

Uranium Purchases Report 1993

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Preface

This report is the second in a series of annual publications by the Energy Information Administration required by the *Energy Policy Act of 1992* (EPACT 1992), Public Law 102-486 (October 24, 1992), Subtitle B, 42 USC § 2296b-4 Section 1015 of P.L. 102-486, which provides that:

... the owner or operator of any civilian nuclear power reactor shall report to the Secretary (of Energy), acting through the Administrator of the Energy Information Administration, for activities of the previous fiscal year—

(1) the country of origin and the seller of any uranium or enriched uranium purchased or imported into the United States either directly or indirectly by such owner or operator; and

(2) the country of origin and the seller of any enrichment services purchased by such owner or operator.

This information is required to be made available to the Congress annually. Data reported by domestic nuclear utility companies in their responses to the 1991 through

1993 "Uranium Industry Annual Survey," Form EIA-858, Schedule B, "Uranium Marketing Activities," are provided in response to the requirements in the EPACT 1992. Appendix A contains an explanation of Form EIA-858 survey methodologies with emphasis on the processing of Schedule B data.

Additional information published in this report, not included in *Uranium Purchases Report 1992*, includes a new data table (Table 1). Presented in Table 1 are U.S. utility purchases of uranium and enrichment services by origin country. Also, this report contains additional purchase information covering average price and contract duration. Table 2 is an update of Table 1 and Table 3 is an update of Table 2 from the previous year's report. The report contains a glossary of terms.

This report was prepared by the Survey Management Division (SMD), Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration. Questions of a general nature should be directed to Howard L. Walton, Director SMD, at 202/254-5500, or Luther Smith at 202/254-5565. Questions of a detailed or technical nature should be addressed to Doug Bonnar at 202/254-5560 or Charles Johnson at 202/254-5568.

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Uranium Purchases by U.S. Utilities

During 1993, the owners and operators of U.S. civilian nuclear electric generating units took delivery of 31.2 million pounds U_3O_8 equivalent (U_3O_8e) under purchase contracts from suppliers (Table 1). Of the delivered total of 31.2 million pounds, natural uranium¹ accounted for 30.2 million pounds (97 percent) and enriched uranium accounted for 1.0 million pounds (3 percent). The 25 firms that supplied the uranium to the utilities under these contracts are shown in the following list. Ten of the 25 firms (designated with an asterisk) made deliveries under new purchase contracts in 1993.

Uranium Sellers

Albuquerque Uranium Corporation
 AlliedSignal, Inc.*
 Cameco Corporation*
 China Nuclear Energy Industry Corp. (CNEIC)
 COGEMA, Inc.
 Energy Fuels Exploration Company
 Energy Fuels Corporation
 Energy Fuels Limited*
 Energy Resources of Australia*
 Everest Exploration, Inc.
 Geomex Minerals, Inc.*
 Highland Uranium Project
 Malapai Resources Company
 Nuexco Trading Corporation*
 NUKEM, Inc.*
 Pathfinder Mines Corporation
 Power Resources, Inc.
 Siemens Nuclear Power Corporation*
 Total Minerals Corporation
 U.S. Energy Corporation
 UG U.S.A., Inc.*
 Uranerz Exploration & Mining Ltd.*
 Urangesellschaft Mbh
 Uranium Resources Inc.
 Westinghouse Electric Corporation

Of the 31.2 million pounds U_3O_8e delivered to U.S. utilities in 1993, deliveries under spot contract² purchases accounted for 3.1 million pounds at a price of \$9.38 per pound; short-term contract³ purchases totaled 2.9 million pounds at a price of \$8.24 per pound; medium-term contract⁴ purchases accounted for 8.5 million pounds at a price of \$10.59 per pound; and long-term contract⁵ purchases totaled 16.6 million pounds at a price of \$13.82 per pound. Some long-term contracts were signed in the 1970's.

Of the 31.2 million pounds U_3O_8e delivered to U.S. utilities in 1993 at a price of \$11.97 per pound, 3.9 million pounds (12 percent) were of U.S. origin at a price of \$15.53 per pound. Non-U.S. origin uranium accounted for 27.3 million pounds (88 percent) of the deliveries. Some of this material was in the United States and not imported in 1993. The top five origin countries in descending order by quantity for non-U.S. origin uranium are shown in the list below.

Top Five Non-U.S. Origin Countries	Average Price (\$ per lb. U_3O_8e)
Canada	\$13.02
Russia	\$10.02
China	\$9.31
Australia	\$10.65
Kazakhstan	\$9.56

¹Natural uranium is uranium concentrate (U_3O_8) and uranium hexafluoride (UF_6).

²Spot contract - A one time delivery of the entire contract quantity to occur within the calendar year of contract signing.

³Short-term contract - All deliveries to occur within the first 2 calendar years of contract signing.

⁴Medium-term contract - At least one delivery to occur between 2 to 6 years following contract signing.

⁵Long-term contract - At least 1 delivery to occur after 6 years following contract signing.

Table 1. U.S. Utility Purchases of Uranium and Enrichment Services, 1993

Origin Country	Deliveries		
	Uranium (thousand pounds U ₃ O ₈ equivalent)	Enrichment Feed (thousand pounds U ₃ O ₈ equivalent)	Separative Work Units (thousand SWU)
Total	31,184	35,100	8,773
By origin country:			
Australia	1,777	1,615	--
Canada	14,019	11,473	--
China	2,922	3,540	W ^a
France	0	W	W ^b
Gabon	W	641	--
Germany	W	W	W ^c
Mongolia	W	0	--
Namibia	392	735	--
Netherlands	--	--	W ^d
Niger	0	20	--
NIS ^e Total	6,230	7,266	--
Kazakhstan	1,618	1,074	--
Kyrgyzstan	W	W	--
Russia	3,705	5,351	215 ^f
Uzbekistan	W	W	--
South Africa	W	1,123	0 ^g
Spain	0	W	--
United Kingdom	W	W	W ^h
United States	3,896	7,786	8,109 ⁱ

^a CNEIC (China Nuclear Energy Industry Corp.) enrichment plant, Lanzhou Province, Peoples Republic of China.

^b Eurodif enrichment plant, Georges Besse, France.

^c Urenco enrichment plant, Gronau, Germany.

^d Urenco enrichment plant, Almelo, Netherlands.

^e NIS = Newly Independent States

^f Technobexport (Tenex) enrichment plants located in Angarsk, Russia; Ekaterinburg, Russia; Krasnoyarsk, Russia; and Tomsk, Russia.

^g AEC (Atomic Energy Corporation of South Africa, Ltd.) enrichment plant, Valindaba, South Africa.

^h Urenco enrichment plant, Capenhurst, United Kingdom.

ⁱ DOE/USEC enrichment plants, Paducah, Kentucky and Portsmouth, Ohio.

W = Withheld to avoid disclosure of company identifiable data.

-- = Not applicable.

Note: Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, Form EIA-858, "Uranium Industry Annual Survey"(1993).

U.S. utilities signed 38 new purchase contracts in 1993. The quantity of uranium delivered in 1993 under these new contracts was 3.6 million pounds U₃O₈e with an average

price of \$9.36 per pound. In 1993, deliveries associated with new purchase contracts accounted for 12

percent of total deliveries. In 1993, imports accounted for 15.7 million pounds U_3O_8 or 50 percent of total deliveries to utilities, compared with only 35 and 33 percent in 1991 and 1992, respectively (Table 2).

Table 2. Uranium Purchases by U.S. Utilities, 1991 - 1993

(Thousand Pounds U₃O₈ Equivalent)

Category	Deliveries		
	1991	1992	1993
Total	40,947	35,383	31,184
Deliveries Under Purchase Contracts (Non-Imports)^a	26,812	23,572	15,511
By material type:			
Natural U ₃ O ₈	17,011	17,847	13,024
Natural UF ₆	7,458	3,180	2,198
Enriched UF ₆	2,343	2,546	289
By origin country:			
Australia	1,374	W	737
Canada	2,943	5,347	4,219
China	1,146	920	2,127
France	0	W	0
Gabon	W	0	W
Namibia	917	1,333	0
Portugal	W	W	0
NIS ^b Total	6,824 ^c	5,831 ^c	3,163
Kazakhstan	NA	NA	W
Kyrgyzstan	NA	NA	W
Russia	NA	NA	2,285
Uzbekistan	NA	NA	587
South Africa	0	349	W
Spain	W	0	0
United Kingdom	W	0	W
United States	12,443	7,934	3,896
Import Deliveries Under Purchase Contracts^a	14,135	11,811	15,673
By material type:			
Natural U ₃ O ₈	12,559	10,263	11,972
Natural UF ₆	1,576	1,548	3,013
Enriched UF ₆	0	0	688
By origin country:			
Australia	701	2,245	1,040
Canada	11,793	7,030	9,800
China	W	W	795
Gabon	W	W	0
Germany	W	W	W
Mongolia	0	0	W
Namibia	0	W	392
NIS ^b Total	W ^c	1,123 ^c	3,067
Kazakhstan	NA	NA	W
Kyrgyzstan	NA	NA	W
Russia	NA	NA	1,420
Uzbekistan	NA	NA	W
South Africa	0	W	0
United Kingdom	0	0	W

^aU.S. utilities reported whether or not that year's delivery involved importation. If not, the importation of non-U.S. origin uranium was conducted in a previous year. The total quantity of deliveries shown for 1991 through 1993 represents, for each year, the sum of quantities for non-import and import purchased deliveries.

^bNIS = Newly Independent States.

^cThe name "Russia" was used to report data for 1991 and 1992. No further breakdown into the newly formed, separate Republics, known now as the Newly Independent States, was available.

W = Withheld to avoid disclosure of company identifiable data.

NA = Not available.

Note: Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, Form EIA-858, "Uranium Industry Annual Survey."

Uranium Enrichment Feed

Actual deliveries by U.S. utilities of uranium feed to enrichment plants are shown by year in Table 1 and Table 3. In 1993, utility enrichment feed deliveries totaled 35.1 million pounds U_3O_8e shipped to both domestic and foreign enrichment suppliers, 10 percent above the 1992 level. Deliveries consisted of 7.8 million pounds (22 percent) of U.S. origin and 27.3 million pounds (78 percent) of non-U.S. origin uranium. For non-U.S. origin uranium, the top five origin countries in descending order were Canada (42 percent), Russia (20 percent), China (13 percent), Australia (6 percent), and South Africa (4 percent). The remaining 15 percent of the non-U.S. origin uranium delivered to enrichment plants was from Gabon, Germany, Namibia, Niger, Kazakhstan, Kyrgyzstan, Uzbekistan, Spain, and the United Kingdom (Table 1). Utilities took delivery of 30.2 million pounds natural uranium under purchase contracts in 1993, and the additional 4.9 million pounds of enrichment feed came from inventory withdrawals or deliveries by other transactions such as exchanges or loans. Utility enrichment feed deliveries to U.S. enrichers in 1993 totaled 32.4 million pounds U_3O_8e (92 percent of total deliveries). Feed deliveries to non-U.S. enrichers in 1993 totaled 2.7 million pounds U_3O_8e (8 percent of total deliveries).

Enrichment Services Purchased by U.S. Utilities

In 1993, two new enrichment service contracts were signed by U.S. utilities. Several utilities reported modifying their existing enrichment contracts during 1993 to change quantities, prices, and/or deliveries or to elect and finalize future enrichment options remaining under those contracts.

The amount of separative work units (SWU) purchased by U.S. utilities under enrichment service contracts that were delivered in 1993 was 8.8 million SWU (Table 1). The nine firms that were named as the sellers of enrichment services for these SWU deliveries in 1993 are shown in the following list.

Enrichment Service Sellers

China Nuclear Energy Industry Corp. (CNEIC)
COGEMA, Inc.
Energy Fuels Corporation
Nuexco Trading Corporation
NUKEM, Inc.
Siemens Nuclear Power Corporation
U.S. Department of Energy (U.S. DOE)
United States Enrichment Corporation (USEC)
Urenco

Ninety-one percent of the enrichment was conducted at U.S. enrichment plants under the U.S. Department of Energy /United States Enrichment Corporation operation. The remaining enrichment for U.S. utilities was performed by CNEIC, Eurodif, Tenex, and Urenco⁶.

⁶CNEIC (China Nuclear Energy Industry Corporation), Peoples Republic of China. Eurodif, a consortium of Cogema, 37 percent ; Sofidif, 25 percent (Cogima 60 percent and OIAETI (Iran) 40 percent); Synatom (Belgium) and Enusa (Spain), 11 percent each; and ENEA and AGIP (both Italy), 8 percent each, operates the Georges Besse gaseous diffusion plant at the Tricastin site in France. Cogema handles sales and marketing of Eurodif products and services, excluding sales to Eurodif partners. Tenex (Techsnabexport) utilizes four gas centrifuge technology plants at Ekaterinburg, Angarsk, Krasnoyarsk, and Tomsk in Russia. The four plants are owned by The Ministry of Atomic Energy of the Russian Federation (Minatom). Urenco is a consortium created by treaty between Germany, the Netherlands, and the United Kingdom. Urenco, Ltd., is the holding company for gas centrifuge plants located at three wholly-owned subsidiaries: Urenco (NL), Almelo, The Netherlands; Urenco (D), Gronau, Germany; and Urenco (UK), Capenhurst, United Kingdom. British Nuclear Fuels plc (BNFL), in the United Kingdom, Ultra-Centrifuge Nederland N.V. (UCN) in the Netherlands, and Uranit GmbH in Germany are equal shareholders in Urenco, Ltd.

Table 3. U.S. Utility Enrichment Feed Deliveries, 1991 - 1993

(Thousand Pounds U₃O₈ Equivalent)

Category	Quantity		
	1991	1992	1993
Enrichment Feed Deliveries (Total)^a	37,992	32,045	35,100
To U.S. DOE/USEC (Total)^b	33,852	27,622	32,362
U.S. Origin Uranium (Total)	11,711	9,077	7,731
Non-U.S. Origin Uranium (Total)	22,141	18,545	24,631
By origin country:			
Australia	2,641	1,784	1,463
Canada	11,327	8,984	11,168
China	W	W	W
France	W	W	W
Gabon	W	W	W
Germany	0	0	W
Namibia	W	W	735
NIS ^c Total	3,176 ^d	5,146 ^d	5,748
Kazakhstan	NA	NA	457
Kyrgyzstan	NA	NA	0
Russia	NA	NA	5,072
Uzbekistan	NA	NA	0
Portugal	0	W	0
South Africa	W	662	1,123
Spain	0	0	W
United Kingdom	W	W	W
To Non-U.S. Enrichers (Total)^e	4,140	4,423	2,738
U.S. Origin Uranium (Total)	2,120	1,048	55
Non-U.S. Origin Uranium (Total)	2,020	3,375	2,683

^aThe total quantity of Utility Enrichment Feed Deliveries shown for 1991 through 1993 represents, for each year, the sum of materials shipped for enrichment to United States Department of Energy (USDOE) and/or United States Enrichment Corporation (USEC), and to Non-U.S. Enrichers.

^bThe total quantity for 1991 through 1993 shipped to USDOE or USEC represents, for each year, the sum of U.S. Origin Uranium and Non-U.S. Origin Uranium.

^cNIS = Newly Independent States.

^dThe name "Russia" was used to report data for 1991 and 1992. No further breakdown into the newly formed, separate Republics, known now as the Newly Independent States, was available.

^eThe total quantity for 1991 through 1993 shipped to Non-U.S. Enrichers represents, for each year, the sum of U.S. Origin Uranium and Non-U.S. Origin Uranium.

W = Withheld to avoid disclosure of company identifiable data. NA = Not available.

Note: Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration, Form EIA-858, "Uranium Industry Annual Survey."

Appendix

Survey Methodology

Survey Design

The Energy Information Administration (EIA) conducted the tenth annual “Uranium Industry Annual Survey,” Form EIA-858, to collect information from all companies known or believed to have been involved in the U.S. uranium industry during 1993. Included in this survey are domestic utilities that own and/or operate nuclear power reactors. The 1993 survey form was mailed to respondents in January 1994, and was due back in March 1994. Respondents to the “Uranium Industry Annual Survey” were asked to provide data current to the end of 1993 about their Uranium Raw Materials Activities (Schedule A) and Uranium Marketing Activities (Schedule B).

In particular, Schedule B covers: uranium transaction parameters including name of the other party; type of transaction; uranium materials covered; origin for the uranium materials and conversion and enrichment services, and delivery destination; importation and exportation; contract pricing mechanism; contract options; litigation status; schedule of uranium deliveries with corresponding prices; uranium inventories; materials shipped for enrichment; projected enrichment feed deliveries; unfilled market requirements; and enrichment services by U.S. utilities. Quantities of uranium reported are as equivalent U_3O_8 to the nearest thousand pounds.

The data collected on Form EIA-858 are subject to several sources of error. These sources are: (1) *coverage* (the respondent frame might not be complete or, on the other hand, there might be double counting); (2) *nonresponse* (all units that are surveyed might not respond or might not provide all the information requested); (3) *respondents* (respondents might commit errors in reporting the data); (4) *processing* (the data collection agency might omit or incorrectly transcribe a submission); (5) *concept* (the data collection elements might not measure the items they were

intended to measure); and (6) *adjustments* (errors might be made in estimating values for missing data).

Because the “Uranium Industry Annual Survey” is a universe survey rather than a sample survey, sampling errors do not affect the data provided in this report.⁷ Although it is not possible to present estimates of non-sampling error, precautionary steps were taken at each stage of the survey design and operation to minimize the possible occurrence of these errors. These steps are described below, and the errors they were designed to minimize are named (in parenthesis).

Survey Universe/Frame (Coverage Errors)

The survey universe includes all nuclear utilities involved in the U.S. uranium industry. The criteria for responding to Schedule B are: firms that during 1993 (1) held existing contracts covering the sale, purchase, exchange, loan, loan repayment, or custody of uranium or entered into similar new contracts; (2) held inventories of uranium in any form excluding reactor-inserted, fabricated fuel; (3) maintained a forward-coverage, uranium-inventory policy; (4) made actual deliveries of uranium feed materials to any enrichment supplier and/or (5) purchased enrichment services.

The respondent list used for the Form EIA-858 survey was developed from a frame of all establishments known to meet the selection criteria. The frame of potential respondents was compiled from previous surveys and from information in the public domain. As it specifically relates to Schedule B, the frame was intended to cover the following: all utilities owning nuclear-fueled generating stations, fuel converters and fabricators, and utilities with whole or partial ownership in operating or planned uranium-fueled power plants.

⁷Sampling error is a measure of the variation that occurs by chance because a sample rather than a complete enumeration of units is surveyed.

Survey Procedures (Nonresponse)

The survey forms were sent by first class mail to ensure their receipt only by the proper respondent organization. If the U.S. Postal Service was unable to deliver the survey form, the corrected address was obtained where possible. All nuclear utilities currently conducting business in the U.S. uranium industry were contacted during this survey.

The Form EIA-858 is a self-administered questionnaire requesting data about many areas of company operations. The scope of the questions is necessarily broad, and self-reporting of company-specific data is required.

Cooperation from industry on the 1993 survey was, as in previous years, excellent. A large number of respondents replied to the form within the specified deadlines. Those that had not responded by the due dates were telephoned to encourage submission of the forms, and those calls resulted in the submission of most of the remaining forms. In addition, a followup letter was mailed to nonrespondents requesting compliance with the survey. Subsequently, telephone calls were made to obtain forms not yet submitted. In some instances, company data were modified/collected through telephone conversations made to clarify items reported/omitted on their submissions. To reduce the reporting burden on the respondents, data for contracts and selected other data elements from the prior year's survey form were preprinted on each respondent's 1993 survey.

Data Editing, Analysis, and Processing (Respondent and Processing Errors)

The survey forms were logged in and reviewed by agency personnel prior to data entry into the Uranium Industry Annual System, an automated data base containing all current and historical data from each company's submission. The data base is maintained on the EIA computer facility in Washington, DC. After entry into the data base, a copy of each Schedule B was distributed to the Survey Management Division analyst for review and approval. The submissions were checked for internal consistency, and the reported data were compared with previous collections of similar data. After reviewing the submissions, the analyst consulted with the reporting company, as needed, to resolve data problems and to confirm any corrections of the data. Data areas that were reviewed and the corrections that were made differed from company to company. Most represented differing interpretations of the data item definitions. No data in the

data base were changed without first consulting with the reporting company. Computer edits were also used to identify keypunch errors, out-of-range values, and unlikely data combinations. These edits either were corrected to represent the data reported on the submissions or were changed only after confirming the corrected values by telephone conversations with company representatives. Data coding and entry errors were eliminated by proofing data after entry. All changes to reported data were documented.

Response Rates

Schedule B of Form EIA-858 was mailed to 131 firms and to the Office of Uranium Programs (NE-30), U.S. Department of Energy and to the United States Enrichment Corporation (USEC). All of the schedules that were mailed to nuclear utilities, to NE-30 and to USEC were returned (100 percent response) with information as requested on the form. Of course, not all Schedule B data items were applicable to each responding utility, to NE-30, or to USEC.

Missing Data

Omissions of data identified during the prescreening and editing of the data fell into two categories: data that were withheld because of contractual constraints or because a particular contract was under litigation. Respondents were contacted regarding omissions to verify that the data could not be reported. Only confirmed company-reported data are contained in the data base and included in this report.

Nondisclosure of Data

To protect the confidentiality of individual respondents' data, a policy was implemented to ensure that the reporting of survey data in this report would not associate those data with a particular company. This policy is in compliance with EIA Standard No. 88-05-06, "Nondisclosure of Company Identifiable Data in Aggregate Cells." In tables where the nonzero value of a cell is composed of data from fewer than three companies or if a single company dominates a table-cell value so that the reporting of the value would lead to identification of a company's data, then the EIA classifies the cell value as "sensitive," and the cell value is withheld ("W") from the report. Within a table with a sensitive cell value, selected values in other cells of the table are also withheld, as necessary, so that the sensitive cell value cannot be computed using the values in published cells.

Glossary of Terms

Average Price: The quantity-weighted average of the prices paid for deliveries.

Enrichment Feed Deliveries: Uranium materials made available under contract to an enrichment-services supplier for processing into enriched-uranium product that is destined for use as fuel in a nuclear reactor.

Enrichment Services: See Separative Work Units (SWU).

Purchases of Uranium: The amount of uranium material that is delivered during a survey year as reported on the "Uranium Industry Annual Survey" (UIAS), Form EIA-858, as purchases of either uranium ore, U_3O_8 , natural UF_6 , or enriched UF_6 . The amount of uranium material under other types of contracts reported on the UIAS, i.e., loans and exchanges, is excluded.

Separative Work Units (SWU): The standard measure of enrichment services. The effort expended in separating a mass F of feed of assay xf into a mass P of product assay xp and waste of mass W and assay xw is expressed in terms of the number of separative work units needed, given by the expression $SWU = WV(xw) + PV(xp) - FV(xf)$, where V(x) is the "value function," defined as $V(x) = (1 - 2x) \ln((1 - x)/x)$.

Uranium: A heavy, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature to any appreciable extent that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to plutonium-239, an isotope that also is fissionable by thermal neutrons.

- o Concentrate: A yellow or brown powder produced from naturally occurring uranium minerals as a result of milling uranium ore or processing uranium-bearing solutions. Synonymous with yellowcake, U_3O_8 , or uranium oxide.

- o Enriched Uranium: Uranium enriched in the isotope U-235 from 0.711 percent (by weight) in natural uranium to an average of 3.0 to 3.5 percent U-235.

- o Uranium Hexafluoride (UF_6): A white solid obtained by chemical treatment of U_3O_8 , which forms a vapor at temperatures above 56 degrees Centigrade. UF_6 is the form of uranium required for the enrichment process.

Uranium Oxide: Uranium concentrate or yellowcake. Abbreviated as U_3O_8 .