in the other cost categories.

On the other hand, while inflationary pressures cause forward costs to increase, the price of uranium has also increased, making the recovery of higher cost ore more profitable. For example, industry estimates show that for June 1974 through June 1975, the price of uranium for delivery in 1980 averaged \$27 a pound. This represents a \$13 a pound increase for 1980 deliveries over uranium prices for June 1973 through June 1974. As of January 1976, uranium was selling for about \$40 a pound for 1980 delivery.

Because of the increasing concern about the adequacy of uranium supplies by the late 1980s, utilities have increased their efforts to contract for uranium supply for long-term deliveries. The amount of uranium reserves in the United States which have been developed to the point

1/Decisions regarding the operation of uranium enrichment plants and recycling of plutonium could delay this shortage in production capacity by as much as 2 years.

where they are available for sale--even in the long term-- is limited. Therefore the opportunity for utility companies to enter into contracts for long-term delivery of uranium ore is severely restricted. As of January 1, 1975, arrangements had been made only for meeting the first core uranium fueling requirements for 61 percent of the reactors under construction or on order. In addition, fuel arrangements beyond 3 years of operation are largely open.

ERDA EFFORTS TO IMPROVE URANIUM RESOURCE ESTIMATES

4 In the spring of 1973, AEC initiated, and ERDA is continuing, the national uranium resource evaluation program (NURE) to extend its uranium resource estimates to include an assessment of this Nation's total domestic uranium resources. A deadline of mid-1976 has been set for a preliminary evaluation report on domestic uranium resources with the first comprehensive report due in 1981. ERDA has not yet established the total cost of the program but has spent about \$7 million in fiscal years 1974 and 1975 and expects to spend about \$14 million in fiscal year 1976. 743

The program will involve extensive geophysical and geological investigations to identify possible sources of uranium. The NURE reports will include new data based on widespread geological, geophysical, and geochemical investigations and the investigation of economic and production factors affecting exploration. The information gathered is expected to add to ERDA's estimates of potential resources but will not add to ERDA's estimates of uranium reserves. ERDA expects private industry to use the information as a basis for funding most of the exploratory drilling to delineate the existence of uranium.

IMPORTING FOREIGN URANIUM

If the United States cannot meet its uranium requirements with domestic reserves, greater reliance must be placed on foreign sources.

Under certain provisions of the 1964 amendment to the Atomic Energy Act of 1954, by which standards governing the use and possession of source, special nuclear or byproduct materials may be established, ERDA in 1977 will permit utilities to use imported uranium in 1977 to satisfy up to 10 percent of their uranium requirements for enrichment at ERDA's facilities. The allowable percentage will increase each year until 1984 when 100 percent of a utility's requirement may

be furnished to ERDA enrichment facilities from imported material. It is unclear at this time how much uranium will be available for import because the foreign demand for uranium is very high in relation to foreign supply. Also, as foreign countries place greater reliance on nuclear power, demand will increase, further aggravating the situation. The exporting policies of leading uranium-exporting nations may further limit the uranium available for import. Canada, for example, will not permit the exporting of uranium until the lifetime uranium requirements for its reactors have been provided for. (See app. III.)

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Recognizing the uncertainty that exists as to the amount of economical uranium available for reactor fuel, it was not our intention to question whether there is--or will be--a uranium shortage nor did we evaluate in any detail the problems involved in expanding uranium production capability. There is little disagreement that, if the United States is to meet the expectation for nuclear energy, uranium resources must be developed and used wisely. We, therefore, evaluated several aspects of uranium supply including

- the effectiveness of ERDA's monitoring over, and the reliability of information on, uranium exports and possible control of uranium by foreign investors in the uranium industry and
- ongoing efforts to increase uranium supply through
 - (1) recovering low-quality uranium ore and
 - (2) researching and developing better exploration, mining, and milling techniques.

CHAPTER 2

MORE RELIABLE DATA COULD HELP IN FORMULATING

SOUND URANIUM EXPORT POLICIES

The supply and availability of domestic uranium 1/ as a fuel for U.S. nuclear reactors is dependent to some degree on factors not solely related to the amount of uranium reserves and resources. The amount of uranium being exported and the extent to which future discoveries of domestic uranium are being controlled by foreign investors are two such factors.

The importance of uranium as a means to meet this Nation's self-sufficiency goals and the possibility of its short supply make it imperative that the Energy Research and Development Administration have reliable information on both of these factors so that sound export policies which are consistent with our energy goals can be established.

ERDA's data base for verifying the accuracy of its voluntary reporting system on exports of domestic uranium is incomplete. In addition, ERDA does not have reliable information on possible control of future discoveries of uranium by foreign companies which are investing in the exploration, mining, and/or milling of uranium ore. Such information does not centrally exist anywhere within the Federal Government.

ERDA and industry officials we talked with agreed that reliable information on uranium exports and possible uranium control by foreign investors would be useful in formulating and monitoring this country's export policies. The need for such information takes on greater importance as this Nation's reserves of relatively low-cost uranium are exhausted.

ERDA believes that it has a good idea of the extent of possible control of uranium by foreign investors and an elaborate reporting system is not yet needed. It agrees, however, that such information will be needed in the future as uranium becomes more scarce.

In addition, although possible uranium shortages are generally considered in making overall export policies, domestic uranium supply is not considered by any Federal

1/Uranium of U.S. origin.

agency during the export licensing review process. Although ERDA does not currently view this situation as a problem because of the reported low level of exports (see p. 11), we believe such considerations are necessary to insure that the domestic uranium supply is protected. We recognize that other factors which influence export decisions, such as foreign relations, national defense information, and certain political considerations must also be taken into account. We note, however, that the Department of Commerce--which has responsibilities for granting export licenses for certain radioactive materials other than those produced in reactors, reactor components, civilian maritime nuclear propulsion equipment and technology, and certain items used in nuclear research--considers shortages when granting certain export licenses.

NEED FOR RELIABLE INFORMATION
ON DOMESTIC URANIUM EXPORTS

Agencies having responsibility
over uranium exports

For civil uses of atomic energy, the Atomic Energy Act of 1954, as amended, requires that an agreement for cooperation be signed with another government or group of governments before production facilities, nuclear reactors, or special nuclear material 1/ can be exported (42 U.S.C. 2153). Under such an agreement, supply contracts can be entered into with the cooperating government or private entities within that country. Typical provisions of such an agreement as well as how these agreements are approved are discussed in appendix IV.

Byproduct material 2/ may be exported when the Nuclear Regulatory Commission determines that the proposed export would not be inimical to the common defense and security or when the export is pursuant to the terms of an agreement

1/Plutonium--other than plutonium-238--uranium-233, uranium containing more than the natural abundance of uranium-235, or any material artificially enriched in any of these substances.

2/Any radioactive material (except source or fissionable material) obtained during the production or use of source or fissionable material.

for cooperation. Source material 1/ may be exported if NRC determines that the proposed export would be pursuant to an agreement for cooperation and would not be inimical to the interests of the United States. Certain quantities of source materials may be exported subject only upon a finding of noninimicability to the interests of the United States.

Under the act, NRC is responsible for issuing export licenses for production and utilization facilities and by-product, source, and special nuclear material. Before issuing such licenses, it must determine whether the proposed export would be inimical to the common defense and security or interests of the United States, as appropriate, and in certain cases, whether the proposed export would be under the terms of an agreement for cooperation. To determine this, NRC obtains the views of other executive branch agencies--through the Department of State--such as national security and foreign relations agencies which gather the information and make integrated national policy assessments as to common defense and security. ERDA has the technical expertise and information to provide an assessment for the export of all nuclear materials, including uranium.

NRC and executive branch agencies procedures for issuing export licenses have been in effect since May 1975. Executive Order 11902, dated February 2, 1976, formalized these procedures.

Need for better data to independently
verify uranium exports

ERDA currently uses a voluntary reporting system to estimate the amount of domestic uranium being exported. Perhaps the single most important problem with such a system is the question of credibility. As long as much of the reporting of data by industry is voluntary and unverified, the Congress and the public can be expected to raise questions as to the credibility of the data, even though the data may be entirely valid.

1/Any material except special nuclear material which contains .05 percent or more of uranium, thorium, or any combination of the two. This includes uranium as found in nature containing 0.7 percent fissionable U-235 (the uranium isotope needed to fuel nuclear reactors).

To obtain data on uranium exports, ERDA surveys the uranium industry which voluntarily supplies data on uranium commitments from domestic producers to foreign buyers. An April 1975 ERDA survey report of the U.S. uranium marketing activity showed that 6,900 tons of uranium were committed to foreign countries by domestic producers as of January 1, 1974, and 3,700 additional tons were committed to foreign buyers in 1974.

On the basis of this information and its data on domestic uranium production, ERDA estimated that about 3 percent of the total uranium produced through fiscal year 1974 was purchased by foreign customers. ERDA expects that there will be some variation from time to time in the ratio of domestic to foreign uranium sales but does not anticipate exports to exceed 3 to 5 percent of industry's annual capacity between 1975 and 2000.

ERDA has a management information system--the Nuclear Materials Information System (NMIS)--which we used to test the accuracy of ERDA's voluntary system. Under NRC's and ERDA's regulations and requirements, transactions involving movement of 1 gram or more of nuclear materials--including plutonium and other special nuclear materials--must be reported to them. The Code of Federal Regulations (10 C.F.R. 40.64) has required since July 1970 that all imports of uranium concentrate (chemically designated as U_3O_8) into the United States greater than 1,000 kilograms of uranium be reported and recorded in NMIS which allows the monitoring of nuclear material transfers. Before July 1970 only movements of special nuclear material were required to be reported. According to an ERDA official, NMIS is not used to determine exports because ERDA believes its voluntary system provides reliable data.

In testing ERDA's voluntary system, we found that exports of domestic U_3O_8 reported through NMIS were substantially higher than the 3-percent level noted above. As shown in the following, we calculated that about 20 percent of the domestic U_3O_8 being produced was being exported. These amounts included exported U_3O_8 as well as exports of enriched uranium, which we converted into U_3O_8 equivalents. After our evaluation, ERDA said this discrepancy occurred because the NMIS data base is incomplete.

Total Domestic U₃O₈
and Equivalents Exported

<u>Fiscal</u> <u>year</u>	Net exports (note a)	<u>Production</u>	Percent of net exports to production
		(tons)	
1970	715	12,400	5.8
1971	1,916	12,500	15.3
1972	4,273	12,600	33.9
1973	2,997	13,300	22.5
1974	<u>2,922</u>	<u>12,200</u>	<u>24.0</u>
Totals	<u>b/12,823</u>	<u>b/63,000</u>	20.4

a/U₃O₈ enters the country from foreign countries to be enriched and is included in the NMIS import data. When the enriched uranium is returned, it is included in the NMIS export data. Because NMIS does not document the source of U₃O₈, total imports must be subtracted from total exports to determine net exports of domestic U₃O₈.

b/All figures are given in tons of U₃O₈.

We were unable to reconcile our export estimates with ERDA's but noted that ERDA's voluntary reporting system may not include domestic uranium which could be sold initially to a domestic buyer and then later sold to a foreign entity. Although we could not determine how much uranium this process involved, this potential flow raises questions about the voluntary system's ability to reasonably determine the amount of uranium exports and further demonstrates the need to verify the information.

In a September 25, 1975, letter, we asked ERDA to reconcile this discrepancy. ERDA, in a December 29, 1975, letter, said that the NMIS import data was not complete, resulting in an overstatement of the net amount of domestic uranium being exported.

To reconcile the two systems, ERDA used information from the Bureau of Customs and found that numerous entries of U₃O₈ shipments into the United States were not recorded in NMIS. It said this apparently occurred because, contrary to the Code of Federal Regulations, the necessary forms had not been filed with ERDA and NRC by the licensee.

ERDA believes that, because the NMIS record on imports is low, our estimates of net exports using NMIS are correspondingly high, which leads to an inaccurate relation of exports to domestic production.

ERDA officials believed that the NMIS data on total domestic uranium exports was correct because of certain internal checks within the system to verify this data. They said that while their export estimate of 3 to 5 percent might not be precise, they did not believe uranium exports exceeded 7 percent.

Nevertheless, ERDA, in its December 29, 1975, letter, said that action would be taken to insure that complete information was routinely incorporated in the NMIS system and that some modification of current ERDA and NRC reporting procedures or institution of new reporting requirements appeared necessary to develop a reliable information base on the original sources and ultimate destinations of uranium.

On January 13, 1976, ERDA initiated action to improve the reporting into NMIS by advising NRC of the problem, pointing out the reporting requirements of 10 CFR 40.64, and requested advice as to when the deficiencies in the reporting of information to NMIS would be corrected. NRC informed ERDA, in a February 19, 1976, letter, that the matter had been referred to the NRC Office of Inspection and Enforcement for appropriate action and that enforcement of the reporting requirements should yield a satisfactory flow of uranium import data into NMIS. In addition, an ERDA official said that, as part of its efforts to improve the reporting of data into the system, ERDA was attempting to install a means of tracking material of foreign origin as it moves into, within, and out of the country. He said this should improve NMIS and provide an accurate method of determining the amount of domestic uranium exported.

Short supply consideration

Although ERDA has no regulations by which to review export license applications referred to it by the Department of State, it does follow some specific guidelines and criteria. These guidelines, however, do not consider the possible future short supply of uranium and the resulting implications for achieving and maintaining energy self-sufficiency.

ERDA officials said that short supply considerations are not made because they do not believe domestic uranium exports exceed 3 to 5 percent. As pointed out previously,

however, we could not verify the reasonableness of ERDA's export estimates through NMIS.

We also noted that, while the Department of Commerce considered supply shortages when granting export licenses for certain items under its jurisdiction, it did not do so for nuclear facilities and materials--such as parts and components for nuclear reactors--under its control. According to Commerce officials, actions to place nuclear items on Commerce's short supply list would have to be initiated by ERDA and NRC.

NRC and Department of State officials also said that, although possible uranium shortages are generally considered in making overall export policies, the present system used in determining whether a uranium export license should be issued does not include short supply considerations but is geared toward safeguard issues.

Conclusions

Without a complete NMIS data base to independently verify the amount of domestic uranium exports being reported to ERDA through its voluntary reporting system, ERDA has no way of insuring the Congress or the public that its estimates are reasonable and reliable. It is important that ERDA continue to take steps to require identification of the origin of exported material and improve the reporting into NMIS. ERDA should also evaluate the impact that various levels of uranium exports will have on this Nation's domestic needs.

We are not assessing the adequacy of this Nation's export policies nor are we advocating either increased or decreased uranium exports. In our view, however, steps to improve input to NMIS and to evaluate uranium exports are needed to insure that this country's export policies are sound and consistent with its energy goals. Such information would also help in better determining what impact uranium exports may have on the domestic uranium supply.

In addition, we did not specifically evaluate the movement of plutonium and other special nuclear material. NMIS is also used to monitor the movement of these materials. Because we found problems with incomplete data on the shipments of uranium, ERDA should make a limited review of the source documents for the movement of plutonium and other special nuclear materials to verify that the NMIS data on these substances is reliable.

We plan to closely monitor ERDA's actions to improve the reporting of data into NMIS, including a verification

of the completeness of data on the movement of plutonium and other special nuclear materials.

Recommendations to the
Administrator, ERDA

We recommend that the Administrator, ERDA:

- Continue to evaluate and improve the reporting of data into NMIS to verify the amount of domestic uranium being exported to foreign countries, and in view of these improvements, determine whether the voluntary system for obtaining this information should be discontinued.
- Evaluate the effects of various levels of uranium exports in terms of a possible short supply of uranium in this country and use such information in making its recommendations to NRC--through the Department of State--on uranium export license applications.
- Make a limited review of the source documents for the movement of plutonium and other special nuclear materials to verify that the NMIS data base on these substances is complete.

Agency comments and unresolved issues

ERDA, NRC, and FEA officials generally agreed with the need for reliable data on uranium exports. In its April 30, 1976, comments on this report (see app. I), however, ERDA emphasized its belief that the voluntary system gives accurate export information and pointed out that NMIS was not originally planned to determine the amount of domestic uranium exported and it was not expected that this system would be used for that purpose. While we agree that NMIS was not originally designed to determine the amount of domestic uranium exports, if complete, it has the necessary data to be used for that purpose and, at a minimum, can be used as a reliable check on the accuracy of the voluntary system. ERDA reemphasized, however, that it has initiated action with NRC to insure that more complete uranium import information is routinely incorporated in the NMIS system.

ERDA also noted in its comments that accurate information is kept on the amount of uranium licensed for export although this data does not show whether the material is of U.S. or foreign origin. We did not verify the accuracy of ERDA's information on the amount of uranium licensed for export. Such information is not useful for determining the amount of domestic uranium actually being exported because (1) it does not show the source of the material and (2)

obtaining a license to export uranium does not necessarily mean that the material is, in fact, exported.

In addition, FEA, in its April 9, 1976, comments on this report (see app. II), disagreed with our recommendation that ERDA make a limited review of the source documents for the movement of plutonium and other special nuclear materials to verify that the NMIS data on these substances is complete. FEA said that, based on its discussions with ERDA, it appears that a separate, comprehensive, and thorough accounting is made of plutonium material flows, with substantial cross-checking to insure the adequacy of the data. While this may be true, we believe that, in view of problems noted in reporting of data into NMIS on source materials, a limited ERDA review of the accuracy of data on plutonium is warranted. In this respect, ERDA's Assistant Director for Information Support, Division of Safeguards and Security, told us that ERDA would make such a limited review as part of its ongoing efforts to insure the accuracy of NMIS.

NEED FOR MORE RELIABLE INFORMATION ON URANIUM CONTROLLED BY FOREIGN COUNTRIES

There are certain advantages to encouraging foreign investment, such as providing much needed risk capital for uranium exploration. Nevertheless, there is one obvious disadvantage--the possible control of this much needed resource by foreign countries when it may be in short supply in this country.

In this report a distinction is being made between the commitment of uranium to foreign buyers, which is used as a basis for estimating uranium exports (see p. 11), and the control of uranium by foreign companies because of their investment in the exploration, mining, and/or milling of uranium ore. In the former there is a definite commitment for uranium to leave the country, while in the latter there is a potential control of uranium because of the foreign investment.

Sources of information on foreign investments

Historically, there have been few restrictions placed on foreign investors in the United States, and they generally have enjoyed the same freedom as domestic investors. Selective restrictions are placed on foreign ownership of U.S. enterprises engaged in certain areas considered vital to the national interest, such as commercial aviation, communication systems, hydroelectric power, and nuclear energy. (See app. V.)

Official statistics on foreign investments have been collected primarily for inclusion in the balance-of-payments data reported to the International Monetary Fund pursuant to section 8 of the Bretton Woods Agreement Act, as amended (22 U.S.C. 286-286k-1). The Department of Commerce (for direct investments) and the Department of the Treasury (for portfolio investments) compile and maintain these statistics. However, there is no legal reporting requirement for foreign investments. According to Department of Commerce officials, they attempt to maintain a list of foreign investors through direct contacts, newspaper articles, State agencies, banks, and U.S. foreign agencies.

These agencies, nevertheless, initiated a survey pursuant to the Foreign Investment Study Act of 1974 (Public Law 93-479) which recognized the wisdom of monitoring the extent and impact of such investments. The purpose of the Department of Commerce study is to obtain data on the amount, types, and financial and operational characteristics of direct foreign investment in the United States in 1974. However, the extent of foreign investment in the domestic uranium industry cannot be determined from this study because the information obtained from the questionnaires will not identify uranium mining as a separate item. That information will be included with other metallic ores and metal-mining services.

The Federal Energy Administration Act of 1974 (15 U.S.C. 761-786) gave FEA authority to require mandatory reporting of energy information--including information on foreign investment and control--and required FEA to report to the Congress on foreign ownership of, influence on, and control of domestic energy sources. FEA's December 1974 report recognized that neither it nor any other report could, with any assurance, present a comprehensive list of foreign ownership unless data collection is improved. According to an FEA official, without a reliable data base, there was no way to monitor foreign influence in U.S. energy activities. He said that private publications and foreign embassies were the principal sources used for compiling information on foreign companies involved in the domestic uranium industry.

An FEA official said that FEA had not established a mandatory reporting system on foreign investment primarily because (1) there was a lack of resources to establish such a system, (2) the law required FEA to only monitor foreign activity, and (3) concern over foreign involvement had declined recently. He noted also that foreign involvement in the uranium industry had only increased in very recent years as more countries placed greater reliance on nuclear power.

ERDA efforts

ERDA recognizes the need to develop information on foreign investments and the possible control of uranium by foreign investors. ERDA officials said this information was needed to (1) project the capability of the domestic uranium industry to meet uranium requirements and (2) project the time required to respond to changes in available foreign supplies.

These officials told us, however, that no monitoring of foreign investment or possible control was done other than informal discussions with mining industry officials. However, they said that, based on their close relationship with the uranium industry, they have a good idea of the extent of foreign investment in the domestic uranium industry and an elaborate reporting system was not yet needed.

The domestic uranium-producing industry voluntarily supplies ERDA with information on domestic reserves and resources, exploration activities, and mining and milling capacity and gives ERDA access to mines and mills for examination and special studies. Much of this information is summarized and published annually by ERDA. While some information on foreign investment is available through this system, it is incomplete and possible control of domestic uranium by foreign investors is not reported nor is the available information separated from domestic information in the annual report.

At our request ERDA analyzed data supplied by industry as part of its report on overall domestic exploration during calendar years 1973 and 1974. From this analysis, ERDA said that the number of those companies--primarily involved in uranium exploration--which were based in the United States but which were wholly owned by foreign companies or countries had increased from 5 to 12 during that period. The total exploration expenditures reported by 4 of these companies in 1973 and 10 companies in 1974 showed an increase from \$1 million to \$6.9 million during that period. This represents about 2.2 percent and 8.6 percent, respectively, of the total reported U.S. exploration expenditures. One foreign company in 1973 and two foreign companies in 1974 did not report the amount of their expenditures in uranium exploration.

It is important to note that these costs do not necessarily represent the total foreign involvement because (1) joint ventures between U.S. and foreign companies may only be reported in total by the U.S. company, (2) information reported by foreign companies may not include data from subsidiary firms, and (3) some companies choose not to report.

We discussed the possible control of domestic uranium by foreign investors with eight domestic companies involved in the uranium industry as well as four electric power companies. Most of these companies generally agreed that foreign investment in and of itself is good but a need exists to control the extent and impact of such investments on the viability of the domestic uranium industry and on this Nation's ability to meet domestic needs.

Several companies said that this money was needed to provide capital for uranium exploration. They said, however, that these activities should be controlled to insure the domestic uranium supply.

One domestic company, for example, told us it was involved in joint ventures with two foreign companies for uranium exploration. The agreement provides that 50 percent of the uranium discovered is to be controlled by the foreign investors. Another company told us that foreign countries are exploring for uranium in the United States for export. According to an ERDA official, foreign countries are exploring for uranium in this country because they believe there is more opportunity to recover and export uranium from the United States than from other countries which have rigid export requirements. (See app. III.)

Another ERDA official told us that, while the extent of foreign investment is not yet great, such information would be useful for formulating sound export policies. He believed that this information could be obtained from uranium companies through ERDA's current voluntary reporting system.

Conclusions

Reliable information on the possible control of domestic uranium by foreign investors is necessary to formulate sound export policies and to insure that sound decisions are made. Currently, ERDA does not compile or report this information. In our view, there is a pressing need for ERDA to develop this information to insure that the data base from which future uranium policies are made is complete.

Recommendation to the Administrator, ERDA

We recommend that the ERDA Administrator work closely with the uranium industry to voluntarily obtain information on (1) the amount of foreign investment in the domestic uranium industry and (2) the possible amount of uranium controlled by these foreign investors and to assess the

impact such investments may have on the Nation's ability to meet future energy requirements. Recognizing the problems involved in obtaining any information on a voluntary basis, ERDA should assess the reliability of data obtained voluntarily on control of uranium by foreign countries. If it finds that the voluntary system is not reliable, ERDA should work closely with FEA to establish reporting requirements on a mandatory basis to obtain this information.

Agency comments and unresolved issues

ERDA, in its April 30, 1976, comments, agreed with our conclusions that reliable information on the possible control of domestic uranium by foreign investors is desirable. ERDA officials said that ERDA had begun actions to obtain better information on foreign investment in the domestic uranium industry through its voluntary reporting system. ERDA pointed out, however, that control or ownership of domestic uranium by foreign investors did not carry with it the right to export such uranium from this country. (See p. 16 and app. IV.)

Although we agree that NRC controls all exports of domestic uranium through its export-licensing procedures, we believe information on foreign control of domestic uranium is vital so that sound export policies which are consistent with our energy goals can be established. In addition, as noted on page 9, decisions on export licenses are based on many factors other than the domestic uranium supply, such as foreign relations, national defense information, and certain political considerations.

FEA, in its comments on this report, said that it is currently determining the extent and value of foreign investment in the U.S. domestic uranium industry and will continue to monitor such investment in the future. An FEA official said, however, that this determination was still based on the same data sources as the December 1974 report and that the data base could be improved. We also noted that FEA's efforts would not attempt to determine the extent of possible control of domestic uranium by foreign investors.

FEA, in its comments, also said that, under the Federal Energy Act of 1974, it currently reviews all energy-related, Export-Import Bank transactions to insure that they do not adversely affect domestic energy programs. While such reviews would provide some data on foreign investments where the Export-Import Bank is involved, it is not complete and does not provide information on uranium controlled by foreign

investors. An FEA official agreed that a review of these transactions would not provide information on uranium controlled by foreign investors.

FEA noted that it would attempt to develop appropriate arrangements with ERDA to establish mandatory reporting requirements to obtain information on foreign investment and control of domestic uranium if ERDA's voluntary system proves inadequate.

Recommendations to the Congress

In view of the importance of uranium in meeting this Nation's plans for nuclear energy, the Congress should require ERDA to report on the results of its efforts to improve the reporting of data into its management information system. This report should reconcile differences between domestic uranium exports as currently reported through ERDA's management information system with such exports reported through its voluntary reporting system. The Congress should also closely monitor ERDA's efforts in determining the amount and effect of foreign investments in the domestic uranium industry.

CHAPTER 3

OPPORTUNITIES FOR INCREASING

THE DOMESTIC SUPPLY OF URANIUM RESOURCES

With the increasing demand for uranium as a nuclear fuel and the possible short supply of this important resource, attempts must be made to (1) increase the amount of uranium recovered and (2) research new and better ways to develop this resource, particularly as higher quality ore deposits are depleted. There may be some opportunities for improving this Nation's efforts in both of these areas.

POSSIBILITY OF RECOVERING LOWER QUALITY ORE DEPOSITS

To meet this Nation's future domestic uranium requirements, every practicable effort should be made to take full advantage of existing, known uranium deposits. At the time of our review, this was not being done. Low-quality ore deposits which are associated with high-quality deposits are being left in the ground and may never be recovered. Since the time of our review, however, the market price of uranium has risen significantly. According to the Energy Research and Development Administration, this price increase has provided the necessary incentive for mining companies to recover much lower quality ore, thereby diminishing the significance of this problem.

Uranium companies, in mining uranium ore, for the most part attempt to recover all high-quality uranium ore which will provide the most profitable return in the short run. In doing so, the mining methods used by these companies in some cases cause the mine to cave in leaving behind low-quality ore which is located nearby. To recover this ore, the mine would have to be reopened at substantial additional costs. This is also true when open pit or strip-mining methods are used, and the low-quality ore is covered in the pit as part of the waste. We noted, however, that mining companies were recovering and stockpiling low-quality ore in some cases when open pit or strip-mining methods were used.

The quality or grade of uranium ore is measured by the amount of U_3O_8 contained in the ore. The higher the content, the higher the quality of the ore. As the uranium content and the accessibility of the ore decreases, the forward cost required to recover it tends to increase. About 7 million tons of ore were produced in 1974 containing an average of 0.18 percent U_3O_8 . Low-quality ores,

as used in this report, are any ores for which the cost of recovery would be higher than the current market price. This, however, does not include uranium in very low-quality deposits, such as shale and seawater.

The Atomic Energy Commission, in the past, has recognized the wisdom of recovering low-quality ore. At a March 1973 uranium seminar, it said:

"The additional cost to the consumer of uranium from low-grade ore should be avoided if possible. In 1985 the difference between \$8 and \$15 uranium would amount to about \$1 billion per year. Possibly the industry should accelerate development of improved exploration methods for high-grade ore and new extraction techniques for low-grade material."

High-quality surface ore deposits of the magnitude found in New Mexico and Wyoming in the early 1950s, which provided 75 percent of the current uranium requirements, are generally believed to be something of the past. Uranium ore in recently discovered deposits is deeper and more difficult to find. Increased exploration and better mining technology may result in additional uranium recoveries, some of which may be of high quality and economically recoverable at today's prices. However, because there is an 8- to 10-year leadtime between the initial discovery of a new uranium deposit and the time it can be produced as U_3O_8 , it is important to take advantage of all deposits as is practicable to insure that this country has an adequate supply until and if new discoveries can be made and processed.

Why low-quality ore is not recovered

Mining company officials we talked to generally agreed that low-quality ore should be recovered under current mining operations. Most of these mining officials told us that sizable quantities of low-quality ore are not being mined under current operations and the ore considered uneconomical today will be needed and will be economical sometime in the near future. The problem of mining low-quality ore is primarily one of economics. In the short run, there is no economic incentive to recover the ore. On the other hand, increased prices would provide an incentive to recover more of this ore.

Uranium mining requires considerably more time to realize a return on investment than either coal or oil and some of the other energy resources. Mining of low-quality ore not only adds to present operating costs but also

increases the investment recovery time because the ore will not be marketable without incentives until sometime in the future. Some mining company officials are reluctant to recover low-quality ore on speculation that the ore will be profitable sometime in the future. Some of these officials told us that ERDA should again consider incentives for a recovery program for low-quality ore similar to those provided by AEC during the infancy of the uranium industry.

To encourage widespread participation in developing and using atomic energy and to create a viable domestic uranium industry, AEC, in the late 1940s, developed an incentive program to gain private industry participation in the search for uranium. This program provided a guaranteed market, haulage and development allowances, and production bonuses. Incentives were terminated in 1962, and existing contracts and commitments for uranium were honored through 1966. During the period 1947 through 1966 AEC purchased 284,890 tons of U_3O_8 .

Possible advantages of recovering low-quality ore

Current development of low-quality ore deposits associated with high-quality ore deposits could help alleviate uranium shortages in both the short and long run.

Certain long-term benefits would accrue from recovering low-quality ore. Mining costs are increasing and will continue to increase in the future. Because of this inflationary trend, recovery now of low-quality ore with ore of higher quality may involve less overall cost than if mines must be reopened at a later time to recover the lower quality ore left behind.

Mining and stockpiling low-quality uranium ore would

- increase the supply of uranium available to meet future demand, particularly in crisis situations, and
- significantly reduce the time required to make low-quality ore available when needed if it is recovered as part of current operations rather than attempting to recover it at a later time.

The liquid metal fast breeder reactor is one of our Nation's highest priority energy programs and is being developed to help extend this country's uranium reserves. Because it can create more fuel than it uses, the fast breeder reactor holds the promise of extending the useful life of available

economically recoverable uranium sufficiently to provide a large fraction of the Nation's growing electric energy needs for many hundreds of years. The United States, however, would need these breeders in operation well before depletion of economically recoverable uranium so that the liquid metal fast breeder reactor could produce fuel needed to replace the natural uranium.

The ERDA Administrator, in a December 31, 1975, press release, said that the liquid metal fast breeder reactor program and supporting programs would provide sufficient data by 1986 for ERDA to make a decision on the acceptability of widespread commercial deployment. ERDA estimates that it will have spent about \$10.3 billion on this program through fiscal year 1986.

The recovery and stockpiling of low-quality uranium ore could provide the Nation with a hedge against an unfavorable decision for commercializing the liquid metal fast breeder reactor. If an unfavorable decision is made, more reliance would need to be placed on light-water reactors which use uranium as a fuel less efficiently than the breeder. On the other hand, even if the breeder reactor program is successful, a shortage could occur before its commercialization. Stockpiling low-quality ore could be used to help alleviate that shortage.

In November 1974, before recent price increases, an ERDA official noted that a Government program to purchase and stockpile low-quality ore would not disturb the current market because this ore most likely would not be recovered without some type of Government assistance. He said that, in his opinion, the price that could be obtained for the ore in a shortage situation could more than offset the purchase and storage costs.

Through its voluntary reporting system, ERDA obtains information on the amount of low-quality ore available. ERDA, however, has not determined the total costs involved--including storage--to recover and stockpile low-quality uranium ore. In addition to cost, we recognize that there are other considerations that must be made--such as the effect of an incentive program on the Federal budget--before deciding on the best course of action.

In responding to this report, ERDA officials recognized that, until recently, the possible loss of low-quality ore as high-quality ore was being mined was a problem. They said, however, that the significant increase in the price of uranium since the time of our review has resulted in new initiatives by mining companies to begin recovery of much lower quality ore. They said that (1) current prices allow mining

of uranium to considerably lower quality than did prices being paid a few years ago, (2) mining companies are increasingly concerned about maintaining access to low-quality portions of their ore deposits for future mining, and (3) recovering lower quality ore which is associated with high-quality deposits would add less than 5 percent to the total uranium supplies--or about 30,000 tons.

As a result of the recent price increases, ERDA examined, during the course of our review, the cost to the Government of recovering this additional material. ERDA estimated that, on the basis of the current market price of \$40 a pound as the minimum price the Government would have to pay to encourage recovery, it would cost the Government at least \$2.4 billion to encourage recovery of this additional ore. ERDA believes that these funds could better be spent in identifying additional resources.

ERDA officials point out that ERDA-AEC has for many years studied, and continues to study, the distribution and recovery of low-quality uranium in domestic deposits. In this respect, ERDA is currently studying the impact of including ore costing up to \$50 a pound to recover (compared to the maximum of \$30 a pound recovery cost now used), as well as preparing a mineral inventory assessment including an ore quality as low as .01 percent U_3O_8 .

Conclusions

If (1) the nuclear industry is to grow as projected in meeting this country's energy needs and/or (2) delays are experienced in commercialization of the liquid metal fast breeder reactor, all that is practicable should be done to insure an adequate supply of uranium. Recovering more ore in any given deposit than is now being done could be one way of increasing the supply of uranium for nuclear fuel.

The recent price increases since the time of our review have probably spurred new initiatives to recover low-quality ore. We endorse ERDA's efforts in continually reassessing the distribution and recovery of low-quality ore. Such reassessments are desirable in view of any fluctuations in market prices. In this respect, we plan to closely monitor ERDA's continuing efforts to assess the desirability of recovering low-quality ore.

NEED FOR MORE EMPHASIS ON URANIUM RESEARCH AND DEVELOPMENT

The recovery of uneconomical low-quality ore could also be enhanced by the research and development of new, lower cost technology. According to industry officials, the

technology used to identify uranium deposits and to mine and process uranium ore has remained basically the same over the past 30 years. Little has been done by the Federal Government or private industry to research and develop new, lower cost uranium identification, mining, and milling technology. As the quality of uranium ore decreases, the methods of recovering and refining uranium must be improved to hold costs down.

Some examples of possible projects for research and development--as presented to ERDA by industry in an October 1974 conference--include:

- Better milling instrumentation which could lead to more efficient operations with less manpower.
- Better mining equipment and techniques.
- In situ leaching.

Although ERDA has begun a research and development program for uranium identification and assessment, little is being done to research and develop new and better mining and milling techniques.

Funding for uranium research and development

AEC, the Department of the Interior, the National Science Foundation, and the Environmental Protection Agency, in the past, carried on the bulk of Federal energy research and development. With the passage of the Energy Reorganization Act of 1974, ERDA now receives a major portion of the total Federal energy research and development budget.

Most of ERDA's energy research and development funds are used to develop and improve various nuclear reactor programs. For example, in fiscal year 1974, AEC spent \$354 million--or about 55 percent of AEC's total research and development budget--in developing a civilian fission breeder reactor. During the same period, AEC spent only \$2.2 million to improve uranium exploration, mining, and milling techniques or less than one-half of one percent of the research and development funds.

In fiscal year 1975 the funding level of uranium exploration, mining, and milling research and development increased to about \$5 million, still less than one-half of one percent of the total research and development budget. This increase was due to ERDA's national uranium resource evaluation program. NURE is intended to provide information on uranium resources, both discovered and undiscovered,

for use in assessing the domestic uranium supply position. Two of the major objectives of the program are to research and develop new and improved procedures, equipment, and technology for uranium research and assessment and to disseminate, as rapidly as possible, information on new exploration concepts and exploration technology and areas considered favorable for uranium discoveries to encourage private exploration. The program will not provide funds to drill for the uranium to determine the extent of the discovery. This function will be the responsibility of private industry.

ERDA officials estimate that less than 1 percent of ERDA's research and development budget for fiscal year 1976 (\$14 million) would be spent on improving uranium exploration. No ERDA funds are budgeted for new and improved mining and milling techniques.

Department of the Interior efforts

The Department of the Interior also has responsibility for energy-related research and development. The Bureau of Mines is responsible for research to stimulate the private sector toward producing an appropriate and substantial share of the national mineral and fuel needs, and the Geological Survey is responsible for, among other things, examining the geological structure, mineral resources, and products of the national domain. The Geological Survey is also responsible for research programs concerning the extraction, processing, and use of materials and mineral fuels.

In fiscal year 1974 the Department spent about \$1.3 million, classified as uranium research and development, to develop fundamental geologic information on the occurrence of uranium and thorium. Most of these funds were spent to develop new methods to find uranium deposits. As shown by the following table, the Department increased its funding for uranium research and development to about \$9.6 million in fiscal year 1975. However, most of this increase was for exploration and environmental studies.

Department of the Interior Uranium Research and Development

	Fiscal year		
	<u>1974</u>	<u>1975</u>	<u>1976</u>
	(millions)		
Exploration	\$1.32	\$4.26	\$ 4.30
Extracting	-	-	.20
Refining	-	1.10	.90
Environmental and other research and studies	-	<u>4.20</u>	<u>6.87</u>
Total	<u>\$1.32</u>	<u>\$9.56</u>	<u>\$12.27</u>

During fiscal year 1975 the Department spent over \$1 million to improve the processes for refining uranium from ores and certain low-quality materials. However, except for a \$0.2 million Bureau of Mines program to develop technology which would produce minimal environmental disturbances and reduce the cost of mining and a \$0.9 million program to make technological improvements in the process for extracting uranium from ores and low-grade uraniumiferous materials, no projects are planned to improve mining and processing techniques in fiscal year 1976. The primary increase in uranium research and development funds will be used for environmental research and studies.

Private industry efforts and comments

Neither ERDA, the Department of the Interior, nor a private mining association know the amount of money spent by private industry to improve existing uranium exploration, mining, and milling techniques. This has occurred primarily because of the proprietary nature of industry's research and development.

Officials from uranium companies indicated, however, that neither the Federal Government nor private industry had taken the strong initiative needed to research and develop methods to improve the technology for uranium mining and processing. An ERDA official told us that uranium research and development--particularly as it relates to the mining and processing of uranium--had not received more attention because a possible uranium shortage has only surfaced in the last 3 years with increased energy demands. Thus, research and development funds have been channeled to priority programs other than uranium.

Conclusions

More needs to be done to research and develop new and better ways to mine and mill this Nation's uranium resources. Little has been done by the Federal Government or the uranium industry. Under the Energy Reorganization Act of 1974, the Administrator, ERDA, is responsible for encouraging and conducting research and development, including demonstration of commercial feasibility and practical applications of the extraction, conversion, storage, transmission, and utilization phases related to the development and use of energy from nuclear and other energy sources. Accordingly, we believe that ERDA should take the initiative to encourage and research new and better ways to increase the efficiency of the mining and milling of uranium ore. Success in this area would help to reduce the cost of recovering uranium, thereby increasing the domestic supply of uranium available for nuclear fuel.

Recommendation to the Administrator, ERDA

We recommend that the Administrator, ERDA, take steps to develop and implement a plan for increased uranium mining and milling research and development.

Agency comments and unresolved issues

In its April 30, 1976, comments on this report, ERDA agreed that more research and development needs to be carried out on advanced technology for mining and processing uranium ore. It pointed out that, as part of the NURE program, preliminary studies have been undertaken to determine those areas of such technology in which research and development is most needed and to develop plans for such work. ERDA said it was actively engaged in developing a neutron source probe to measure uranium and facilitate assessment of low-quality resources. Development of such a probe, however, is directed toward exploration research and development rather than mining and milling.

CHAPTER 4

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 for nuclear reactors. 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 Grand Junction, Colorado; and at the Departments of the Interior, Labor, and State. In addition, we met with officials of the following organizations:

- American Mining Congress, Washington, D.C.
- Atomic Industrial Forum, New York, New York.
- Gulf Energy and Minerals Company, Denver, Colorado.
- Teton Exploration Drilling Company, Cooper, Wyoming.
- Exxon Company, Casper, Wyoming.
- AMAX Uranium Corporation, Casper, Wyoming.
- SOHIO Petroleum Company and Reserve Oil and Minerals Corporation, Albuquerque, New Mexico.
- Ranchers Exploration and Development, Albuquerque, New Mexico.
- Kerr-McGee Corporation, Oklahoma City, Oklahoma.
- Anaconda Company, Englewood, Colorado.
- Colorado Public Service Company, Denver, Colorado.
- Virginia Electric Power Company, Richmond, Virginia.
- Baltimore Gas and Electric Company, Baltimore, Maryland.
- Potomac Electric Power Company, Washington, D.C.



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

APR 6 1976

Mr. Henry Eschwege, Director
Resources and Economic Division
U.S. General Accounting Office

Dear Mr. Eschwege:

Thank you for the opportunity to review and comment on the draft report entitled "Some Ways to Assure Adequate Uranium Supplies for Nuclear Energy." We have reviewed the draft with members of your staff and a number of suggested changes have been agreed upon. We understand that the title of the report may be changed to read "Certain Actions That Can be Taken to Help Achieve an Adequate Uranium Supply."

We are certainly in agreement with the opinion expressed in the report that unless an adequate supply of fuel is available for both current light water reactors operating and planned and for new reactors under development, the Nation's plans for nuclear power development may not be realized. The draft report deals with some of the basic issues which must be considered in our attempts to obtain an adequate supply of uranium. Our comments with respect to the conclusions and recommendations contained in the draft report regarding these issues are as follows:

A. Need for reliable information on exports of uranium of U.S. origin.

As previously indicated to members of your staff, we do not agree with the high GAO estimate of domestic uranium exports because the GAO estimate was calculated from incomplete information contained in our NMIS system with respect to the import and reexport of uranium of U.S. origin. The NMIS system was not originally intended to determine the amount of domestic uranium exported, and it was not expected that this system would be used to calculate the amount of domestic uranium exported. We are firmly convinced that the considerably lower estimate produced by the voluntary reporting system is more accurate than the NMIS system in this respect. However, we have initiated action with NRC to assure that more complete uranium import information is routinely incorporated in the NMIS system. The flow of this information into the NMIS should yield satisfactory results. It should be noted, however, that accurate information is kept by ERDA on the amount of uranium licensed for export, albeit this data does not show whether the material is of U.S. or foreign origin.



B. Need for more reliable information on domestic uranium controlled by foreign countries.

While we agree with GAO's conclusion that reliable information on the possible control of domestic uranium by foreign investors is desirable, we feel that the report should make it clear that "control," or ownership of domestic uranium by foreign investors does not carry with it the right to export such uranium from this country. All exports of domestic uranium are covered by export licenses, which are controlled by NRC. We shall continue to monitor the amount of foreign activity in the domestic uranium industry.

C. Possibility of recovering lower quality ore deposits.

Non-recovery of low grade materials in the course of current mining operations has been of concern to the AEC and ERDA for several years. The subject was discussed in an AEC report, WASH-1242, issued in May 1973. At that time, there was concern that if uranium continued to be sold at low prices--less than \$8 per pound U_3O_8 --over an extended period of time, substantial amounts of uranium would be lost if low grade ores were not saved and the mines were abandoned before price increases occurred which would justify extraction of the lower grade ore.

We would like to reemphasize that since 1973 there has been a significant increase in uranium prices and mining companies are now mining much lower grade ores than before. The mining companies are increasingly concerned about maintaining access to low grade portions of their ore deposits for future mining. Prices in the \$30-\$40 range, which are currently being reported, allow mining of material down to considerably lower grades than did the \$6 to \$8 prices which were being paid a few years ago. The higher prices allow mining of materials down to grades in the .02 to .04% U_3O_8 range. The amount of material of even lower grade in most deposits is estimated to be less than an additional 5%. For any given mining operation, the incremental cost per pound to recover any uranium now being left in the ground would be substantially higher than the average costs for the ores which are now being extracted. Very much higher prices would be needed to induce mining of such material.

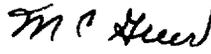
ERDA/AEC has for many years studied, and continues to study, the distribution and recovery of low grade uranium in U.S. deposits. We are now studying the impact of a \$50/lb. cutoff (compared to a \$30/lb. cutoff now used), as well as preparing a mineral inventory assessment which will ignore economic considerations and include material as low in grade as can be determined by gamma ray logs--around 0.01% U_3O_8 .

It appears that the natural increase in uranium prices has largely solved the basic problem of non-recovery of low grade material associated with higher grade uranium ores. We estimate that a government program to encourage recovery of even lower grade material would involve expenditures in excess of \$2.4 billion, for little return in uranium. It is our view that these funds could better be spent in identification of additional resources.

D. Need for more emphasis on uranium research and development.

ERDA agrees that more R&D needs to be carried out on advanced technology for mining and processing of uranium ores. As part of the NURE program, preliminary studies have been undertaken to determine those areas of such technology in which R&D is most needed and to develop plans for such work. In fact, ERDA is very actively engaged in one of the projects suggested in the draft report; i.e., the development of a neutron source probe which measures uranium directly and facilitates assessment of low grade resources.

Sincerely,


M. C. Greer
Controller



FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D C 20461

APR 19 1976

OFFICE OF THE ADMINISTRATOR

Mr. Monte Canfield, Jr.
Director, Office of Special Programs
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Canfield:

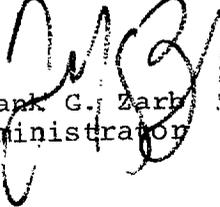
Enclosed is our response to your March 5, 1976, request for comments on the proposed report to Congress, "More Needs to Be Done to Assure Adequate Uranium Supplies for Nuclear Energy."

The Federal Energy Administration agrees with a basic recommendation of the report that the Federal Government improve its system for monitoring the rate of export and import of uranium. We understand that the Energy Research and Development Administration has already initiated actions to implement this recommendation.

(See GAO note 1, p. 36.)

Additional comments covering specific details are being provided in meetings which have been arranged between our staffs.

Sincerely,



Frank G. Zarb
Administrator

Enclosure

- GAO note:
1. Material has been deleted because of changes to the final report.
 2. The attachments to this letter are not included in this appendix due to their length. We have, however, considered their contents in developing the report.

RESTRICTIONS ON URANIUMEXPORT--FOREIGN SUPPLIERSAUSTRALIA

Uranium in the Northern Territory of Australia, where most of the reserves are, is declared to be the property of the Australian Government pursuant to their Atomic Energy Act. The Australian Atomic Energy Commission will participate in the mining and milling of uranium located in the Northern Territory and will undertake all new exploration.

Future sales of uranium concentrate from the Northern Territory will be by the Australian Government on a government-to-government basis. The conditions for other sales commitments are uncertain but in any case must be approved by the Government. A share of Australian uranium is insured to Australia's "major trading partners," Japan, Italy, and West Germany.

Current Government policy is to sell uranium in the highest form possible. This will be as uranium concentrate for some time.

The Australian Government, however, is reassessing its role as a major uranium-producing country with a view toward the orderly development and marketing of its uranium deposits. The Australian Government has decided that its long-term objective is that companies be relatively free to plan the development of their deposits and to negotiate sales contracts subject to any requirements of export controls plus appropriate safeguards and environmental requirements and the protection of Aboriginal interests.

CANADA

The Canadian Government's policy regarding uranium export was announced September 5, 1974, by the Canadian Minister of Energy, Mines and Resources. Principal export guidelines are as follows: (1) To insure that the domestic market is protected, sufficient uranium must be reserved to enable each reactor operating, committed for construction, or planned for operation 10 years into the future to operate at the average annual capacity factor of 80 percent for 30 years, (2) domestic utilities will be required to maintain at least a contracted 15-year forward supply of fuel for operating and committed reactors, (3) the Energy, Mines and Resources Uranium Resource Appraisal Group will audit Canadian resources recoverable at prices of up to

twice current world market price and mining companies will be allocated domestic reserve margins, (4) unless a specific exemption is granted, all uranium exported will be in the most advanced form possible in Canada, (5) export contracts will be limited to a maximum duration of 10 years from the date of signing with contingent approval for an additional 5 years, (6) uranium will not be exported at a more favorable price than that sold to domestic purchasers, and (7) the Canadian stockpile will only be disposed of in the domestic market and prior to disposal will be available on a commercial loan basis for short-term needs of Canadian producers.

The new policy is clearly directed toward protecting known reserves and production capability for the Canadian domestic nuclear program. Moreover, as an extension of this protective commercial policy, the Canadian Government had, prior to this recent statement, made known its intention to encourage further processing of uranium in Canada.

FRANCE

Detailed information on the French policy toward uranium is unavailable. Indications are that the French Government, which markets its own uranium in addition to that of Niger and Gabon, is currently not selling uranium overseas.

SOUTH AFRICA

For South Africa, no firm statement on current uranium commercial policy is available. It appears that the rate of production and the export of uranium are subject to an extensive degree of control. On March 23, 1974, the local South African press reported that South Africa had temporarily halted export of uranium, but this report has not been confirmed.

In June 1974, South African Chamber of Mines ex-president, R.A. Plumbridge, is reported to have said that in view of the recent requests for uranium under long-term contracts beginning in the late 1970s and 1980s for quantities in excess of the present combined capacity of the producers, former marketing policy had to be reshaped and ways of increasing production investigated. There have been no reports about the exact nature of the proposed reshaping.

GABON

Gabon's President Omar Bongo announced early in February 1974 that the Gabon Government had decided to raise the price

of uranium effective March 1, 1974. There have also been unconfirmed indications of a movement in Gabon toward a policy of Government purchase of the entire unsold production and stockpiling pending improvement in prices on the uranium market.

AGREEMENTS FOR
COOPERATION--WHAT THEY
ARE AND HOW THEY ARE APPROVED

Agreements for cooperation contain, among other things, (1) a guaranty by the cooperating party (or foreign country) that security safeguards and standards as set forth in the agreement will be maintained, (2) except for agreements in the military uses of atomic energy, a guaranty by the cooperating party that any material "will not be used for atomic weapons, or for research on or development of atomic weapons or for any other military purpose," and (3) a guaranty that any material or restricted data made available under the agreement will not be transferred to unauthorized persons or beyond the jurisdiction of the cooperating party except as the agreement may provide.

All such agreements must be approved by the President who is required to authorize their execution and determine in writing that performance of the agreement "will promote and will not constitute an unreasonable risk to the common defense and security." Thereafter, depending on the extent of cooperation to be undertaken, civil agreements for cooperation must lie before either the Joint Committee on Atomic Energy for 30 days or before the Congress for 60 days while Congress is in session before they may be brought into effect. Agreements involving significant cooperative activities may be prevented from being brought into effect if the Congress, by concurrent resolution, expresses its disapproval of the proposed agreement during the 60-day waiting period.

SUMMARY OF U.S. RESTRICTIONS ON FOREIGN INVESTMENT

Foreign investments in certain sensitive industries in the United States are restricted or prohibited by Federal law. These industries--banking, communications, aviation, coastal and fresh water shipping, exploitation of public lands, hydroelectric power, and atomic energy--are considered vital to the national interest. Additionally, there are administrative restrictions on foreign ownership in firms engaged in U.S. Government contracting.

BANKING

Foreign banks may not be members of the Federal Reserve System and/or the Federal Deposit Insurance Corporation. There is, however, no limitation on the percentage of foreign ownership in a domestic member bank. (12 U.S.C. 321, 1813, and 1814)

COMMUNICATION

Neither foreign-owned corporations or those directly or indirectly controlled by foreign interests may be licensed to operate an instrument for the transmission of communications. A corporation is considered foreign owned if a director or officer is an alien, if more than one-fifth of its capital stock is owned by aliens, or if it is set up under laws of another country. Neither may a foreign government be licensed. The corporation is considered foreign controlled if one-fourth of its capital stock is owned by foreign interests. (47 U.S.C. 310)

AVIATION

The registration of aircraft is limited to U.S. citizens or U.S. corporations in which U.S. citizens constitute at least two-thirds of the directorship and own at least 75 percent of the stock. Some exceptions allow foreign-registered aircraft to operate within the United States when reciprocal privileges are extended to U.S. aircraft by the country of registration, but these operations are not to include intra-country movement of goods or passengers. (49 U.S.C. 1301, 1401, and 1508)

COASTAL AND FRESH WATER SHIPPING

Only U.S. citizens may own vessels conducting shipping operations in the United States or between the United States and its territories, even if the goods are shipped through a foreign port. The vessels must be built and registered in the United States.

If reciprocity is granted by a foreign country, that country's vessels may be granted an exemption by the United States permitting intercoastal transportation of empty items, such as barges or tanks. (46 U.S.C. 883)

ACQUISITION OR LEASING OF PUBLIC LANDS

Public or Federal-owned lands may be transferred or leased only by U.S. citizens or persons who have declared their intent to become U.S. citizens, by partnerships or associations whose members are U.S. citizens, or by corporations domestically incorporated. Foreign individuals or associations could form or acquire a domestic corporation and qualify to lease or own public lands provided their country of origin granted reciprocal privileges to U.S. citizens and associations. (48 U.S.C. 1501-1508, and 43 U.S.C. 682a-e)

Somewhat similar provisions apply to acquisition of leasing rights to mineral deposits on public lands. (30 U.S.C. 22, 24, 71, 181, and 352)

Laws governing the transfer of private or State-owned lands rest with the individual States.

HYDROELECTRIC POWER

Development of hydroelectric power projects on navigable U.S. streams may be undertaken only by U.S. citizens or domestic corporations. However, the law does not prohibit foreign ownership or control of such domestic corporations. (16 U.S.C. 797(e))

ATOMIC ENERGY

Foreign-owned or controlled corporations may not be granted licenses to operate domestic nuclear reactors or atomic production facilities. (42 U.S.C. 2133(d))

GOVERNMENT CONTRACTING

In awarding Government contracts, no distinction is made between U.S. contractors on the basis of their foreign or domestic ownership or control. However, security clearances may be required for the contractor's personnel, and most foreign nationals are ineligible for security clearances. (Department of Defense Industrial Security Regulation, DOD 5220.22R)

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Glenn T. Seaborg	Mar. 1961	Aug. 1971

GENERAL MANAGER:

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John A. Erlewine	Jan. 1974	Dec. 1974
Robert E. Hollingsworth	Aug. 1964	Jan. 1974

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ADMINISTRATOR:

Robert C. Seamans, Jr.	Jan. 1975	Present
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ASSISTANT ADMINISTRATOR FOR

NUCLEAR ENERGY:

Richard W. Roberts	June 1975	Present
Robert D. Thorne (acting deputy)	Jan. 1975	June 1975

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