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Enrichment Backgrounder

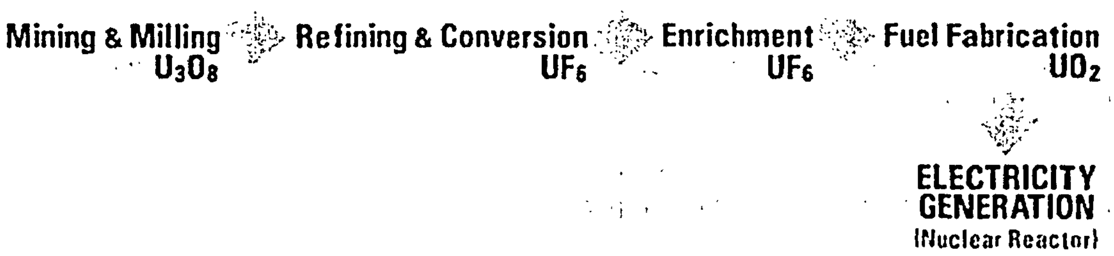
Introduction

- On July 22, 2002, Cameco signed a memorandum of agreement (MOA) as an initial step toward entering a formal partnership to build a $1.1 billion (US) enrichment facility in the United States.
- The facility would use Urenco's centrifuge technology, the world's lowest cost and most advanced method of uranium enrichment.
- Cameco's plans to invest in enrichment increases the company's involvement in the front end of the nuclear fuel cycle to cover all phases except fuel fabrication.

The Front End of the Nuclear Fuel Cycle

- Uranium's transformation from ore in the ground into usable fuel that most reactors use for electricity generation has four key stages collectively described as the front end of the nuclear fuel cycle

Front End of the Fuel Cycle



- Uranium is extracted from the ground, processed in a mill and becomes uranium concentrates in the form of triuranium octoxide (U_3O_8) also known as yellowcake.
- The U_3O_8 is then chemically refined and converted to uranium hexafluoride (UF_6).
- The UF_6 is then enriched to increase the percentage of the isotope of uranium (U-235).
- The enriched UF_6 is converted into UO_2 and pressed into fuel pellets, which are inserted into thin metal tubes for assembly into fuel bundles.
- The enriched uranium in fuel bundles is then ready for use in a nuclear reactor.

Enrichment

- Most commercial reactors require uranium fuel to have a U-235 content of 3 - 5%.
- Naturally occurring uranium is mostly made up of two different types of uranium atoms or isotopes, approximately 99.3% U-238 and 0.7% U-235.
- Uranium enrichment is required to increase the U-235 concentration from 0.7% to 3 - 5%.
- The enrichment process involves separation of the lighter U-235 atoms from the heavier and more predominant U-238 atoms in order to concentrate the U-235 portion.

- There are two commercial enrichment methods: gaseous diffusion and centrifuge.

Gaseous Diffusion

- In the gaseous diffusion process, U-235 and U-238 atoms are separated by feeding UF_6 in gaseous form through a series of porous walls or membranes that allow more U-235 to pass through.
- To understand how this method of enrichment works, think of UF_6 as equal sized sand particles of two different weights suspended in air. All the sand grains are blown through thousands of sieves, one after another. Because the lighter U-235 particles travel faster than the heavier U-238 particles, more of them penetrate each sieve. As more sieves are passed, the concentration of U-235 increases.
- The process continues until the concentration of U-235 is increased to 3 - 5%.
- The slower U-238 particles left behind are collected as byproduct and referred to as "depleted tails" or "tails," in other words uranium with a reduced concentration of U-235.
- The high amount of energy required to force the UF_6 through the porous membranes makes the gaseous diffusion process very expensive.

Centrifuge

- In this type of enrichment process, the gaseous UF_6 is introduced into a centrifuge (a cylindrical container that spins the UF_6 at high speeds).
- The rapid spinning flings the heavier U-238 atoms contained in the UF_6 to the outside of the centrifuge, leaving UF_6 in the centre enriched with a higher proportion of U-235 atoms.
- The enrichment level achieved by a single centrifuge is insufficient to obtain the desired concentration of U-235. It is therefore necessary to connect a number of centrifuges together in an arrangement known as a cascade.
- The U-235 concentration is gradually increased to 3 - 5% as it passes through the successive stages of the centrifuge cascades.
- Enrichment using centrifuge technology requires very little energy, giving this method a significant cost advantage. Centrifuge technology requires only about 2% of the energy needed for gaseous diffusion technology.

Separative Work Units

- Enrichment service is sold in separative work units (SWU).
- A SWU is a unit that expresses the energy required to separate U-235 and U-238.

Enrichment Process

- How uranium is enriched depends on:
  - the amount of uranium feed (UF_6) at the beginning of the process
  - the amount of SWU used
  - and the concentration of U-235 atoms left over (tails assay) at the end of the process.

- A reactor operator knows the amount and concentration of uranium fuel required by each reactor. By varying the level of tails assay, a reactor operator can find the most economical combination of UF_6 feed and SWU required for enrichment. To illustrate, consider the following example:

  - Let's assume you are in the freshly squeezed orange juice business. By deciding first how much juice yo are prepared to leave behind in the pulp, you can then decide the optimum balance between the numbe of oranges you require and the effort required to squeeze them.
  - If oranges are cheap and the cost of squeezing is high you are less concerned with how many oranges you use, but you want to make your orange juice with the least amount of squeezing. If oranges are relatively expensive and the squeezing process is cheap, you will minimize costs by squeezing fewer oranges more times to get the same amount of juice.
  - Now think of the oranges as uranium and the effort to squeeze them as SWU. If the price of uranium is relatively low, then you will use more uranium and less SWU to enrich the UF_6. If the price of uranium i: high and SWU is relatively cheaper, you will use more SWU and less uranium.

- Enrichment is measured both as the percentage of U-235 in the product and in the depletion. So the percentage of U-235 left behind in the tails assay is critical to the calculation of enrichment. The reactor operator always starts with the tails assay to find the best combination of UF_6 feed and SWU. The following table shows two examples of how a given quantity of enrichment could be contracted. The shaded part of the table shows the relative amounts of electricity required to produce that quantity of enrichment which points to one of the key advantages of centrifuge enrichment.

1 kg of UF_6 enriched to 3% U-235 could be produced by either of the following combinations:				
			Gaseous Diffusion	Centrifuge
Tails Assay	Separative Work Units	Natural UF_6 Feed	Approximate Kilowatt Hours Required to achieve contracted enrichment	
0.25%	3.8 SWU	6.0 kg	9,500	190
0.30%	3.4 SWU	6.6 kg	8,500	170

- It takes about 100,000 SWU (100 t SWU) of enriched uranium to fuel a typical 1,000-megawatt commercia nuclear reactor for a year. A 1,000-megawatt plant can supply the electricity needs for a city of 600,000 people.

- SWU spot prices are published weekly on the Uranium Exchange web site (www.uxc.com), however, utility contracts with a new US enrichment plant would be primarily based on long-term prices.

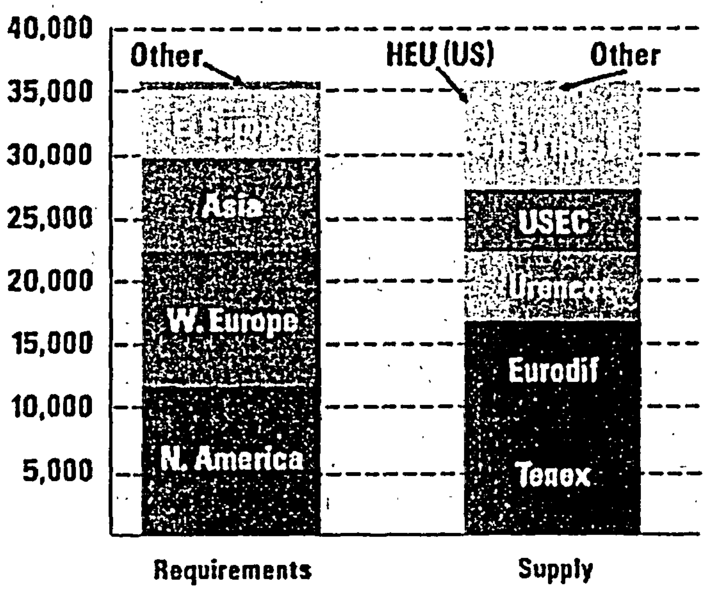
World Enrichment Market

- The annual world market demand for enrichment is about 35 million SWU according to the World Nuclear Association.

- Enrichment services are supplied by a number of sources as outlined in the table below. Actual annual production figures are not published for competitive reasons.

Supplier	Method	Approximate Annual Supply (000s SWU)	Market Share
USEC (US)	Gaseous Diffusion	4,500 - 5,500	13 - 16%
Eurodif (France)	Gaseous Diffusion	7,000 - 8,000	20 - 23%
Urenco (Europe)	Centrifuge	5,000	14%
Tenex (Russia)	Centrifuge	8,000 - 9,000	23 - 26%
Other	Centrifuge	1,500	4%
Highly Enriched Uranium (Russia)	n/a	5,500	15%
Highly Enriched Uranium (US)	n/a	500	1%
Total		35,000	100%

Estimated World Supply and Demand (thousands SWU)



United States Enrichment Market

- The United States is the world's largest market for enrichment services with annual demand of approximately 11 million SWU.
- Domestic production currently supplies less than half of the US market and the only operating US enrichment facility is a higher cost gaseous diffusion plant.
- US utilities need a secure supply of enrichment services as an integral part of their fuel supply and they prefer a competitive domestic enrichment market to provide it.

PDF of Enrichment Backgrounder (0.04MB)

Cameco Pursues Uranium Enrichment Business

Saskatoon, Saskatchewan, Canada, July 22, 2002

Enrichment Backgrounder
Enrichment Partnership News Release

Cameco Corporation announced today that it has signed a memorandum of agreement (MOA) as an initial step toward entering a formal partnership to establish a $1.1 billion (US) enrichment facility to be built in the United States. The facility would use Urenco Limited's centrifuge, the world's lowest cost and most advanced uranium enrichment technology. The Urenco centrifuge is currently operating in the company's European enrichment facilities.

The proposal to establish the US facility is being advanced by a consortium including Urenco, Westinghouse Electric Company, Cameco and three US utilities with nuclear plants, Exelon Generation Company, Entergy Louisiana Inc. and Claiborne Energy Services Inc. (a wholly-owned subsidiary of Duke Energy).

Discussions about the project have already been initiated with the US Nuclear Regulatory Commission.

Under the terms of the MOA, Cameco will obtain, upon entering the partnership, an initial 20% interest in the project. Following receipt of the NRC licence and a final restructuring of the partnership, Cameco's interest will increase to 25%.

"This proposal represents an excellent opportunity for Cameco, given that the United States is the world's largest user of enrichment services and Cameco's biggest customer base," said Bernard Michel, Cameco's chair and chief executive officer. "We would enhance our existing uranium and conversion business in the key US nuclear fuel market, build our relationship with partners committed to the nuclear business and advance our company's strategy to further integrate in the nuclear fuel cycle."

The project will proceed only if it receives licences and approvals from the US Nuclear Regulatory Commission and other government agencies.

Cameco's involvement in the project is conditional upon:

- successful execution of a final partnership agreement
- completion of a feasibility study that demonstrates an acceptable rate of return
- an ability to obtain project financing, and
- securing a portfolio of long-term contracts to support the project.

Under the terms of the MOA, Cameco can withdraw from the project with no further obligation.

Cameco's short-term commitment during the licensing phase (next three years) is expected to be approximately $8.5 million (US). If the project advances and Cameco's commitment is maintained through to construction and operation, the company expects to meet its longer term financial commitments through a combination of debt financing and internally generated cash flow.

The proposed facility is expected to be in operation by 2007/2008 with an initial capacity of 1 million SWU, ramping up to about 3 million SWU by 2012. Siting of the plant is yet to be determined and once operational, it will employ approximately 200 to 250 employees.

The US has the largest fleet of nuclear reactors in the world with annual demand for enrichment services of approximately 11 million SWU. Domestic production currently supplies about one-third of the country's demand.

Cameco, with its head office in Saskatoon, Saskatchewan, is the world's largest uranium supplier. The company's uranium products are used to generate electricity in nuclear energy plants around the world, providing one of the cleanest sources of energy available today. Cameco's shares trade on the Toronto and New York stock exchanges.

Statements contained in this news release which are not historical facts are forward-looking statements that involve risks, uncertainties and other factors that could cause actual results to differ materially from those expressed or implied by such forward-looking statements. Factors that could cause such differences, without limiting the generality of the following, include: volatility and sensitivity to market prices for uranium, electricity in Ontario and gold; the impact of the sales volume of uranium, conversion services, electricity generated and gold; competition; the impact of change in foreign currency exchange rates and interest rates; imprecision in reserve estimates; environmental and safety risks including increased regulatory burdens; unexpected geological or hydrological conditions; political risks arising from operating in certain developing countries; a possible deterioration in political support for nuclear energy; changes in government regulations and policies, including trade laws and policies; demand for nuclear power; replacement of production and failure to obtain necessary permits and approvals from government authorities; legislative and regulatory initiatives regarding deregulation, regulation or restructuring of the electric utility industry in Ontario; Ontario electricity rate regulations; weather and other natural phenomena; ability to maintain and further improve positive labour relations; operating performance of the facilities; success of planned development projects; an other development and operating risks.

- End -

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