

Uranium

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OVERVIEW

Uranium producers continued to face challenging market conditions in 2001 as abundant secondary supplies continued to compete for limited demand. However, energy shortages in California, coupled with an increasing focus on clean air and climate change, stimulated a public debate on energy policy that produced a generally more favourable attitude toward nuclear power. These events may translate into improved market conditions for uranium producers over the next few years.

Against this background, spot market prices recovered from a near record low at the end of 2000, rising generally during 2001 and ending the year 34% higher than they started. Canadian uranium producers remain well positioned to capitalize on any additional market upturn as the transition to new production centres tapping high-grade, low-cost deposits in northern Saskatchewan is successfully proceeding.

Canadian uranium production in 2001 amounted to a record total of 12 522 tU, up some 17% from the 2000 total due to increased contributions from the McArthur River and McClean Lake mines. As Figure 1 shows, the world's two largest uranium-producing companies have operations in Canada. As of January 1, 2002, Canada's total "known" recoverable uranium resources totalled 452 000 tU, compared with 437 000 tU as of January 1, 2001. This upward adjustment of some 3% is the result of ongoing deposit appraisal.

Despite low prices, Canadian uranium production capability continues to expand in the province of Saskatchewan. The McClean Lake mill increased its licensed production capacity by some 33% (to 3077 tU). The McArthur River mine continued to

ramp up to its annual licensed production capacity of 6900 tU, producing 6639 tU in 2001. A feasibility study was approved and a detailed engineering plan was initiated for the Cigar Lake mine in 2001 with production currently expected to begin as early as 2005.

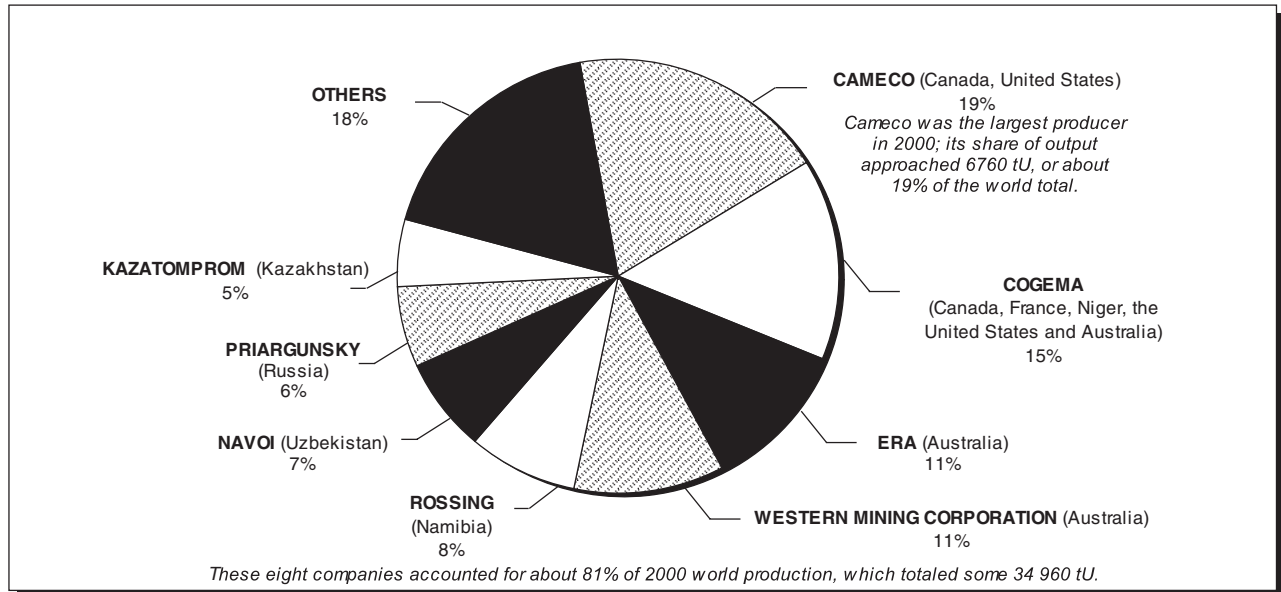
DOMESTIC PRODUCTION AND DEVELOPMENTS

In 2000, the most recent year with complete data available, production amounted to 10 683 tU, a sharp increase of 35% from the 1999 total. This increase is the result of contributions from the new McArthur River and McClean Lake production centres. Overall employment in Canada's uranium mining industry remained slightly above 1000 in 2000 (Table 1). Shipments from mining centres decreased slightly in 2000, compared to 1999, and the value of the shipments declined as well (Table 2). These data primarily reflect the successful transition uranium producers are making to new high-grade production centres as resources near depletion at older production centres. With increased 2000 production, 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 2000, 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 2000 (Figure 3) was dominated by Cameco Corporation and COGEMA Resources Inc. (CRI).

On March 18, 2001, Billiton Plc and BHP Limited merged to become Australian-based BHP Billiton, one of the world's largest producers of minerals and metals. The merger followed Billiton's October 2000 purchase of Rio Algom Limited, a Toronto-based mining company that operated uranium mines in Elliot Lake, Ontario.

On September 1, 2001, Mr. T. Gitzel was appointed President and Chief Executive Officer of CRI, replacing Mr. A. de Bourayne, who became Head of

Figure 1
World's Top Uranium Mining Companies in 2000



Source: *World Nuclear Association Pocket Guide*.

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

COGEMA S.A.'s Enrichment Business Unit and Chairman of EURODIF Production Company. Later that same month, the AREVA Group was created through the amalgamation of CRI's parent company, COGEMA S.A., with FRAMATOME Advanced Nuclear Power and FCI Electronics.

On February 14, 2002, Crown Investments Corporation of Saskatchewan sold its remaining 10% ownership in Cameco for \$226.4 million. The only remaining government stake in the company is one Class B share, owned by the Government of Saskatchewan, that entitles it to vote separately as a class with respect to any proposal to locate Cameco's head office outside the province of Saskatchewan.

Cameco was formed in 1988 through the merger of the Saskatchewan Mining Development Corporation and the federal Crown corporation, Eldorado Nuclear Limited. Since then, the two levels of government have gradually reduced their share holdings. The Government of Canada divested its last remaining shares in Cameco in 1995.

Elliot Lake, Ontario

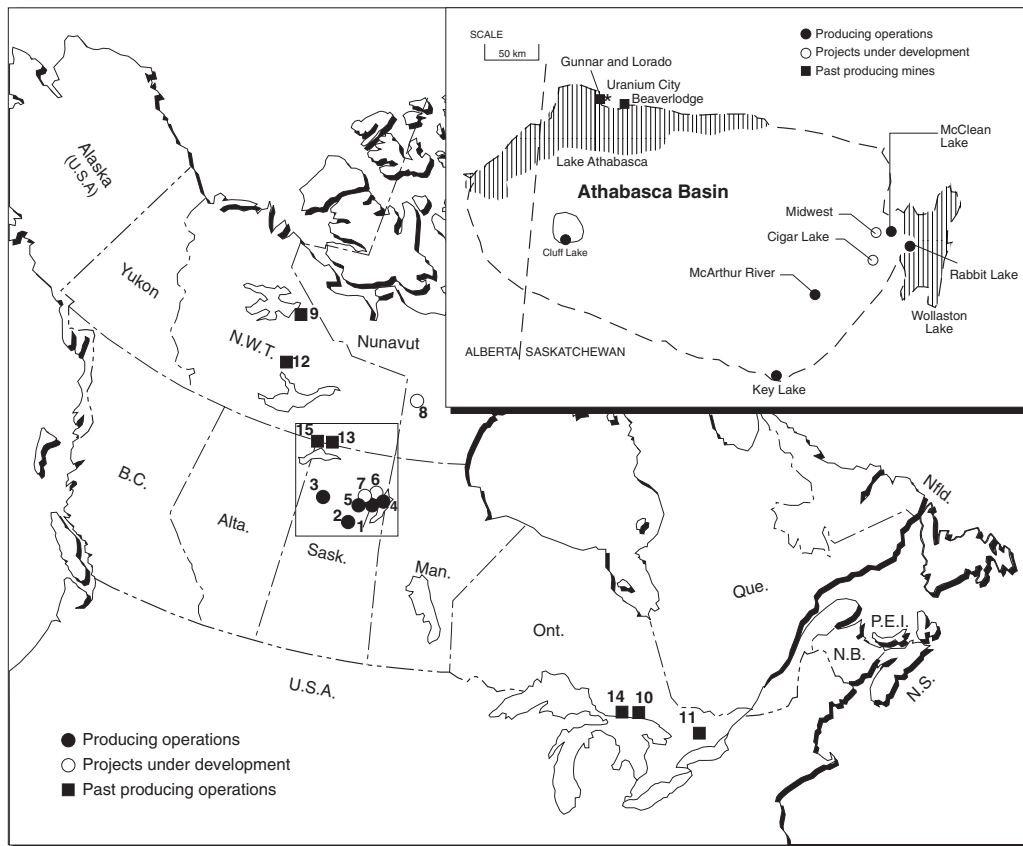
Elliot Lake, Ontario, was a major uranium mining centre in Canada for several decades. Since the last facility closed in 1996, Rio Algom and Denison Mines Limited have committed over \$75 million to decommission their mine and mill sites. Following an environmental assessment and receipt of government

approvals and licences from regulatory agencies, buildings were dismantled and waste management areas were stabilized and contained. Some tailings areas were flooded to control radon emissions and acid generation. All major reclamation work was completed in the late 1990s.

The Serpent River Watershed Monitoring Program was initiated to gauge the recovery of the watershed that hosted the mining. Sample collections are designed to assess water quality, sediment quality, benthic community health, and fish health, as well as radiation and metal doses to humans and wildlife utilizing the watershed. Data collected in 1999 from 20 lakes and 28 streams both upstream and downstream from the mine sites show that the impact of mining is discernable, mainly in the form of above background levels of salts, total dissolved solids and some metals. However, with rare exceptions, measured concentrations are within projected levels and the fish, benthic invertebrates and wildlife are displaying no adverse effects. The monitoring program is slated to continue on a five-year cycle.

Some of the older waste sites (containing principally uranium mine tailings) in the Elliot Lake area were not flooded but were stabilized by vegetation to control dust and surface run-off. Run-off and seepage from these sites are collected for treatment. Of these older sites, Rio Algom's Spanish American, Milliken, Lacnor, Nordic/Buckles and Pronto sites are not presently licensed by the Canadian Nuclear Safety

Figure 2
Uranium Mining in Canada, 2001



Numbers refer to locations on map above

PRODUCING OPERATIONS

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

PROJECTS UNDER DEVELOPMENT

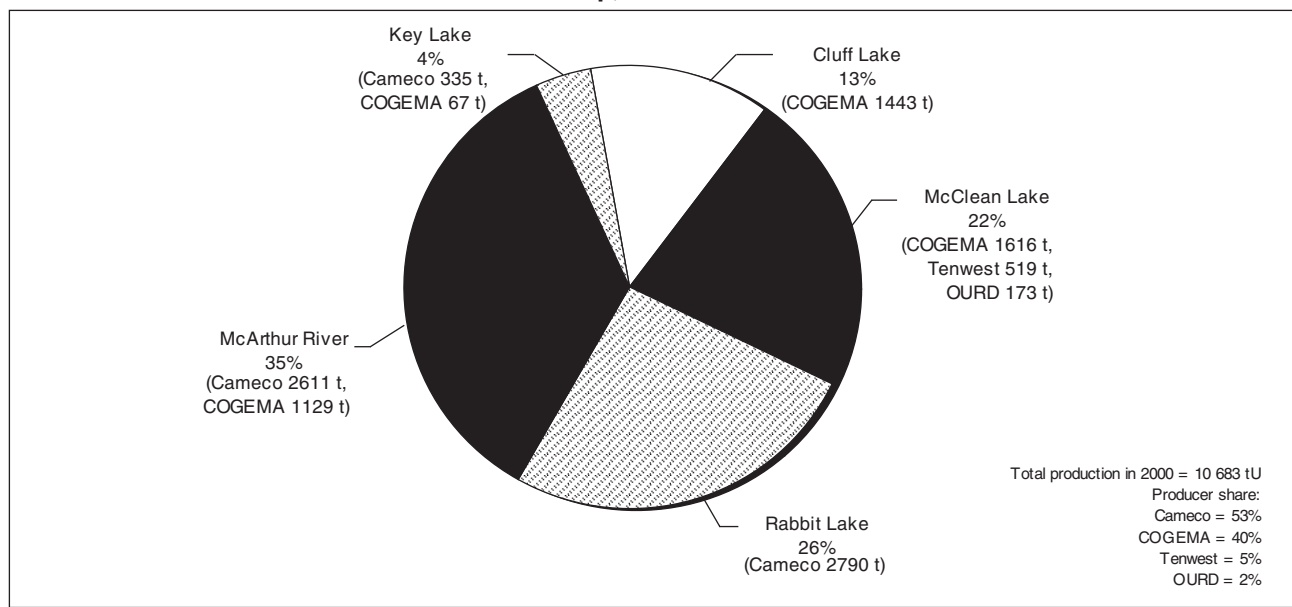
- 6. Midwest
- 7. Cigar Lake
- 8. Kiggavik

PAST PRODUCING OPERATIONS

- 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, 2000



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

Cameco: Cameco Corporation; COGEMA: COGEMA Resources Inc.; OURD: OURD (Canada) Co. Ltd.; Tenwest: Tenwest Uranium Ltd.

Notes: Production reflects equity interest in production facilities. Tenwest is a wholly owned subsidiary of Denison Mines Limited.

Commission (CNSC). Although uranium mining and milling ceased at these facilities over 30 years ago, Rio Algom is currently in the process of obtaining a CNSC radioactive waste facility operating licence, which is expected in 2002.

Athabasca Basin, Saskatchewan

McArthur River

The McArthur River mine, the world's largest high-grade uranium deposit discovered to date, is a Cameco-CRI joint venture operated by Cameco. Mining began at McArthur River in December 1999 and commercial design capacity of 577 tU per month was achieved throughout most of 2001. Production in 2001 totalled 6639 tU, up sharply from 2000 production of 3740 tU.

Mining high-grade uranium requires the use of innovative high-tech, remote-controlled, non-entry methods. The high water content of the McArthur River ore and surrounding rock requires the use of a calcium chloride brine to create a freeze curtain separating the water-bearing sandstone from the ore. The use of remote-controlled methods, including raise boring, underground crushing and grinding circuits, and transporting the ore to the mill in purpose-designed containers that are loaded and unloaded at specially designed, remote-controlled stations, minimizes workers' exposure to radiation.

McArthur River reserves currently total over 175 000 tU (at an average grade of over 17% U), sufficient for over 20 years of operation at current production rates.

On October 30, 2001, the CNSC renewed the McArthur River uranium mine operating licence for a term ending on February 28, 2004. A conceptual decommissioning and reclamation plan and an \$8.6 million letter of credit to implement this plan have been filed with the Government of Saskatchewan.

Key Lake

The Key Lake project is a Cameco and CRI joint venture operated by Cameco. Local deposits were mined out in 1997, but the mill continues operating, processing McArthur River ore. In 2001, Key Lake produced 6938 tU, up sharply from the 2000 total of 4142 tU. All but 299 t of 2001 uranium production was derived from McArthur River ore. The small contribution from Key Lake came from stockpiled low-grade ore which is used to lower the McArthur River ore grade to about 3.5% U before being run through the mill circuit.

A 1998 agreement with International Uranium Corporation of Denver, Colorado, has facilitated the processing of uranium-bearing by-products from Cameco's Blind River refinery and Port Hope conver-

sion plant at the White Mesa Mill in Utah. In 2001, Cameco completed a pilot test program to recycle these by-products at the Key Lake mill in order to develop information required to support an application to recycle these by-products at that mill on a regular basis.

On October 30, 2001, the CNSC renewed the Key Lake uranium mine operating licence for a term ending on February 28, 2004. A conceptual decommissioning and reclamation plan has been filed with the Government of Saskatchewan, along with a \$45.6 million letter of credit.

McClellan Lake

The McClellan Lake uranium production facility is majority-owned and operated by CRI. In 2001, production amounted to 2540 tU, up from the 2308 tU produced in 2000. On August 31, 2001, the CNSC renewed the McClellan Lake uranium mine operating licence for a term ending on August 31, 2005, with an increased annual production limit of 3077 tU.

During 2001, the McClellan Lake mill was fed by low-to high-grade ore from the Sue C open pit and low-grade stockpiled ore from the JEB open pit. Mining of the Sue C deposit was completed in February 2001. After follow-up activities were completed, such as ore haulage and select reclamation activities, about 40 of the McClellan Lake mining staff were laid off at the end of May 2001.

The Sue C deposit produced almost 550 000 t of ore with an average grade of about 2% U, containing over 10 000 tU. Combined with the remaining ore from the mined-out JEB deposit, the McClellan Lake ore stockpile is sufficient to provide feed for the mill for several years.

A conceptual decommissioning and reclamation plan and a financial guarantee of \$35 million, assured by letters of credit, has been filed with the Government of Saskatchewan.

Rabbit Lake

The Rabbit Lake uranium production facility is wholly owned and operated by Cameco. Mill output in 2001 amounted to 1755 tU, down significantly from 2000 production of 2790 tU, owing to Cameco's decision to suspend operations at the mill after stockpiled ore was depleted in May 2001. Mining had been suspended in March 1999. Cameco has re-evaluated the mining plan for the Eagle Point underground mine and is expected to resume mining in mid-2002 with milling expected to resume later that same year.

The remaining Eagle Point reserves total over 6500 tU with an average grade of about 1% U, sufficient to

provide feed for the mill until about 2005. Subject to regulatory approval and mutually satisfactory business arrangements among the owners of the Cigar Lake mine, deliveries of Cigar Lake ore to Rabbit Lake could commence as early as 2007. An Environmental Impact Statement outlining plans to mill about half of the Cigar Lake ore at Rabbit Lake is expected to be filed with regulatory agencies in 2003.

In July 2001, International Atomic Energy Agency (IAEA) personnel inspected surface and underground facilities at Rabbit Lake. This was the first inspection of its kind in Canada under the IAEA's strengthened safeguard system that now extends to the front end of the nuclear fuel cycle. The objective of this short-notice complementary access inspection was to ensure consistency with Canada's declared nuclear fuel cycle activities. Complementary access was provided as outlined in procedures now incorporated in CNSC uranium mine operating licences.

On October 30, 2001, the CNSC renewed the Rabbit Lake uranium mine operating licence for a term ending on October 31, 2003. A conceptual decommissioning and reclamation plan has been filed with the Government of Saskatchewan, along with a \$36 million letter of credit to cover the costs of implementing this plan.

Cluff Lake

The Cluff Lake uranium production facility is wholly owned and operated by CRI. The mill operated throughout most of 2001 on an alternate week schedule. Overall production amounted to 1288 tU, down slightly from the 1443 tU produced in 2000. Mining of the west Dominique-Janine deposit was completed on May 31, 2002. The current plan is to continue operating the mill until December 2002 in order to process all stockpiled ore and then suspend operations at the site.

CRI continues site clean-up and reclamation activities in anticipation of the suspension of operations. Buildings and structures no longer required have been dismantled. In 2001, the placement of a 1-metre soil cap on the tailings management upper solids area began and portions of the Claude waste rock pile were levelled and re-sloped. A test till cover and groundwater wells with instrumentation were installed to gather information on the potential environmental impacts of the waste rock pile.

On December 28, 2001, the CNSC renewed the Cluff Lake uranium mine operating licence with a term extending to the end of April 2004, which permits the completion of the planned mining and milling activities. A conceptual decommissioning and reclamation plan has been filed with the Government of Saskatchewan, along with a \$33.6 million letter of credit to cover the costs of implementing this plan.

Cigar Lake

The Cigar Lake mine is a joint venture that has been developed by the Cigar Lake Mining Corporation. Effective January 1, 2002, Cameco became the operator of the project. This change had no effect on the ownership of the mine (Table 4).

Cigar Lake is the world's second largest high-grade uranium deposit discovered to date with reserves totalling over 85 000 tU at an average grade of over 17%. After an updated feasibility study incorporating the results of additional jet-boring mining tests was approved by the joint-venture owners in June 2001, a detailed engineering design was initiated. Subject to market conditions and regulatory approvals, the mine could enter into production as early as 2005.

Subject to regulatory approvals, the mining method will consist of 4-m-diameter holes bored with a high-pressure water jet. As at McArthur River, the high water content of the ore and surrounding rock means that the deposit must be frozen prior to mining. The ore will be ground and mixed into a slurry underground, pumped to the surface, loaded into specialized containers and trucked to McClean Lake for processing. For the first phase of mining, about one-half of the ore will be processed entirely at McClean Lake with the remainder expected to be shipped to Rabbit Lake for further processing after it has reached the pregnant aqueous solution stage at McClean Lake.

On December 11, 2001, the CNSC issued a uranium mine-site preparation licence with a term extending to July 31, 2004. The main activity over the duration of this licence will be operating the site on a care and maintenance basis. A conceptual decommissioning and reclamation plan for test mining infrastructure and surface disturbance has been filed with the Government of Saskatchewan, along with financial assurance amounting to \$4.2 million.

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, subject to favourable market conditions and the receipt of environmental and regulatory approvals. Table 4 updates, as of June 1, 2002, recent developments at the mining projects that could contribute to Canada's uranium production capability in the future.

Environmental Assessments

CRI's decommissioning plan for the Cluff Lake project is the subject of a comprehensive environmental assessment study pursuant to the *Canadian Environmental Assessment Act*. Once all questions from

regulatory agencies have been satisfactorily addressed by CRI (anticipated in July 2002), the document will be submitted to the Canadian Environmental Assessment Agency for public review. Once completed, the licensing process with federal and provincial agencies can be initiated.

In 2001, CRI and the Cigar Lake Mining Corporation submitted a screening environmental assessment that outlines options for disposing of potentially acid-generating waste rock from the Cigar Lake mine. After reviewing several options, it was determined that disposal in the mined-out Sue C pit at McClean Lake is the environmentally preferred option as it is expected to produce no significant environmental effects. Public consultations are continuing and the report is being reviewed by regulatory agencies.

A comprehensive environmental assessment study of the proposal to mill approximately half of the Cigar Lake ore at the Rabbit Lake mill is expected to be submitted to regulatory agencies in 2003. Subject to regulatory approvals and mutually agreeable business arrangements among the joint-venture partners, ore from Cigar Lake could provide feed for the Rabbit Lake mill for some 15 years.

Other Developments Affecting Canada's Uranium Industry

In October 2000, Cameco announced that it had signed an agreement with British Energy plc to acquire a 15% interest in the Bruce Power Partnership (Bruce Power). Under the terms of the agreement, which came into effect on May 12, 2001, Cameco assumed full responsibility for managing all of Bruce Power's fuel procurement needs.

The Bruce nuclear power station consists of four Bruce B reactors currently operating and four laid-up Bruce A reactors. In April 2001, Bruce Power announced that it planned to restart two of the laid-up Bruce A reactors (Units 3 and 4; an additional 1500 MWe). The two Bruce A reactors are expected to be back in operation in 2003, subject to regulatory approvals. The total cost of the restart is estimated to be in the order of \$340 million.

On February 12, 2001, Cameco received a gold level achievement award from the Canadian Council for Aboriginal Business. The award recognizes Cameco's commitment to establishing a fair and balanced business relationship with Aboriginal communities in northern Saskatchewan.

EXPLORATION

Natural Resources Canada (NRCan) completed its 26th annual assessment of Canada's uranium supply capabilities and reported² the results in October

2001. 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 the Northwest Territories and Nunavut. In 2000, overall uranium exploration expenditures reached \$46 million while uranium exploration and surface development drilling amounted to over 77 000 m, down from the 89 000 m reported for 1999.

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 amounted to \$18 million in 2000, up slightly from the 1999 total of \$14 million. Table 5 summarizes uranium exploration activity in Canada from 1987 to 2000.

In recent years, the number of companies with major exploration programs in Canada has declined. The top five operators,³ accounting for a major portion of the \$46 million expended in 2000, were: Cameco Corporation, Cigar Lake Mining Corporation, CRI, JNR Resources Ltd., and Pioneer Metals Corporation. Expenditures by CRI include those of Urangesellschaft Canada Limited.

On October 21, 2001, Cameco and Pioneer Metals Corporation announced that they had entered into an agreement to form a new public company, UEX Corporation, to focus on uranium exploration in the Athabasca Basin. A condition required to close this arrangement is that third-party financing be obtained. After closing, Cameco will retain a 40% interest in UEX.

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*, which 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, 2001, total recoverable known uranium resources were estimated at 437 000 tU, compared with 417 000 tU as of January 1, 2000. This upward adjustment of about 5% primarily reflects increased McArthur River resources.

SUPPLY CAPABILITY

In 2001, Canada's uranium supply capability increased as McArthur River production was successfully ramped up to design capacity and licensed production capacity was increased at McClean Lake. A continued smooth transition to other new mines, combined with timely licensing approvals and improved market conditions, will be required to allow Canada's production capability to expand to its full potential of some 15 000 tU annually.

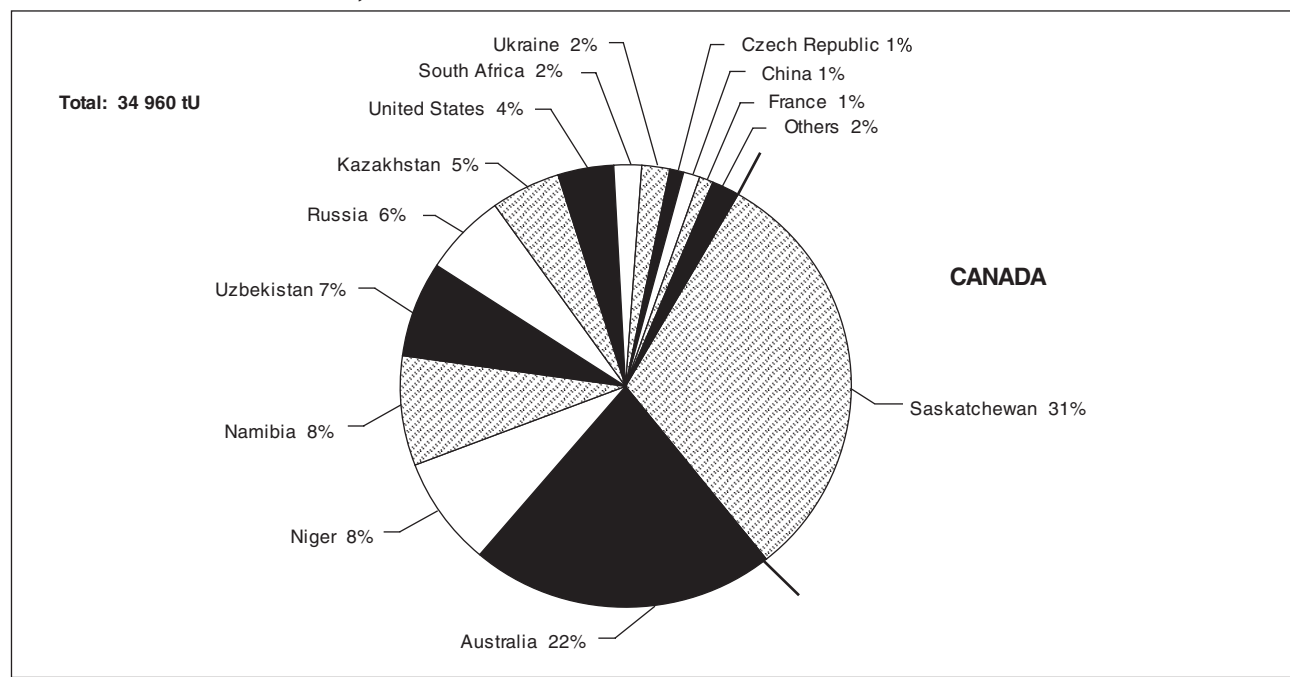
Developments in the international uranium market, the rate at which projects receive environmental approvals, and uncertainty regarding the costs associated with certain of the planned new projects preclude projecting future production capability levels with much certainty. Table 7 ranks Canada among the world's major producers, showing actual uranium production from 1996 through 2000. Figure 4 illustrates Canada's share of world output in 2000 compared with other major producers.

GOVERNMENT INITIATIVES

On January 1, 2001, the Government of Saskatchewan implemented a revised royalty system that consists of both a basic and tiered royalty. The basic royalty is equal to 5% of the gross uranium sales, reduced by a Saskatchewan Resource Credit equivalent to 1% of the gross sales. An additional tiered royalty, which increases with the price of uranium, is applied after capital allowances for mine and mill development are reduced to zero.

On June 13, 2002, *An Act Respecting the Long-Term Management of Nuclear Fuel Waste* received Royal Assent. The legislation requires nuclear utilities to form a waste management organization that will report regularly to the Government of Canada and provide recommendations on the long-term management of nuclear fuel waste. The legislation also requires that the utilities establish a trust fund to finance implementation of the management approach, ensuring that Canadian taxpayers are not exposed to this financial liability over the long term.

Figure 4
World Uranium Production, 2000



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

THE URANIUM MARKET

Overview

During the course of 2001, there was a good deal of talk of a “nuclear renaissance,” particularly in the United States, coupled with positive press coverage. In May, the United States released its National Energy Policy, which was very supportive of the role of nuclear power. Serious energy shortages in California during the spring drew worldwide attention. These events began to stimulate public debate on energy policy and a more favourable public attitude toward nuclear power emerged. It has become clear that it could be difficult to meet Kyoto Protocol targets without a significant contribution from nuclear electricity generation. This may bode well for uranium demand five or ten years from now.

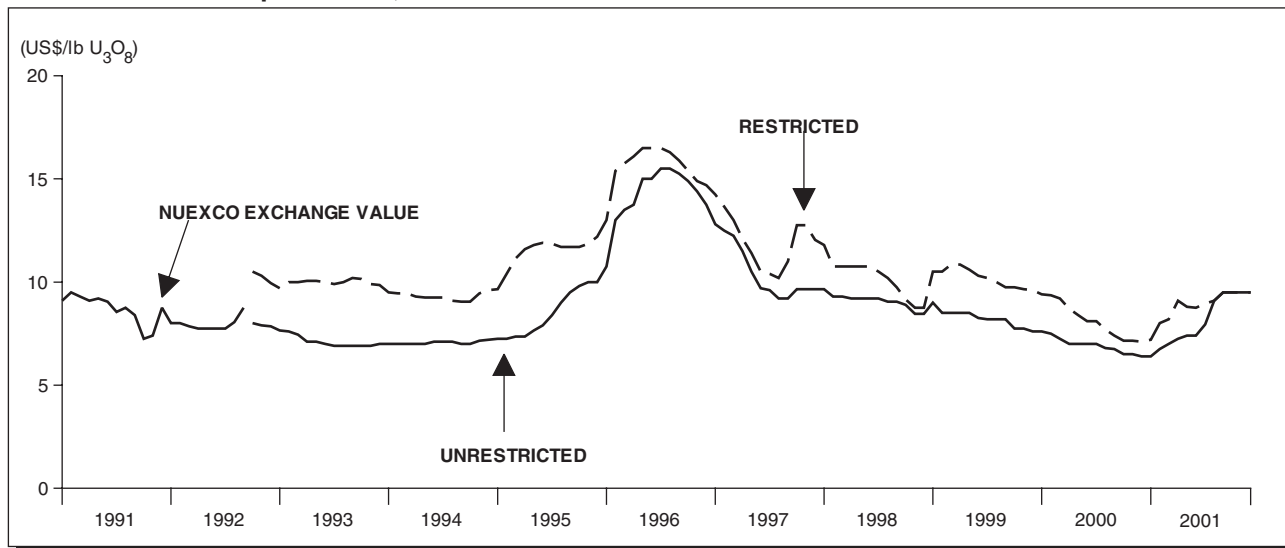
Against this background, spot market prices rose generally during the year, ending it 34% higher than they started. The Euratom Supply Agency relaxed its restrictions on the import of Kazakh- and Uzbek-origin uranium, leaving Russian uranium as the only origin still subject to restrictions in Western markets. During September, all of the major organizations reporting on spot prices ceased publication of a separate price attributable to uranium from the former Soviet Union and the market once again converged to a single uranium price.

During November, Cameco, COGEMA S.A., and RWE Nukem Inc. announced that they had agreed to purchase from the Russian company Technobexport Co. Ltd. firm quantities of uranium arising from the agreement on Highly Enriched Uranium (HEU) between the United States and the Russian Federation. These quantities, which had formerly been covered by options, were at least equal to the respective shares of these companies in the quota allowing for the sale of this uranium in the U.S. market over the remaining term of the HEU Agreement from 2002 through 2013. These commitments placed this important disarmament agreement on a stable commercial footing and provided the Russian government with a predictable long-term revenue stream.

Uranium Prices

After reaching a historic low in real terms at the end of 2000, uranium spot market prices recovered throughout 2001. Figure 5 shows that the “restricted” spot market price, as reported by Trade-Tech,⁴ began the year at US\$7.10/lb U₃O₈ (uranium oxide concentrate, commonly referred to as yellow-cake) and ended up at \$9.50. The “unrestricted” spot market price, attributable to uranium from the former Soviet Union, followed a similar trend through the end of August. Thereupon Trade-Tech, and other organizations reporting uranium spot prices, discontinued publication of this separate price following the

Figure 5
Trend in Uranium Spot Prices, 1991-2001



Source: TradeTech.

cessation of U.S. and European Union restrictions against all but Russian-origin uranium.

The average price of Canadian export deliveries declined from \$47.70/kgU (US\$12.40/lb U₃O₈) in 2000 to \$46.60/kgU (US\$11.60/lb U₃O₈) in 2001. Table 8 shows the export price trend from 1978 to 2001 while Table 9 indicates actual exports of Canadian-origin uranium to principal customers from 1995 to 2000. The destination of Canada's exports of uranium on a cumulative basis (1996-2000 inclusive) is illustrated in Figure 6, which highlights the 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 converted to UO₂. Table 10 tabulates Canada's produc-

tion of refined and converted uranium, and notes the associated work force from 1997 to 2000 inclusive.

On February 9, 2001, British Nuclear Fuels Limited (BNFL) announced that it intended to halt UF₆ production in 2006 and that it was immediately ceasing the marketing of its UF₆ conversion services. All uncommitted BNFL UF₆ conversion services were sold to Cameco.

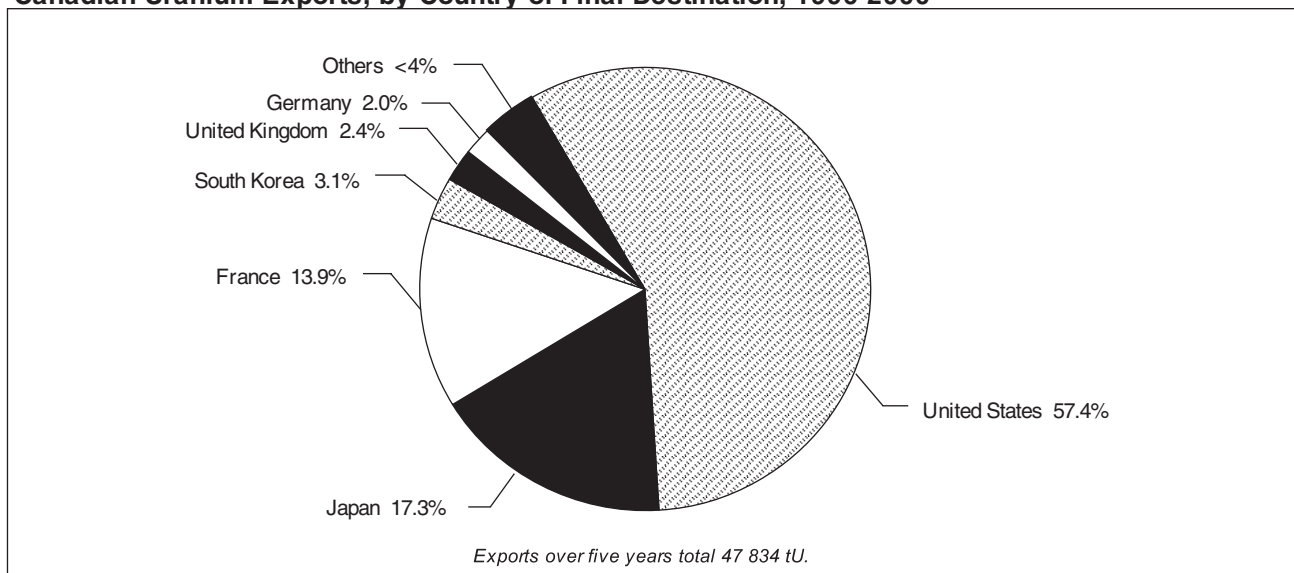
In March 2002, the Blind River refinery received certification under ISO 14001, the most widely recognized international standard for environmental management systems.

OUTLOOK

Talk of a "nuclear renaissance," particularly in the United States, coupled with positive press coverage, policy support for nuclear power in the United States, and a more favourable public attitude toward nuclear power, have improved the outlook for uranium producers. In addition, the realization that it could be difficult to meet Kyoto Protocol targets without a significant contribution from nuclear electricity generation may bode well for future uranium demand.

Improved market conditions will be welcomed by Canadian producers as they continue the transition to the new generation of uranium mines in northern Saskatchewan. With favourable market conditions and timely regulatory approvals, the Cigar Lake mine is expected to enter into production as early as

Figure 6
Canadian Uranium Exports, by Country of Final Destination, 1996-2000



Source: Canadian Nuclear Safety Commission.

2005. Continued success in bringing 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 2001 - Production Rebounds with New Mines On Stream* - NRCan Mailing, October 2001.

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 \$46 million total expenditure for 2000.

⁴ NUEXCO, an international uranium brokerage firm, was originally called the Nuclear Exchange Corporation. Several companies in the NUEXCO organization, which 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 64. (2) Information in this review was current as of June 15, 2002. (3) This paper on uranium and other information on developments in Canadian nuclear policy can be accessed on the Internet at nuclear.nrcan.gc.ca. (4) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmy/index_e.html.

NOTE TO READERS

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TABLE 1. URANIUM PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1998-2000

Production Centre and Producer	Company Work Force (1) (Dec. 31)			Annual Output (2) (tU)		
	1998	1999	2000	1998	1999	2000
ATHABASCA BASIN, SASKATCHEWAN						
Cluff Mining (COGEMA Resources Inc., 100%)	158	151	105	1 039	1 234	1 443
Key Lake JV (Cameco operator)	285	277	260	5 392	3 715	402
Rabbit Lake JV (Cameco, 100%)	287	155	156	4 491	2 705	2 790
McClellan Lake JV (COGEMA Resources Inc. operator)	265	283	258	–	560	2 308
McArthur River JV (Cameco operator)	89	157	225	–	–	3 740
Cigar Lake JV (pre-production)	50	53	22	–	–	–
Total	1 105	1 134	1 026	10 922	8 214	10 683

Sources: Company annual reports; Canadian Nuclear Safety Commission open files.

– Nil.

(1) Figures are for company payroll employees only; on-site contractors (mining, construction, services, etc.) are not included. (2) Primary output only.

TABLE 2. VALUE⁽¹⁾ OF URANIUM SHIPMENTS⁽²⁾ BY PRODUCERS IN CANADA, 1997-2001

	Unit	1997	1998	1999	2000	2001 (p)
Total producer shipments	tU	11 127	9 984	10 157	9 921	12 922
Total value of shipments	\$ millions	554	500	500	485	600

Source: Natural Resources Canada.

(p) Preliminary.

(1) Value of shipments is estimated from an average market price. (2) Shipments in tonnes of uranium (tU), contained in concentrate, from ore-processing plants.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 2000

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	117 005	1.27
McClellan Lake JV (COGEMA Resources Inc.)/ McClellan Lake, Saskatchewan	300	97	81 966	2.90
Rabbit Lake (Cameco Corporation)/ Rabbit Lake, Saskatchewan	1 920	97	216 170	1.33
Key Lake JV (Cameco Corporation)/ Key Lake, Saskatchewan (2)	750	97	186 514	2.37

Sources: Corporate annual reports; Canadian Nuclear Safety Commission open files.

(1) Figures are rounded. (2) All McArthur River ore is processed at Key Lake.

TABLE 4. CANADIAN URANIUM MINING PROJECTS PLANNED FOR PRODUCTION AS OF JUNE 1, 2002

Project, Province or Territory/Operator	Owners Share	Deposit Type/ Discoverer and Discovery Date	Resources (Company Estimates as of May 29, 2002)	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./ Cameco Corporation	Cameco (50.025), COGEMA Resources Inc. (37.100), Idemitsu (7.875), TEPCO (5)	Unconformity-related/ COGEMA Resources Inc., 1981	Overall property 135 000 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 McClean 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 to begin in 2002	670 km N of Saskatoon; 500-m-deep shaft sunk; brine freezing of ground is required to mine the ore; production to begin as early as 2005
Midwest, Sask./ COGEMA Resources Inc.	COGEMA Resources Inc. (54.8), Redstone Resources Inc. (20.7), Tenwest Uranium Ltd. (20), OURD (4.5)	Unconformity-related/ Esso Minerals Canada, 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 McClean Lake; contributing 2300 tU/y	\$80 million co-venture with McClean; 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 Resources Inc. revised EIS; start-up subject to feasibility study
Kiggavik, Nunavut/ Urangesellschaft Canada Limited	Urangesellschaft (79), COGEMA Resources Inc. (20), Daewoo Corporation (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; Centre pit depth 100 m, Main pit 200 m	Open-pit mining methods; mill feed at 1200 t/d; output rate of 1200 tU/y originally expected	EIS submitted but project deemed deficient by Panel; new EIS required before project start-up	75 km W of Baker Lake; start-up not expected in the near future; >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 COGEMA S.A., which is wholly owned by the AREVA Group 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. Redstone Resources Inc. is a subsidiary of Franco-Nevada Mining Corporation Limited. Tenwest Uranium Ltd. is a wholly owned subsidiary of Denison Energy Inc.

TABLE 5. URANIUM EXPLORATION ACTIVITY IN CANADA, 1987-2000

Year	Expenditures (1)	Drilling (2)	Million-Dollar Projects (3)
	(\$ millions)	(km)	(no.)
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
1999	49	89	3
2000	46	77	3

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, 2000, AND JANUARY 1, 2001

Price Ranges Within Which Mineable Ore is Assessed (2)	Measured		Indicated		Inferred	
	1/1/00	1/1/01	1/1/00	1/1/01	1/1/00	1/1/01
	(000 tU)					
Up to C\$50/kgU	201	258	29	20	128	103
C\$50 to \$100/kgU	–	–	39	36	20	20
Total	201	258	68	56	148	123

Source: Natural Resources Canada.

– Nil.

(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 2000/2001 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, 1996-2000

	1996	1997	1998	1999	2000
	(tonnes U)				
Canada (1)	11 750	12 030	10 920	8 210	10 680
Australia	4 970	5 520	4 910	5 980	7 580
China	560	500	500	500	500
France	930	750	510	440	310
Gabon	570	470	730	290	—
Kazakhstan	1 210	1 000	1 270	1 350	1 740
Namibia	2 450	2 900	2 760	2 690	2 710
Niger	3 320	3 500	3 730	2 920	2 900
Russia	2 600	2 000	2 000	2 000	2 000
South Africa	1 440	1 100	990	980	870
Uzbekistan	1 460	1 760	1 930	2 130	2 350
United States	2 430	2 170	1 810	1 810	1 460
Other (2)	2 540	1 990	1 730	1 770	1 860
Total (3)	36 230	35 690	33 790	31 070	34 960

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, and miscellaneous corporate, national and international reports.

— Nil.

(1) Includes refinery/conversion facility by-product prior to 1997; 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⁾ 1978-2001

Year	Average Export Price		Spot Sale Portion of Deliveries
	Current Dollars	Constant 2000 Dollars	
	(\$/kgU) (2)		(%)
1978	125	293	n.r.
1979	130	278	n.r.
1980	135	260	n.r.
1981	110	193	1
1982	113	183	1.5
1983	98	150	10
1984	90	134	26
1985	91	131	20
1986	89	124	21
1987	79	105	35
1988	79	101	13
1989	74	90	<1
1990	71	84	<1
1991	61	70	<2
1992	59	67	<1
1993	50	56	<1
1994	51	56	<1
1995	47	51	2
1996	53.60	57.07	1
1997	51.30	53.97	<1
1998	51.10	53.97	<2
1999	49.10	50.99	<1
2000	47.70	48.20	<1
2001	46.60	46.60	<2

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, 1995-2000

Country of Final Destination	1995	1996	1997	1998	1999	2000
(tonnes of contained uranium(1))						
Argentina	–	–	–	–	–	1
Belgium	3	115	–	–	–	110
Czech Republic	–	–	–	–	–	246
France	1 016	679	587	67	1 819	3 505
Germany	348	776	184	–	–	–
Japan	363	1 490	1 968	1 310	1 116	2 386
South Korea	290	261	315	444	309	172
Spain	186	103	160	–	121	97
Sweden	84	142	450	147	–	–
Taiwan	–	–	–	–	107	26
United Kingdom	188	250	374	345	–	193
United States	5 702	7 407	6 187	5 962	3 674	4 230
Total	8 180	11 223	10 225	8 274	7 146	10 966

Source: Canadian Nuclear Safety Commission.

– 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, 1997-2000

Process and Location (Nameplate Capacity)	Production				Site Work Force			
	1997	1998	1999	2000	1997	1998	1999	2000
	(tU)				(number)			
Refining at Blind River (18 000 tU as UO ₃)	12 195	12 031	11 360	9 605	102	96	98	98
Conversion at Port Hope (12 500 tU as UF ₆ and 2800 tU as UO ₂)	12 594	11 169	11 231	9 327	277	271	272	267

Source: Cameco Corporation.