

Uranium

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OVERVIEW

The commercial agreement for the disposition of uranium derived from dismantled Russian nuclear weapons was concluded early in 1999, easing concerns about the effects of an uncontrolled release of surplus military inventories into world uranium markets. However, by year's end, there were signs that the United States Enrichment Corporation (USEC), the U.S. executive agent for the arrangement, was disposing of a significant quantity of its uranium inventory into the market, further upsetting the market equilibrium.

World uranium spot prices declined almost continuously during 1999 with little sign of an upturn in the near future. In addition to surplus military uranium making its way into the commercial market, primary producers faced growing competition during the year from uranium being produced by the re-enrichment of depleted uranium tails. Nonetheless, Canadian uranium producers remain well positioned to capitalize on any market upturn with the transition to production centres tapping high-grade, low-cost deposits in northern Saskatchewan well under way. With the transition to these new mines, longstanding production centres are either being closed due to depleted reserves or poor economics, or are being fed by the high-grade ore.

Canadian uranium production in 1999 amounted to about 8215 tU, down some 25% from the 1998 total, mainly due to planned production cutbacks. As Figure 1 shows, the world's two largest uranium-producing companies have operations in Canada. As of January 1, 1999, Canada's total "known" recoverable uranium resources were 433 000 tU, compared with 419 000 tU as of January 1, 1998. This upward

adjustment of some 3% relates mainly to increased McArthur River reserves.

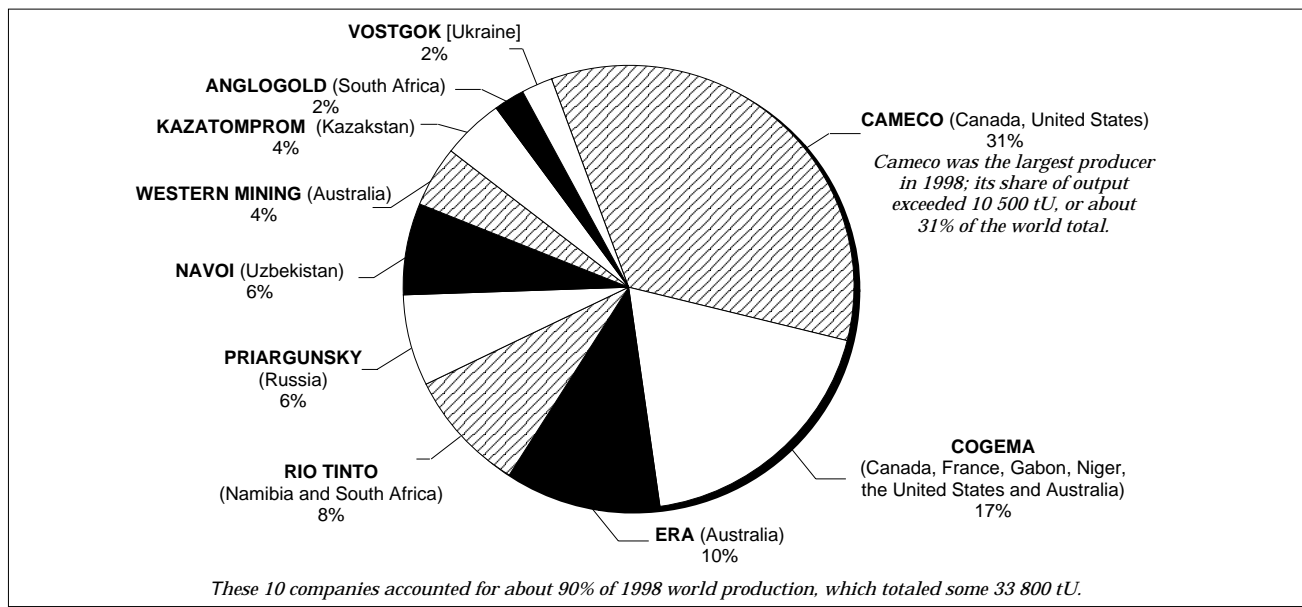
Despite the unfavourable market conditions, uranium production capability continues to increase in Canada. The McClean Lake mill entered into production in July 1999. The mill start-up was smooth and, by March 2000, it was running above designed production and recovery parameters. In December 1999, the McArthur River mine began production. Test mining and development work continued at Cigar Lake with the mine currently scheduled to begin production in 2003.

DOMESTIC PRODUCTION AND DEVELOPMENTS

In 1998, the most recent year with complete data available, production declined slightly from 1997 and 1996, but overall employment at Canada's production centres remained above 1100 (Table 1). Compared to previous years, shipments from mining centres also declined slightly in 1998, although preliminary 1999 data indicate increased mine shipments but decreased value (Table 2). These declining values mainly reflect planned production cutbacks, the transition to new high-grade uranium mines, and the low market price. Despite this decline, however, uranium continues to rank among Canada's top 10 metal commodities in terms of output value. Table 3 documents the main operational characteristics of the existing uranium production centres in Canada in 1998, and Table 4 updates the status of new projects that represent Canada's future production capability. Although current production and new projects are centred in the Athabasca Basin of northern Saskatchewan, one prospective property, Kiggavik, is located in Nunavut (Figure 2). Uranium production in Canada in 1998 (Figure 3) was dominated by two companies: Cameco and COGEMA Resources Inc. (CRI).

In April 1999, Cameco and CRI purchased KEPSCO's (Korea Electric Power Corp.) 2% non-voting interest in the Cigar Lake uranium joint venture for an undisclosed price. In May 1999, Cameco sold interests in selected uranium assets in Saskatchewan (17% of the Key Lake mill, 14% of the McArthur River mine and, subject to rights of first refusal, 20%

Figure 1
World's Top Ten Uranium Mining Companies in 1998



Sources: Natural Resources Canada; trade press.

Note: Ranking reflects equity interest in production facilities, not market share.

of the Midwest mine) to CRI for a total of \$250 million. In August 1999, Denison Mines Ltd. exercised its right of first refusal and purchased an additional 5.17% interest in the Midwest property.

Elliot Lake, Ontario

Decommissioning of the Stanleigh, Quirke and Panel (Rio Algom Ltd.) and the Stanrock/Can-Met and Denison (Denison Mines Ltd.) uranium mining facilities was essentially complete by the end of 1999 under Atomic Energy Control Board (AECB) Mine Facility Decommissioning Licences. Most, if not all, of the major site decommissioning and reclamation has been completed. The waste management and tailings management areas have been stabilized and contained, and most have been flooded (tailings at Stanrock have been saturated to reduce acid generation but have a dry cover). All of these sites will continue under interim monitoring and active management until the effluent meets discharge criteria without treatment. At that time, the sites will enter into a phase of long-term monitoring with care and maintenance.

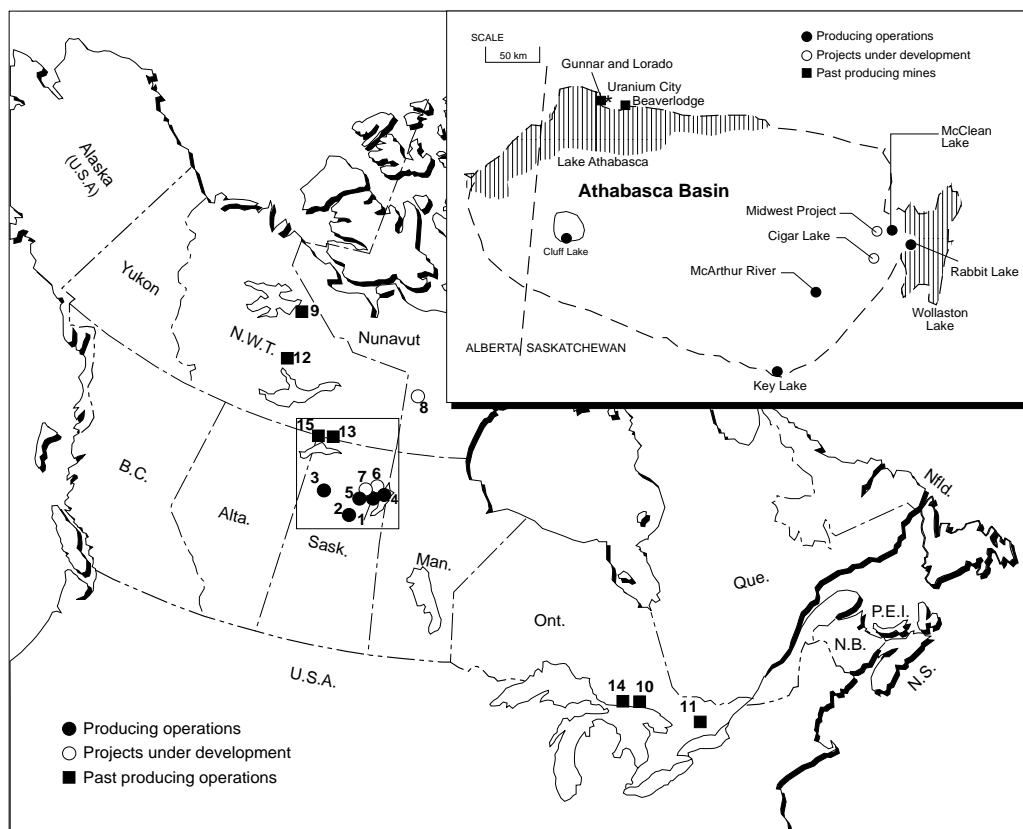
In April 1999, the AECB amended decommissioning licences for the Denison and Stanrock mines to expand the site boundaries to include areas identified in 1998 that exceeded the clean-up criteria established for the two sites. An additional amendment was approved on the same date to acknowledge the

decommissioning work performed by Denison Mines Ltd. at the Denison mine site over the last six years.

Rio Algom's six additional uranium mine facilities in the Elliot Lake area (Spanish American, Milliken, Lacnor, Nordic, Buckles and Pronto) are not presently licensed by the AECB. Although uranium mining and milling ceased at these facilities more than 30 years ago, Rio Algom decided in 1995 to licence these sites to meet the AECB mandate to control radioactive materials. In support of its application for Prescribed Substances Licences (PSL), Rio Algom submitted an environmental assessment report. Government review comments were received by Rio Algom in December 1999, and the environmental assessment report is currently being revised to address these comments. The revised report is expected to be submitted in 2000 with licensing approval expected later that year.

Rio Algom and Denison Mines are also conducting the Serpent River Watershed Monitoring Program to assess the environmental impacts of their operations on the entire Serpent River watershed, which encompasses the majority of the Elliot Lake tailings. The program includes periodic monitoring of background and receiving waters, as well as studies every five years on the biota in the watershed and the man-made tailings environments. Field work for the first of the five-year biota assessments was completed in the fall of 1999 and a report is expected in 2000. Water quality monitoring is ongoing.

Figure 2
Uranium Mining in Canada, 1999



Numbers refer to locations on map above

PRODUCING OPERATIONS

- 1. Rabbit Lake
- 2. Key Lake
- 3. Cluff Lake
- 4. McLean Lake
- 5. McArthur River

PROJECTS UNDER DEVELOPMENT

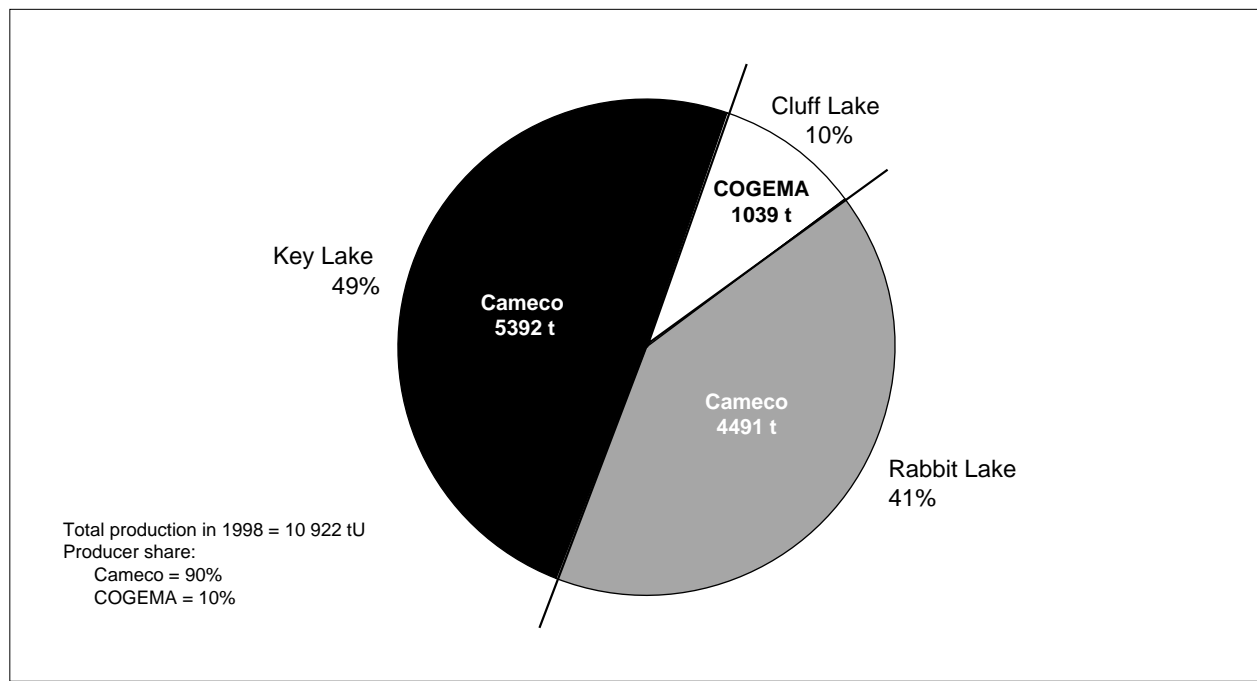
- 6. Midwest
- 7. Cigar Lake
- 8. Kiggavik

PAST PRODUCING DEVELOPMENT

- 9. Port Radium
- 10. Agnew Lake
- 11. Madawaska et al (Bancroft)
- 12. Rayrock (Marian River)
- 13. Beaverlodge et al
- 14. Quirke/Panel/Denison and Stanleigh et al (Elliot Lake)
- 15. Gunnar and Lorado et al

Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

Figure 3
Canadian Uranium Production and Ownership, 1998



Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

Athabasca Basin, Saskatchewan

Rabbit Lake

Cameco is the owner and operator of the Rabbit Lake uranium production facility. Mill output in 1999 was about 2700 tU, almost half of 1998 production (4491 tU). Due to poor market conditions, Cameco ran the mill at reduced capacity throughout 1999, processing stockpiled ore from the Eagle Point underground mine and the Collins Bay A and B zone deposits. Mining operations were suspended at the Eagle Point underground mine on March 31, 1999.

The Rabbit Lake mill was originally slated to close within the next few years, but Cameco now intends to mill a portion of the Cigar Lake ore at Rabbit Lake, subject to regulatory approvals. Approval of this milling option will extend the life of the facility by some 15 years. A Comprehensive Study environmental assessment of this milling option is currently in progress. Cameco anticipates submitting the study for review by regulatory agencies and government departments in 2000.

Key Lake

The Key Lake uranium production facility, a joint venture with CRI, is operated by Cameco. In 1999,

production from stockpiled Deilmann ore reached 3715 tU, down from the 1997 total of 5390 tU. The Key Lake mill was shut down from July to October 1999 in order to construct ore-receiving and blending facilities to accommodate the high-grade McArthur River ore. All McArthur River ore will be milled at Key Lake. The mill resumed production in the last quarter of 1999 and began processing McArthur River ore in early January 2000.

McArthur River

McArthur River is the site of the world's largest high-grade uranium deposit discovered to date. In October 1999, Cameco obtained the necessary licensing to begin production at the McArthur River mine and production began in December 1999. The Key Lake mill, closed since June 1999 for a \$25 million refurbishment, received the necessary licensing to process McArthur River ore in November 1999. Mine commissioning is expected to be completed in 2000, and the ramp-up to the full production capability of 6900 tU is planned over the next two years. In 2000, McArthur River production is targeted at 4200 tU with the majority of the output to occur in the latter part of the year.

Cigar Lake

The Cigar Lake mine, a joint venture operated by the Cigar Lake Mining Corporation (Table 4), is situated on the world's second largest high-grade uranium deposit discovered to date. The Cigar Lake mining project cleared the environmental review process early in 1998 and testing of the jet boring mining system was conducted through 1999. Further testing of this system in both waste rock and ore is planned for 2000, subject to regulatory approvals. The mine is currently scheduled to begin production in 2003.

Cluff Lake

The Cluff Lake uranium production facility is fully owned and operated by CRI. Overall production amounted to 1234 tU in 1999, slightly above the 1998 production level of 1039 tU. The Dominique-Peter orebody was mined out in October 1999, but mining continues at the Dominique-Janine underground mine. The mill has been running on a continuous basis to process the low-grade surface stockpile. Once this stockpile has been processed, likely by April 2000, it is expected that the mill will move to a one-week-on, one-week-off schedule.

In December 1998, the AECB granted a renewal of the Cluff Lake operating licence through December 2000, the date at which CRI plans to suspend operations at the facility. CRI submitted a decommissioning plan for the facility to the AECB in June 1999 and is currently completing a Comprehensive Study environmental assessment of this plan. CRI anticipates submitting the study for review by regulatory agencies and government departments in 2000.

Clean-up work has begun at Cluff Lake in anticipation of the suspension of operations. The area near the Dominique-Janine mine where freezing and jet boring techniques were tested was reclaimed in 1999, as was one of the discharge areas in the tailings management area. In addition, CRI has cleaned up various small buildings and tanks around the site.

McClean Lake

The McClean Lake uranium production facility is majority-owned and operated by CRI. Construction of the mill was completed late in 1997, but production was held up until June 1999 when CRI obtained all the necessary licensing. CRI reported that, outside of a temporary chloride corrosion problem in the ammonium sulphate crystallization circuit, the mill start-up was smooth. Design capacity was achieved by early 2000.

In November 1999, CRI received final regulatory approvals to begin mining the Sue A, Sue B and Sue C pits at the McClean Lake site. Mining of the Sue C deposit began in late 1999 and is expected to

continue until mid-2000. The Sue C ore is expected to feed the mill for the next 12-18 months.

Additional Production Possibilities

Beyond the existing and committed centres of uranium production mentioned above, there are two projects that could be brought on stream in the next few years if environmental and regulatory approvals are received and market conditions are favourable. Table 4 updates, as of March 1, 2000, recent developments at the mining projects that will contribute to Canada's uranium production capability in the future.

Environmental Assessments

The submission of the joint federal/provincial panel report on the Cigar Lake and Midwest projects, and government responses to this report in 1998, brought to a close the comprehensive, seven-year-long environmental assessment process for all new uranium mine developments in northern Saskatchewan. With Canada's position as the world's leading uranium producer and exporter comes the responsibility to demonstrate that its uranium producers meet all health, safety and environmental standards. The federal/provincial environmental assessment process contributed significantly to these objectives.

CRI's 1998 announcement that the Cluff Lake operations will be suspended on December 31, 2000, and Cameco's plan to mill a portion of the Cigar Lake ore at the Rabbit Lake mill triggered environmental assessments. Both require completion of a Comprehensive Study in accordance with the 1995 *Canadian Environmental Assessment Act* before regulatory approval of the projects can be considered. Cameco and CRI plan to have their respective Comprehensive Studies completed and submitted for review by government agencies in 2000.

Other Developments Affecting Canada's Uranium Industry

On July 5, 1999, Cameco announced that it had filed a preliminary short-form shelf prospectus for the issuance of up to \$300 million worth of unsecured debt securities, and one week later announced that it had completed the sale, in Canada, of \$100 million worth of 6.9% Series A debentures, due July 12, 2006. Cameco stated that it intended to use the net proceeds of \$98.8 million from this offering to repay commercial paper as it matures and, as a result, the sale did not represent additional debt. On September 27, 1999, Cameco announced that it was initiating a one-year share repurchase program beginning September 30, 1999. By December 31, 1999, Cameco had repurchased 535 000 shares at an average cost of \$23.15 each.

EXPLORATION

Natural Resources Canada (NRCan) completed its 25th annual assessment of Canada's uranium supply capabilities and uranium exploration, and reported² the results in September 1999. Uranium exploration activity remains concentrated in areas favourable for the occurrence of deposits associated with Proterozoic unconformities, notably in the Athabasca Basin of Saskatchewan and the Thelon Basin of Nunavut. In 1998, overall uranium exploration expenditures reached \$60 million, while uranium exploration and surface development drilling amounted to over 95 000 m, down from about 104 000 m reported for 1997.

As in recent years, most of the overall exploration expenditures can be attributed to advanced underground exploration, deposit appraisal activities, and care-and-maintenance expenditures associated with those Saskatchewan projects awaiting production approvals. In comparison, the Saskatchewan government estimates that grass-roots uranium exploration in the province reached \$22 million in 1998, down some \$5 million from 1997. A summary of uranium exploration activity in Canada from 1984 to 1998 is provided in Table 5.

In recent years, the number of companies with major exploration programs in Canada has declined. However, about 65% of the more than 60 uranium projects maintained in good standing in 1998 were actively explored. The top operators,³ accounting for a major portion of the \$60 million expended in 1998, were: Cameco Corporation, Cigar Lake Mining Corporation, CRI and JNR Resources. Expenditures by CRI include those of Urangesellschaft Canada Limited.

On October 6, 1999, Cameco announced preliminary exploration data from La Rocque Lake in northern Saskatchewan (some 55 km northwest of the Rabbit Lake project). High-grade uranium ore was found in 3 of 20 drill holes about 280 m below the surface with grades of 8.2%, 19.1% and 29.9% U₃O₈. The La Rocque Lake claim is part of the Dawn Lake joint venture involving Cameco (57.466%), CRI (23.086%) and PNC Exploration Canada Co. Ltd. (19.448%). Conclusions on the economic significance of the mineralization or the likelihood of the occurrence of a uranium deposit will await further drilling in 2000.

RESOURCES

NRCan's annual assessment of domestic uranium supply capability provides a compilation of Canada's "known" uranium resources, based on the results of an evaluation of company data. Uranium supply from Canada in the next decade will come from

known resources, estimates of which are divided into three major categories, *measured*, *indicated* and *inferred*, that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 2.

Recent NRCan assessments of Canada's uranium resources have been restricted to those recoverable from mineable ore at prices of \$100/kgU or less. Table 6 shows the breakdown of the latest resource estimates, compared with those of the previous year. As of January 1, 1999, total recoverable known uranium resources were estimated at 433 000 tU, compared with 419 000 tU as of January 1, 1998. This upward adjustment of some 3.5% is mainly due to increased McArthur River reserves.

SUPPLY CAPABILITY

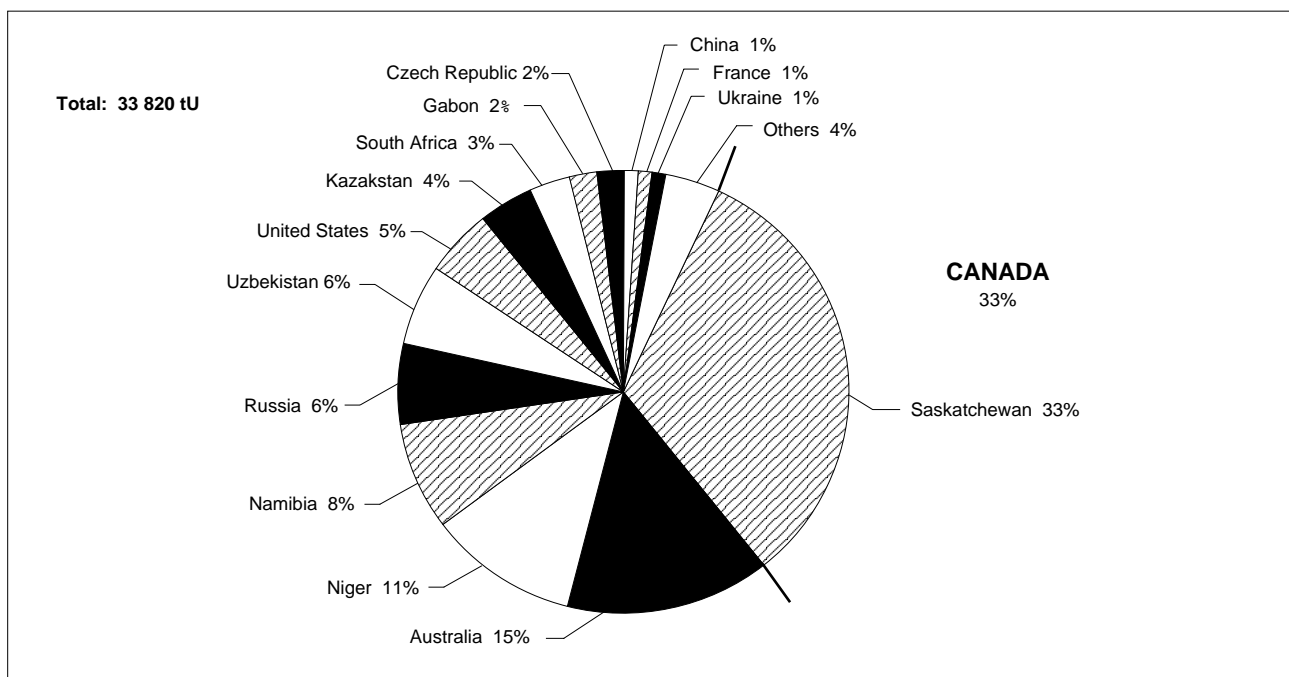
In 1999, Canada's uranium supply capability dropped temporarily as producers began a period of transition to the new high-grade mines in northern Saskatchewan. A smooth transition to these new mines, combined with timely licensing approvals and higher uranium prices, will be required to allow Canada's production capability to expand to its full potential of 15 000 tU or more annually in the next 10 years.

Developments in the international uranium market, the rate at which projects clear environmental reviews, and uncertainty regarding the costs associated with certain of the planned new projects preclude projecting future production capability levels with much certainty. Table 7 ranks Canada among the world's major producers, showing actual uranium production from 1994 through 1998. Figure 4 illustrates Canada's share of world output in 1998, compared with other major producers.

GOVERNMENT INITIATIVES

On March 20, 1997, Bill C-23, the *Nuclear Safety and Control Act* (NSCA), received Royal Assent. Proposed regulations for the NSCA were posted by the AECB for comment in July 1998. In late 1998, the AECB began consultations to address concerns raised by stakeholders regarding the new Act and associated regulations. At the same time, the AECB proceeded with the preparation of Regulatory Guidelines. It is anticipated that the NSCA will come into force in 2000. The revamped law and regulations represent the first major overhaul of Canada's nuclear regulatory regime since 1946 and reflect the increased focus on health, safety, security and environmental protection in recent years.

Figure 4
World Uranium Production, 1998



Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

THE URANIUM MARKET

Overview

There was little sustained improvement in the international uranium market during 1999. As a result of the production cutbacks in late 1998, the share of new mine production in overall uranium supply fell below 50% for the first time but gave only a temporary boost to spot prices. There were several periods of strong demand in the spot market over the course of the year but, after the first quarter, they met with aggressive competition among sellers that served to keep downward pressure on prices.

The trend towards the purchase by foreign utilities of enriched uranium continued. Primary enrichers enjoyed a competitive advantage since they were able to package natural uranium and conversion services with the enrichment services, taking advantage of savings realized in any of these markets. Uranium producers that were not vertically integrated had to offer increasingly lower prices to overcome the disadvantage. In addition, enrichers continued to re-enrich depleted uranium tails and sell the product in competition with freshly mined uranium. By the latter part of the year it became apparent that USEC Inc. was aggressively marketing the large inventories of natural uranium that it received from the government at the time of privatization.

Developments Involving Surplus Uranium from Russia and the United States

On March 24, 1999, Cameco Corporation, COGEMA of France, and Nukem Inc. of the United States and Germany finally announced the conclusion of a commercial agreement with Technobexport (TENEX), the commercial arm of the Ministry of Atomic Energy of the Russian Federation (Minatom), for the purchase of natural uranium derived from highly enriched uranium (HEU) contained in Russian nuclear weapons. This agreement provided the companies with exclusive options to purchase about 100 000 tU of the approximately 138 000 tU scheduled for delivery from Russia to the United States over the 15-year term remaining in the HEU agreement.

The agreement was approved by the governments of the United States and the Russian Federation, and was structured to comply with the HEU agreement and various implementing agreements between the United States and Russia, as well as with U.S. and Russian legal requirements. The bilateral agreements and legal requirements provided for, among other things, the creation of stockpiles of uranium in both the United States and Russia, the establishment of rules governing the disposition of uranium from the stockpiles, and the establishment of limits on the level of sales in the U.S. market.

The spot market did not respond strongly to this development, possibly because a great deal of information about these developments had been in the public domain for a long time and had already been factored into prices. While the details of the agreement eliminated some of the uncertainty from the market, they introduced other variables that could not readily be interpreted, perpetuating much of the uncertainty. It was also believed that most of this uranium would be sold on long-term markets and thus have relatively little impact on spot prices.

Uranium Prices

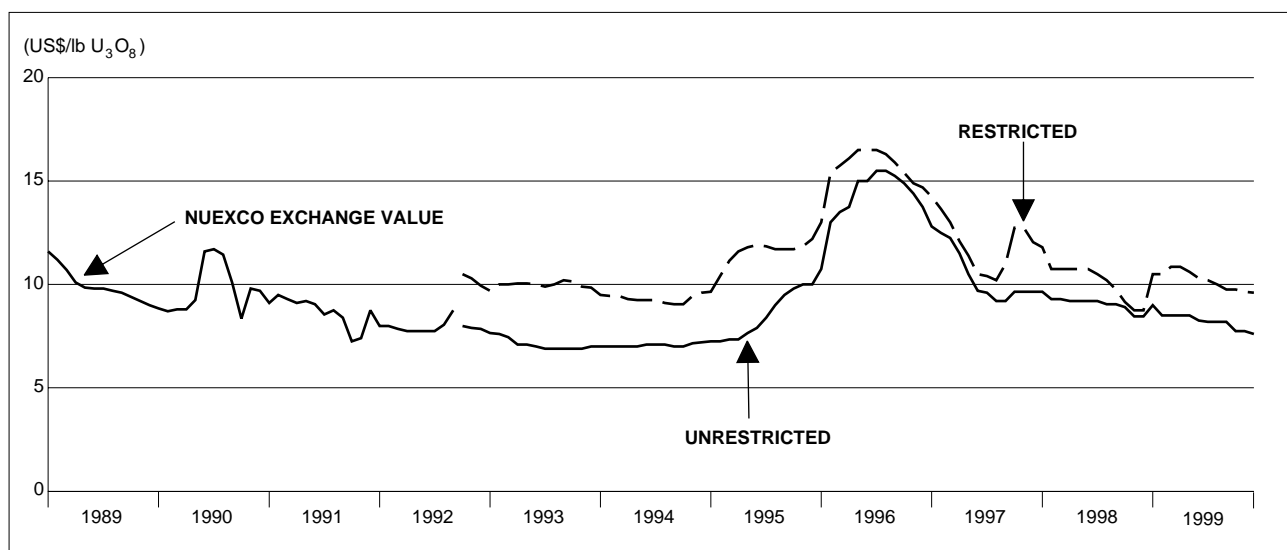
The series of production cutbacks in late 1998 set the stage for changed perceptions in the uranium market during the early part of 1999. Producers became more optimistic and strong spot market demand drove the "restricted" spot market price up quickly, as reported by *TradeTech*,⁴ from its opening level of US\$8.75/lb U₃O₈. As the price rose, buyers quickly withdrew from the market. By March the price had reached its peak for the year at \$10.85/lb. During the second quarter, supplier perceptions turned much more negative. Whenever there was a flurry of demand, it failed to stimulate prices and they began a slow descent to the year-end level of \$9.60/lb. The "unrestricted" price, attributable to uranium from the former Soviet Union, followed a similar pattern, beginning the year at US\$8.45/lb U₃O₈, peaking at \$9.00/lb in January, and then declining slowly to end the year at \$7.60/lb. Figure 5 shows the development of uranium spot prices from 1989.

The average price of Canadian export deliveries decreased from \$51.10/kgU (US\$13.30/lb U₃O₈) in 1998 to \$49.10/kgU (US\$12.70/lb U₃O₈) in 1999. In large measure this reflected the replacement of older long-term contracts dating from the mid-1990s by newer contracts signed during 1999 when the market was weaker. Table 8 shows the export price trend from 1976 to 1999 while Table 9 indicates actual exports of Canadian-origin uranium to principal customers from 1993 to 1998. The destination of Canada's exports of uranium on a cumulative basis (1994-98 inclusive) is illustrated in Figure 6, which highlights the growing importance of the United States as a customer.

REFINING AND CONVERSION

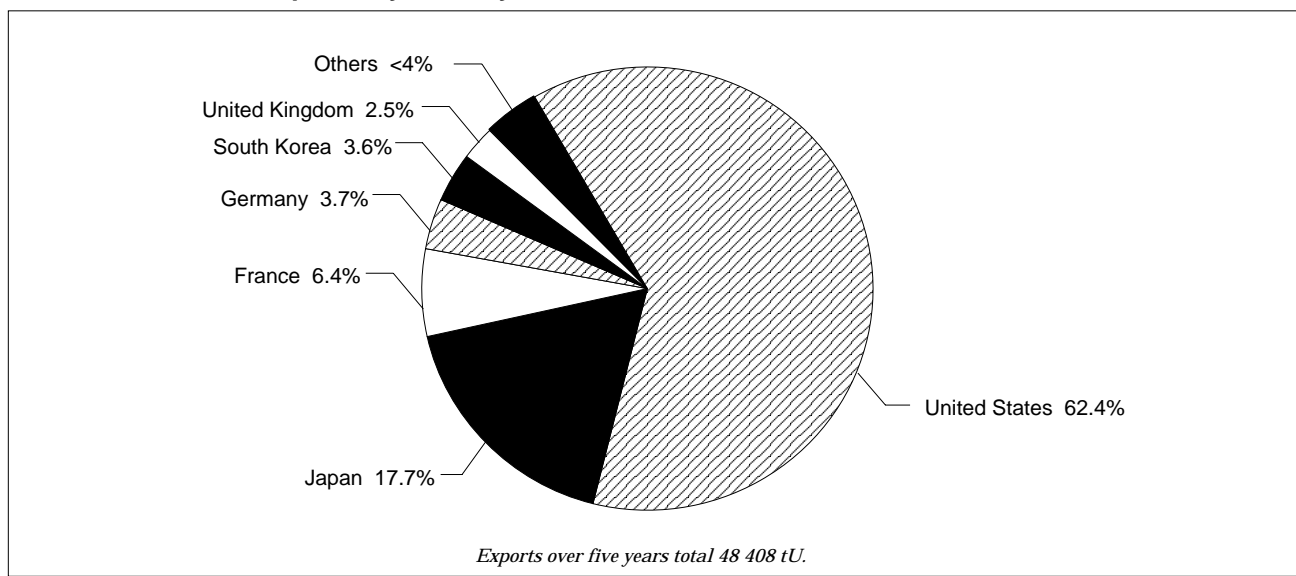
Cameco operates Canada's only uranium refining and conversion facilities, located at Blind River and Port Hope, Ontario, respectively. At the Blind River refinery – the world's largest – uranium mine concentrates from Canada and abroad are refined to uranium trioxide (UO₃), an intermediate product. The UO₃ is then trucked to the Port Hope facilities, which have about one quarter of the Western World's annual uranium hexafluoride (UF₆) conversion capacity and currently provide the only commercial supply of fuel-grade natural uranium dioxide (UO₂). UF₆ is enriched outside Canada for use in foreign light-water reactors while natural UO₂ is used to fabricate fuel bundles for CANDU reactors in Canada and abroad. About 80% of the UO₃ from Blind River is converted to UF₆ while the remaining 20% is con-

Figure 5
Trend in Uranium Spot Prices, 1989-99



Source: *TradeTech*.

Figure 6
Canadian Uranium Exports, by Country of Final Destination, 1994-98



Source: Atomic Energy Control Board (AECB), Canada.

verted to UO₂. Table 10 tabulates Canada's production of refined and converted uranium and notes the associated work force from 1995 to 1998 inclusive.

Early in 2000, the Port Hope conversion facility received certification under ISO 14001, the most widely recognized international standard for environmental management systems.

OUTLOOK

The conclusion of the commercial transaction to allow natural uranium derived from the dismantling of Russian nuclear weapons to move smoothly into Western commercial markets resolved one major concern in the uranium market, reducing some of the uncertainties overhanging the market. This, in turn, will enable Canada to remain a stable and competitive supplier of uranium to world markets for the foreseeable future.

Improved market conditions will be welcomed by Canadian producers as they continue an important period of transition in 2000. As mineable reserves at Key Lake, Rabbit Lake and Cluff Lake are depleted, new high-grade mines are entering into production, beginning with McClean Lake and McArthur River. Given favourable market conditions and timely regulatory approvals, the Cigar Lake mine is expected to enter into production in 2003. Successfully continuing to bring these operations on stream will ensure that Canada remains the world's premier uranium producer well into the 21st century.

ENDNOTES

¹ John French, Advisor, Uranium Markets (tel. (613) 995-7474), has contributed to the text in those sections dealing with international uranium market developments and uranium prices.

² "Canada's Uranium Industry - New Mines Coming on Stream", NRCan Mailing, September 7, 1999.

³ In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the NRCan survey are accounted for in the \$60 million total expenditure for 1998.

⁴ NUEXCO, an international uranium brokerage firm, was originally called the Nuclear Exchange Corporation. Several companies in the NUEXCO organization that were associated with uranium trading declared bankruptcy in early 1995. Certain of these have been reorganized and continue to provide brokerage services. NUEXCO's publication activities are carried on by *TradeTech*.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 1, 2000. (3) This review on uranium and other information on developments in Canadian nuclear policy, can be accessed on the Internet at nuclear.nrcan.gc.ca.

NOTE TO READERS

The intent of this document is to provide general information and to elicit discussion. It is not intended as a reference, guide or suggestion to be used in trading, investment, or other commercial

activities. The author and Natural Resources Canada make no warranty of any kind with respect to the content and accept no liability, either incidental, consequential, financial or otherwise, arising from the use of this document.

TABLE 1. URANIUM PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1996-98

| Province and Producer | Company Work Force ¹ (Dec. 31) | | | Annual Output ² (tU) | | |
|--------------------------------------------|----------------------------------------------|-------|-------|------------------------------------|--------|--------|
| | 1996 | 1997 | 1998 | 1996 | 1997 | 1998 |
| ATHABASCA BASIN, SASKATCHEWAN | | | | | | |
| Cluff Mining (COGEMA Resources Inc., 100%) | 234 | 222 | 158 | 1 926 | 1 964 | 1 039 |
| Key Lake JV (Cameco operator) | 395 | 316 | 285 | 5 429 | 5 434 | 5 392 |
| Rabbit Lake JV (Cameco, 100%) | 281 | 285 | 287 | 3 973 | 4 633 | 4 491 |
| McClellan Lake (pre-production) | 214 | 225 | 265 | – | – | – |
| McArthur River (pre-production) | .. | 57 | 89 | – | – | – |
| Cigar Lake JV (pre-production) | .. | .. | 50 | – | – | – |
| Subtotal | 1 124 | 1 105 | 1 134 | 11 328 | 12 031 | 10 922 |
| ELLIOT LAKE, ONTARIO | | | | | | |
| Rio Algom Limited Stanleigh | 31 | – | – | 378 | – | – |
| Total | 1 155 | 1 105 | 1 134 | 11 706 | 12 031 | 10 922 |

Sources: Company annual reports; Atomic Energy Control Board open files.

– Nil; .. Not available.

¹ Figures are for company payroll employees only; on-site contractors (mining, construction, services, etc.) are not included. ² Primary output only. With the closure of Rio Algom's Stanleigh operation at Elliot Lake in mid-1996, by-products from Cameco's refinery/conversion facilities are no longer processed in Canada. Prior to 1997, by-product totals were NOT included in the Canadian totals of primary uranium production noted above, but were included in the shipments and value of shipments figures provided in Table 2.

TABLE 2. VALUE¹ OF URANIUM SHIPMENTS² BY PRODUCERS IN CANADA, 1995-99

| | Unit | 1995 | 1996 | 1997 | 1998 | 1999P |
|--------------------------|-------------|--------|--------|--------|-------|--------|
| Total producer shipments | tU | 10 293 | 11 396 | 11 127 | 9 984 | 10 157 |
| Total value of shipments | \$ millions | 534 | 624 | 554 | 500 | 500 |

Source: Natural Resources Canada.

P Preliminary.

¹ Value of shipments, estimated from an average market price, includes the value of uranium recovered from the refinery/conversion facility by-products noted in Table 1, which are not included in primary production.

² Shipments in tonnes of uranium (tU), contained in concentrate, from ore-processing plants.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1998

| Operating Entity (Operator)/Location | Ore-Processing Plant ¹ | | | |
|-------------------------------------------------------------------|-----------------------------------|----------|-------------------|-----------|
| | Capacity | Recovery | Annual Throughput | |
| | Nameplate | Overall | Total Ore | Ore Grade |
| | (t/d) | (%) | (t) | (%) |
| Cluff Mining (COGEMA Resources Inc.)/ Cluff Lake, Saskatchewan | 800 | 98 | 159 885 | 0.66 |
| Rabbit Lake (Cameco Corporation)/ Rabbit Lake, Saskatchewan | 2 000 | 97 | 441 430 | 1.23 |
| Key Lake JV (Cameco Corporation)/ Key Lake, Saskatchewan | 710 | 97 | 323 830 | 2.01 |

Sources: Corporate annual reports; Atomic Energy Control Board open files.
¹ Figures are rounded.

TABLE 4. CANADIAN URANIUM MINING PROJECTS PLANNED FOR PRODUCTION AS OF MARCH 1, 2000

| Project, Province/Operator | Owners Share | Deposit Type/ Discoverer and Discovery Date | Resources (Company Estimates as of March 1, 2000) | Ore Grade and Notes on Deposits | Mining Method, Milling Rate and Capacity | Project Particulars and Status | Location of Project/ Notes of Interest |
|----------------------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| | (%) | | | | | | |
| Cigar Lake, Sask./ Cigar Lake Mining Corporation | Cameco (50.025), COGEMA (37.100), Idemitsu (7.875), TEPCO (5) | Unconformity-related/ COGEMA 1981 | Overall property 142 000 tU, <i>mineable</i> | Overall property grade of 14% U; grades vary from 5% to 70% U; orebody at depth of 450 m | "Non-entry" underground; "jet-boring" mining method; milling at McClellan Lake and Rabbit Lake; contributing from 2300 to 6900 tU/y | \$555 million project; test mining completed in 1992; EIS submitted in October 1995; Joint Panel reports November 1997; government response April 1998; comprehensive study of Rabbit Lake milling option ongoing | 670 km N of Saskatoon; 500-m-deep shaft sunk; brine freezing of ground is required to mine the ore; production to begin in 2003 |
| Midwest, Sask./COGEMA Resources Inc. | COGEMA (70.83), Denison (24.67), OURD (4.5) | Unconformity-related/ Esso Minerals 1977 (interests of Bow Valley, Numac Oil & Gas, <i>et al</i> bought by partners) | Overall property 13 800 tU, <i>mineable</i> | Overall property grade of 4.5% U; grades vary from 2% to 30% U; orebody at depth of 200 m | "Non-entry" underground; "jet-boring" mining method; milling at McClellan Lake; contribut- ing 2300 tU/y | \$80 million co-venture with McClellan; in 1993, Joint Panel rejects proposal; new EIS in 1995; final hearings August 1997; Joint Panel report November 1997; government response April 1998 | 710 km N of Saskatoon; 185-m-deep test-mine shaft; new operator, COGEMA, revised EIS; start-up subject to feasibility study |
| Kiggavik, Nunavut/ Urangesellschaft Canada Limited | Urangesellschaft (79), COGEMA (20), Daewoo Corp. (1) | Unconformity-related/ Urangesellschaft 1977 | Overall property 15 000 tU, <i>mineable</i> ; (more incl. Andrew Lake <i>et al</i>) | 0.41% U average overall; depth Centre pit 100 m, Main pit 200 m | Open-pit mining methods; 1200 t/d mill feed; output rate of 1200 tU/y originally expected | EIS submitted but project deemed deficient by Panel; COGEMA expected to review project and submit new EIS | 75 km W of Baker Lake; start- up not likely before 2005; >11-year mine life with tributary ore included |

Notes: OURD (Canada) Co., Ltd. is a subsidiary of the Overseas Uranium Resources Development Corporation (OURD) of Japan. Urangesellschaft Canada Limited, operated by COGEMA Resources Inc., is a subsidiary of Compagnie générale des matières nucléaires (COGEMA) of France. Idemitsu Uranium Exploration Canada Ltd. is a wholly owned subsidiary of Idemitsu Kosan Co., Ltd. of Japan. TEPCO Resources Inc. is a subsidiary of Tokyo Electric Power Co., Inc. (TEPCO), Japan's largest nuclear power utility. In April 1999, Cameco and COGEMA Resources Inc. purchased Kepeco's 2% non-voting interests in the Cigar Lake uranium joint venture. In August 1999, Denison Mines Ltd. purchased an additional 5.17% interest in the Midwest property.

TABLE 5. URANIUM EXPLORATION ACTIVITY IN CANADA, 1984-98

| Year | Expenditures ¹ | Drilling ² | Million-Dollar Projects ³ |
|------|---------------------------|-----------------------|-----------------------------------------|
| | (\$ millions) | (km) | (number) |
| 1984 | 35 | 197 | 12 |
| 1986 | 33 | 162 | 11 |
| 1987 | 37 | 164 | 12 |
| 1988 | 59 | 201 | 11 |
| 1989 | 58 | 158 | 11 |
| 1990 | 45 | 66 | 6 |
| 1991 | 44 | 67 | 4 |
| 1992 | 46 | 79 | 4 |
| 1993 | 40 | 62 | 5 |
| 1994 | 36 | 67 | 8 |
| 1995 | 44 | 75 | 10 |
| 1996 | 39 | 79 | 8 |
| 1997 | 58 | 104 | 6 |
| 1998 | 60 | 95 | 6 |

Source: Natural Resources Canada.

¹ Direct exploration and drilling expenditures in current dollars; from the late 1980s, includes advanced underground exploration and deposit appraisal expenditures; from the mid-1990s, may also include care-and-maintenance costs associated with deposits awaiting production approvals.

² Exploration and surface development drilling; excludes development drilling on producing properties. ³ Number of projects where direct exploration and drilling expenditures exceeded \$1 million in current dollars.

TABLE 6. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE,¹ JANUARY 1, 1998, AND JANUARY 1, 1999

| Price Ranges Within Which Mineable Ore is Assessed ² | Measured | | Indicated | | Inferred | |
|-----------------------------------------------------------------------|----------|--------|-----------|--------|----------|--------|
| | 1/1/98 | 1/1/99 | 1/1/98 | 1/1/99 | 1/1/98 | 1/1/99 |
| | (000 tU) | | | | | |
| Up to C\$50/kgU | .. | 211 | .. | 73 | .. | 87 |
| C\$50 to \$100/kgU | 140 | 1 | 172 | 41 | 107 | 20 |
| Total | 140 | 212 | 172 | 114 | 107 | 107 |

Source: Natural Resources Canada.

.. Not available

¹ Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75-85% of the ore-in-place; higher mining recoveries are achievable in open-pit operations. Canada's weighted average ore processing recovery for existing conventional operations exceeded 97% over the 1997/98 period.

² The Canadian dollar figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. The price of \$100/kgU was used by Natural Resources Canada to illustrate those resources that were of economic interest to Canada during the survey period.

Note: \$1/lb U₃O₈ = \$2.6/kgU.

TABLE 7. PRODUCTION OF URANIUM IN CONCENTRATES BY SELECTED MAJOR PRODUCING COUNTRIES, 1994-98

| | 1994 | 1995 | 1996 | 1997 | 1998 |
|--------------------------|---------------|---------------|---------------|---------------|---------------|
| | (tonnes U) | | | | |
| Canada ¹ | 9 700 | 10 530 | 11 750 | 12 030 | 10 920 |
| Russia | 2 350 | 2 200 | 2 600 | 2 000 | 2 000 |
| Kazakstan | 2 240 | 1 580 | 1 210 | 1 000 | 1 270 |
| Uzbekistan | 2 120 | 1 700 | 1 460 | 1 760 | 1 930 |
| China | 480 | 780 | 560 | 500 | 500 |
| United States | 1 290 | 2 324 | 2 430 | 2 170 | 1 810 |
| South Africa | 1 670 | 1 420 | 1 440 | 1 100 | 990 |
| Namibia | 1 900 | 2 010 | 2 450 | 2 900 | 2 760 |
| Australia | 2 210 | 3 710 | 4 970 | 5 520 | 4 910 |
| Niger | 2 980 | 2 980 | 3 320 | 3 500 | 3 730 |
| France | 1 050 | 1 020 | 930 | 750 | 510 |
| Gabon | 650 | 630 | 570 | 470 | 730 |
| Other ² | 2 370 | 2 730 | 2 540 | 1 990 | 1 730 |
| Total³ | 31 010 | 33 610 | 36 230 | 35 690 | 33 800 |

Sources: *Uranium: Resources, Production and Demand*, a biennial report published jointly by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency; miscellaneous corporate, national and international reports.

¹ Includes refinery/conversion facility by-product; differs from primary production figures shown elsewhere. ² Includes Argentina, Belgium, Brazil, Bulgaria, the Czech Republic, Germany, Hungary, India, Israel, Japan, Mongolia, Pakistan, Portugal, Romania, Spain, Ukraine and Yugoslavia. ³ Totals are of the listed figures only and represent global production.

Note: Country figures are rounded to the nearest 10 tU.

TABLE 8. CANADIAN URANIUM EXPORT PRICE,¹ 1976-99

| Year | Average Export Prices | | Spot Sale Portion of Deliveries |
|------|-----------------------|--------------------------|---------------------------------------|
| | Current Dollars | Constant 1998 Dollars | |
| | (\$/kgU) ² | | (%) |
| 1976 | 104 | 261 | n.r. |
| 1977 | 110 | 259 | n.r. |
| 1978 | 125 | 276 | n.r. |
| 1979 | 130 | 262 | n.r. |
| 1980 | 135 | 245 | n.r. |
| 1981 | 110 | 180 | 1 |
| 1982 | 113 | 170 | 1.5 |
| 1983 | 98 | 140 | 10 |
| 1984 | 90 | 125 | 26 |
| 1985 | 91 | 123 | 20 |
| 1986 | 89 | 117 | 21 |
| 1987 | 79 | 99 | 35 |
| 1988 | 79 | 95 | 13 |
| 1989 | 74 | 85 | <1 |
| 1990 | 71 | 79 | <1 |
| 1991 | 61 | 66 | <2 |
| 1992 | 59 | 63 | <1 |
| 1993 | 50 | 53 | <1 |
| 1994 | 51 | 53 | <1 |
| 1995 | 47 | 48 | 2 |
| 1996 | 53.60 | 53.78 | 1 |
| 1997 | 51.30 | 51.09 | <1 |
| 1998 | 51.10 | 51.94 | <2 |
| 1999 | 49.10 | 49.1 | <1 |

Source: Natural Resources Canada.

n.r. Not reported.

¹ Derived annually based on the average price for all deliveries made by Canadian producers to export customers in the given year. ² \$/kgU x 0.38465 = \$/lb U₃O₈.

Notes: Pre-1996 prices are rounded to the nearest dollar. Constant dollar values are derived using the Implicit Price Index for Gross Domestic Product.

TABLE 9. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1993-98

| Country of Final Destination | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---------------------------------|---------------------------------------------|--------|-------|--------|--------|-------|
| | (tonnes of contained uranium ¹) | | | | | |
| Argentina | 29 | — | — | — | — | — |
| Belgium | — | 115 | 3 | 115 | — | — |
| France | 461 | 766 | 1 016 | 679 | 587 | 67 |
| Germany | 665 | 465 | 348 | 776 | 184 | — |
| Japan | 523 | 3 443 | 363 | 1 490 | 1 968 | 1 310 |
| South Korea | 715 | 455 | 290 | 261 | 315 | 444 |
| Spain | — | 274 | 186 | 103 | 160 | — |
| Sweden | — | — | 84 | 142 | 450 | 147 |
| United Kingdom | — | 50 | 188 | 250 | 374 | 345 |
| United States | 6 291 | 4 938 | 5 702 | 7 407 | 6 187 | 5 962 |
| Total | 8 684 | 10 506 | 8 180 | 11 223 | 10 225 | 8 274 |

Source: Atomic Energy Control Board.

— Nil.

¹ Some of this uranium was first exported to an intermediate country for conversion and/or enrichment prior to transfer to the country of final destination.

TABLE 10. URANIUM PROCESSING PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1995-98

| Process and Location (Nameplate Capacity) | Production | | | | Site Work Force | | | |
|----------------------------------------------------------------------------------------------|------------|--------|--------|--------|-----------------|------|------|------|
| | 1995 | 1996 | 1997 | 1998 | 1995 | 1996 | 1997 | 1998 |
| | (tU) | | | | (number) | | | |
| Refining at Blind River (18 000 tU as UO ₃) | 10 729 | 10 190 | 12 195 | 12 031 | 86 | 90 | 102 | 96 |
| Conversion at Port Hope (12 500 tU as UF ₆ and 2800 tU as UO ₂) | 10 552 | 10 127 | 12 594 | 11 169 | 231 | 257 | 277 | 271 |

Source: Cameco Corporation.